Expectations and information in the United States, 1982-2011: An empirical examination of inflation forecasting between professionals and households.

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EXPECTATIONS AND INFORMATION IN THE UNITED STATES 1982-2011:

AN EMPIRICAL EXAMINATION OF INFLATION FORECASTING BETWEEN PROFESSIONALS AND HOUSEHOLDS

by

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ABSTRACT

Expectations are a keystone concept in macroeconomics, employed across numerous theories and models. The intention of this thesis is to draw upon the richness of economic debate to explore the manner which economic agents form their expectations regarding inflation. Employing direct measures of expectations reported in prominent surveys published in the United States, this study empirically analyses key differences regarding the utilisation of information across agents. The various chapters within this thesis reconsider the analysis of recent studies and offer new insights regarding information and expectation formation.

The general theme examined in this study concerns differences in expectation formation across agents and macroeconomic conditions; however other issues are also analysed. These include: (i) the consistency of survey inflation forecasts with conventional theories of adaptive and rational expectations; (ii) the impact of household demographics on expectations formation, forecast accuracy and group-specific disagreement; (iii) the presence and class of information rigidities embodied amongst the expectations of both professionals and households.

The main results of this study can be summarised as follows. Firstly, whilst the forecast accuracy of agents is identified to be time-variant, it is shown that neither professionals, nor households, consistently outperform the other agent class in terms of realised forecast errors. Moreover, the aggregate inflation forecasts reported by both professionals and households are not invariably consistent with the predictions of traditional expectation theory; instead, information rigidities appear embodied within the expectations of both agent classes. Household expectations are further disaggregated by demographic characteristics. Across sample periods, 'more advantaged households' are observed to report smaller forecast errors and lower levels of disagreement; these groups are also found to be more attentive to various forms of news. Similarly, the forecasts reported by men exhibit greater accuracy and are updated more frequently than those of women. Limited differences are however observed across age groups and regions.

To summarise, agent expectation formation is time-variant whilst various similarities and differences are observed in the utilisation of information and forecast behaviour between professionals and households.

DECLARATION AND STATEMENTS

DECLARATION

This work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree.

Signed .... (Candidate)

Date 22/03/2015..............................

STATEMENT 1

This thesis is the result of my own investigations, except where otherwise stated. Other sources are acknowledge by footnotes giving explicit references and a bibliography is appended.

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I hereby give consent for my thesis, if accepted, to be available for photocopying and for inter-library loan, and for the title and summary to be made available to outside organisations.

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DEFINITIONS AND ABBREVIATIONS

A1834	Michigan Survey respondents aged 18-34 years.
A3544	Michigan Survey respondents aged 35-44 years.
A4554	Michigan Survey respondents aged 45-54 years.
A5564	Michigan Survey respondents aged 55-64 years.
A6597	Michigan Survey respondents aged 65-97 years.
ADF	Augmented Dickey-Fuller.
AEH	Adaptive expectations hypothesis.
ANOVA	Analysis of variance.
CPI	Consumer price index.
ECB	European Central Bank.
ECB-SPF	ECB Survey of Professional Forecasters
ECD	Michigan Survey respondents with college degree education.
EGS	Michigan Survey respondents with graduate school education.
EHSD	Michigan Survey respondents with high school diploma education.
ELHS	Michigan Survey respondents with less than high school education.
ESC	Michigan Survey respondents with some college education.
FOMC	Federal Open Market Committee..
FRED	Federal Reserve Economic Data.
GLS	Generalized least squares.
GDP	Gross domestic product.
GMM	Generalized method of moments.
HICP	Harmonized index of consumer prices.
IQR	Interquartile range.
IRF	Impulse response function.
MAFE	Mean absolute forecast error.
MAPE	Mean absolute percentage error.
MFE	Mean forecast error.
MS	Aggregate Michigan Survey expectations.
MSFE	Mean square forecast error.
NBER	The National Bureau of Economic Research
NKPC	New Keynesian Phillips curve..
RE	Rational expectations.

REH Rational expectations hypothesis

OLS Ordinary least squares.

RMSFE Root mean square forecast error.

SIPC Sticky information Phillips Curve.

SPF Federal Reserve Bank of Philadelphia Survey of Professional Forecasters.

SSE Sum of squared errors.

US United States.

VAR Vector autoregressive.

Y14 Michigan Survey respondents with household income in bottom 25% (first income quartile).

Y24 Michigan Survey respondents with household income in second 25% (second income quartile).

Y34 Michigan Survey respondents with household income in third 25% (third income quartile).

Y44 Michigan Survey respondents with household income in top 25% (fourth income quartile).

CHAPTER 1: INTRODUCTION

This thesis comprises a collection of essays relating to the manner which economic agents form expectations. Utilising survey data from the United States over a period of approximately thirty years, the main objective is to establish differences between the manner which professionals form expectations relative to those formed by households. Drawing upon recent contributions, this study considers whether survey expectations are consistent with the predictions of various theories proposed by economists, and analyses the manner which agents acquire and process information.

Expectations are keystone economic variables, widely employed in macroeconomic modelling, and are defined by Pesaran (1987:14) as "attitudes, dispositions or psychological states of mind' that relate to events the outcomes of which are uncertain." The uncertainty associated with the future dictates that agents need form expectations to allow for appropriate decision making. Moreover, Evans and Honkapohja (2001) highlight that the formation of appropriate expectations are critical to the time-path of the economy which subsequently exerts a feedback effect upon the formation of future expectations.

The role of expectations within macroeconomics has been long emphasised by the literature; whilst classical economists assumed that expectations were exogenously determined, with variables taken to be known with some degree of certainty, the behaviour of firms was identified by Keynes (1936) to be dependent upon forward-looking expectations. Various approaches to the mathematical modelling of expectations have subsequently been proposed by economists including the adaptive expectations hypothesis advocated by Cagan (1956), Friedman (1957) and Nerlove (1958), and the influential rational expectations hypothesis of Muth (1961). In recent years, interest in expectation modelling has been renewed with models of adaptive learning[1], predictor choice (Brock and Hommes, 1997, Branch, 2007), sticky information (Mankiw and Reis, 2002, 2007, Mankiw et al., 2003, Coibion and Gorodnichenko, 2010, 2012) and rational inattentiveness (Sims, 2003, 2006) being developed.

[1] Evans and Honkapohja (2001) provide a detailed survey of expectational learning mechanisms.

Expectations are also of critical importance for numerous macroeconomic relationships, including the Phillips Curve relationship between output and unemployment, and stabilisation policy. The trade-off between inflation and unemployment was formally presented by Phillips (1958), whilst Phelps (1967) and Friedman (1968) develop an expectations-augmented approach, proposing that agents are able to interpret the effect of inflation upon real wages. The resulting reduction in unemployment following an increase in inflation can thus only be maintained in the short-run. In the presence of rational expectations, agent expectations are immediately able to incorporate the effect of policy upon macroeconomic variables, thus leading to an increase in inflation with no change in unemployment. Furthermore, the theory of rational expectations is key to the neutrality or policy ineffectiveness debate as proposed by Lucas (1972), Sargent (1973) and Sargent and Wallace (1975), which ultimately implies that monetary policy will be ineffective as agents are able to correctly forecast systematic changes in policy.

Expectations are therefore central to economic theory; however, there is little consensus regarding the manner in which agents form their expectations. The conclusions from previous empirical studies concerning traditional theories of expectation formation are dependent upon the sample period analysed and the assumptions concerning the available information set. A key focus of this study, in accordance with recent contributions in macroeconomics, concerns the assumption that the formation of expectations is costly. Consequently, agents must consider the relative costs of acquiring and processing relevant information, and the associated improvements in forecast accuracy, against the opportunity costs of inattentiveness. Mitigating the informational assumptions of rational expectations, models of information delay and rigidity have provided interesting insights regarding the formation of agent expectations. There is however some debate concerning whether models of noisy information, as proposed by Sims (2003, 2006), Woodford (2003) and Maćkowiak and Wiederholt (2009, 2010), or those of sticky information, advocated by Mankiw and Reis (2003, 2007), Carroll (2003, 2006), Lanne et al. (2009) and Nunes (2009) are best able to accommodate the evolution of agent forecasts.

The main objective of this study is to contribute to the understanding of expectational differences between professionals and households, and determine whether demographic backgrounds impact on the behaviour of expectation formation amongst households. Furthermore, acknowledging that expectation formation and the utilisation of information may vary overtime, and in response to changes in macroeconomic conditions, this study shall consider distinct sample periods to determine whether the observed relationships are time-variant. Utilising survey data various models of expectation formation shall be empirically examined; the use of survey data is relevant for empirical analysis with Ang, Bekaert and Wei (2007) reporting that survey inflation forecasts outperform those generated from time-series or Phillips Curve models.

Chapter 2 considers direct measures of expectations, introducing the Survey of Professional Forecasters (SPF) compiled by the Federal Reserve Bank of Philadelphia and the Thomson Reuters/University of Michigan Survey of Consumers (Michigan Survey). Moreover, elementary differences between the expectations reported by professionals and households are identified, whilst the issues of employing survey forecasts in modelling the expectation formation process of agents are discussed. Extending the analysis of Chapter 2, aggregate survey forecasts are empirically analysed in Chapter 3 to determine whether agent expectations are consistent with the assumptions of traditional theories. Tests of both backward-looking adaptive expectations, and the forward-looking rational expectations hypothesis, shall be appraised and empirically examined.

Whilst Chapter 2 and Chapter 3 utilise consensus survey forecasts, in line with Jonung (1981), Bryan and Venkatu (2001a, 2001b), Mankiw, Reis and Wolfers (2003), Souleles (2004) and Pfajfar and Santoro (2008, 2010), Chapter 4 acknowledges that agent expectations are not homogeneous across individuals. Utilising disaggregate Michigan Survey inflation expectations, forecast behaviour is found to be dependent upon demographics with past inflation experiences, the observation of specific prices, and the interpretation of survey questions, impacting upon the reported inflation forecasts of households. The empirical analysis in Chapter 3 considers both asymmetries across demographic disaggregations, and the cross-sectional disagreement within individual groups. Moreover, in a similar manner to Lamla and Lein (2008), Easaw and Ghoshray (2010), Lamla and Maag

(2012) and Pfajfar and Santoro (2013), the impact of news on the level of cross-sectional disagreement is examined.

In response to traditional expectation theory being unable to replicate the observed dynamics of economic variables, the economic literature has devoted attention to models which mitigate the issues and limitations of standard approaches. In Chapter 5, the analysis considers an intriguing contribution to expectation formation, namely sticky information, as proposed by Mankiw and Reis (2002). The concept of sticky information is centred upon the premise that in each period only a proportion of agents update their information; news thus slowly diffuses across the population, resulting in a delayed response in aggregate behaviour to economic innovations. Whilst those agents with the latest information form expectations consistent with RE, the remainder formulate current expectations utilising outdated information.

Microfoundations for Mankiw and Reis's (2002) sticky information model are presented by Carroll (2003, 2006) within an epidemiological framework, proposing that agents infrequently absorb inflation forecasts reported by the news media, which themselves reflect the 'rational' forecast reported by professionals. To determine whether the updating frequency estimated by Carroll (2003) is time-variant and sensitive to household demographics, the survey-updating model shall be analysed for disaggregate expectations across various sample periods. Alternatives to Carroll's (2003) survey-updating model, namely the naïve sticky information approach presented by Lanne, Luoma and Luoto (2009), and the rational-updating model proposed by Nunes (2009) shall also be reassessed for both aggregate and disaggregate expectations over the various sample periods, to determine whether households exhibit heterogeneous updating behaviour.

Following recent work by Coibion and Gorodnichenko (2010, 2012), Andrade and Le Bihan (2010), Clements (2012), and Dovern et al. (2012, 2013) Chapter 6 analyses whether professional forecasts are characterised by information rigidities. Exploiting the multi-horizon structure of the SPF, the analysis shall consider whether revisions to fixed-event forecasts, updates to fixed-horizon forecasts, and disagreement amongst professionals, are consistent with the predictions of both sticky information and noisy information models.

The final chapter provides some concluding remarks regarding the observations and contribution of this work to the literature regarding macroeconomic expectation formation and further considers directions for future research.

CHAPTER 2: INFLATION EXPECTATIONS AND FORECAST PROPERTIES – AN INTRODUCTION AND PRELIMINARY EXAMINATION

The introduction identified that expectations are keystone macroeconomic variables. Focusing on inflation, specifically CPI, the purpose of this study, to empirically examine the manner which professionals and households acquire and process information to form their expectations, has also been introduced. To achieve this objective, inflation expectations of both professionals and households shall be empirically examined; this chapter shall introduce the data series to be employed throughout this study and commences the empirical investigations, evaluating a variety of elementary forecast performance measures.

Despite the extensive development of expectation models and their theoretical importance throughout macroeconomics, investigations concerning direct tests of actual empirical data have been limited. Over the past decade there has however been some renewed interest with Thomas (1999) and Mankiw et al. (2003) evaluating forecast performance whilst Carroll (2003, 2006), Branch (2004, 2007) and Coibion and Gorodnichenko (2010, 2012) have empirically examined specific theories of expectation formation. This study attempts to evaluate the results of existing studies and extend the analysis by empirically examining the appropriateness of several key developments and a range of models concerning the formation of macroeconomic expectations.

That expectations are unobservable is a common problem concerning direct empirical tests; indeed, it is not possible to collect subjective expectations for the entire population. One method of evaluating expectations is to solve an economic model where expectations are explicit variables with certain assumptions; this method was popular amongst RE models (Berk, 1999). However, Berk (1999) highlights that empirical analysis utilising this approach is limited as expectations are observed indirectly and are conditional upon the assumptions of the model.

An alternative, and the preferred option of this study, is to use more direct sources of information concerning agent expectations. There are a number of surveys that consider price or inflation expectations for various populations and economies including the Livingston Survey of Professional Economists, the ECB Survey of

Professional Forecasters and the recently established Federal Reserve Bank of New York Survey of Consumer Expectations. For direct comparability with previous empirical studies regarding expectations, this study shall focus upon household expectations from the University of Michigan Survey of Consumers (Michigan Survey), and professional expectations from the US Survey of Professional Forecasters (SPF). These series have been frequently employed by empirical economists and are generally considered a credible basis to measure agent beliefs.

Although survey data is not without its own issues[2], they are preferred for this study as they are publicly available and not dependent upon model assumptions, cover a wide variety of agent classes and allow for direct comparability with the increasingly wide literature concerning expectations. One notable issue concerns measures of central tendency. Both mean and median expectations are widely employed by empirical economists. Whilst the mean is useful to establish the arithmetic average or consensus expectation of the population it is not a robust statistic where expectations are not normally distributed or exhibit skewness. Furthermore, the median is more robust to outliers and may provide a superior measure of the actions of the representative agent, particularly where the expectations distribution is skewed. Moreover, median survey responses are often noted to appear to track the realised inflation series more closely[3] (Pfajfar and Santoro, 2008, Meyer and Venkatu, 2011). This shall be re-evaluated for both professional and household expectations for the sample period employed throughout this study.

The next section of this chapter provides a discussion regarding the various data series employed in this work, identifying various benefits and limitations which may affect the empirical understanding of the manner which agents form expectations. Furthermore the sample period, and various sub-periods, to be employed in the following empirical examination shall be established. Next, we utilise basic forecast comparison techniques to consider whether the forecasts of households are fundamentally different to those of professionals and whether this relationship is time-variant. The final section of this chapter evaluates the key differences between

[2] The issues with survey data shall be explored in more detail in 2.1.3.

[3] However, Pfajfar and Santoro (2008) find that over highly inflationary periods, mean expectations appear to track the evolution of inflation comparatively better than the median.

the expectations of households and professionals and discusses alternative theories of expectations which shall be explored later.

2.1 Introducing Data for Empirical Analysis

The key objectives of this study relate to the evaluation of the relative performance of professional and household forecasts, examining whether these forecasts are consistent with the assumptions and predictions of conventional expectation theory, and identifying whether these relationships are time-variant. These issues are of an empirical nature thus requiring the identification of data sources suitable for hypothesis testing.

This section introduces the various data series which shall be employed in the empirical analysis of this study, namely inflation, and professional and household inflation forecasts. Specifically, this section considers the various alternative series which are available and presents some elementary statistics regarding their evolution over the four sample periods. The final section provides a discussion of the issues with employing survey expectations in empirical analyses, considering the effect of cross-sectional heterogeneity and disagreement amongst participants, and the effect of the wording of questions in influencing reported forecasts.

2.1.1. Inflation

Economists consider inflation, defined as the general rate of price increases throughout the economy, to be a concept of critical importance. Moreover, inflation is essential for many theoretical models whilst inflation dynamics influence the behaviour of business cycles and the conduct of monetary policy (Galí and Gertler, 1999). The two most prominent measures of inflation considered by economists concern the consumer price index (CPI) and the GDP deflator

The BLS defines the Consumer Price Index as "a measure of the average change over time in the prices paid by urban consumers for a market basket of consumer goods and services" (stats.bls.gov). To calculate the CPI the BLS assigns a weight to each item contained within the market basket based upon total family expenditure. In contrast, the GDP deflator measures the price level across all goods and services across the economy. Specifically, the GDP deflator analyses the ratio of nominal GDP to real GDP and can be formally calculated as:

$$GDP\ Deflator = \frac{Nominal\ GDP}{Real\ GDP} \times 100 \qquad (2.1.1)$$

Nominal GDP relates to aggregate output at current prices whereas real GDP is defined as aggregate output measured at a constant base year price level. As the GDP deflator does not depend upon a market basket of goods[4] it thus automatically responds to changes in the composition of output. In contrast, to ensure that the CPI is representative of consumer spending patterns, intermittent revisions to the market basket are essential. In the event of infrequent reweightings, the CPI market basket in any particular period may be outdated, failing to include innovations to consumer spending behaviour; in contrast, the GDP deflator is constructed in a manner that reveals changes and new expenditure patterns. Nevertheless, the CPI is considered the most prominent measure of inflation published by the media and amongst the wider public.

The economic literature has naturally considered the various inflation measures and associated expectations and forecast errors: the GDP deflator is used by Galí and Gertler (1999), Romer and Romer (2000), Croushore (2010) and Coibion and Gorodnichenko (2012). Meanwhile, Roberts (1997), Ang et al. (2007) and Stock

[4] The basket of the GDP deflator consists of all domestically produced goods and services.

and Watson (2010) consider personal consumption expenditure (PCE) inflation. Whilst the GDP deflator indicates the proportion of nominal GDP growth attributable to price rises, the PCE aims to capture changes in prices of goods and services paid by consumers, much like CPI. Both the GDP deflator and PCE have much broader scope than CPI. Whilst the CPI considers the prices of commodities, including imported goods, purchased by (urban) consumers, the GDP deflator considers total domestic production. This is inclusive of economic activity by the rural, investment and government sectors which are excluded from (urban) CPI calculations. In addition to consumer expenditure captured by CPI, the PCE includes spending by non-profit and religious institutions, government agencies including Medicare and Medicaid, and also includes financial services and insurance programs with no identifiable market price (Clark, 1999, Hakkio, 2008). The PCE also omits noisy disturbances associated with energy price fluctuations (Stock and Watson, 2010).

Despite the availability of several viable alternatives, the inflation measure employed throughout this study shall be CPI. Consistency with a large number of previous studies is thus maintained. There are also several other advantages. Unlike other measures, CPI is not revised (Roberts, 1997). The inflation series for empirical analysis is therefore consistent with the information available for the formation of agent expectations; forecast errors can thus be calculated unambiguously and allows for a coherent analysis. Nevertheless, Roberts (1997) advocates the PCE as a superior approximation of the cost of living, whilst Ang et al. (2007) highlight that in conducting monetary policy, this measure is the Federal Reserve's preferred indicator of inflation. In forecasting inflation however, Ang et al. (2007) observe larger RMSE's amongst PCE survey expectations in comparison to ARMA(1,1) models. Contrastingly, CPI survey expectations do not exhibit this characteristic.

Furthermore, whilst data concerning CPI is available from the BLS since 1913, PCE inflation data has only been publicly available since 1992 (Roberts, 1997). Therefore, information regarding this measure of inflation index was not readily available for the first ten years of this study[5]. Consequently, the timeframe for which PCE forecasts are available is considerably shorter than for alternative inflation

[5] Although not published until 1992, quarterly data concerning the PCE dating back to 1947Q2 is available from the US Bureau of Economic Analysis.

measures. Whereas the SPF first began including CPI inflation forecasts in the third quarter of 1981, PCE expectations have only been published since 2007Q1. Forecasts for the GNP/GDP price index have been available from the SPF since its inception in 1968, however, the target variable has changed over time. Since 1996, the series considers forecasts for the GDP price index, yet prior to 1992, expectations concerned the GNP deflator whilst for 1992-1996, expectations considered the GDP implicit deflator. Changes to the target variable would likely result in distinct and systematic breaks in the manner which expectations are formed. Consequently, analysis will have to determine whether changes to expectations are purely due to the different measure of inflation forecasted or some other underlying factor relating to the wider macro-economy[6]. This is particularly noteworthy as the question relating to inflation expectations in the Michigan Survey does not explicitly specify any individual inflation measure to focus consumer expectations. It is primarily for this reason that CPI shall be the prominent inflation measure employed throughout this study.

Some caution needs to be exercised in evaluating CPI prior to 1983 as interest rates, which influence homeownership costs, were included in determining the value of inflation (Romer and Romer, 2000). As this study focuses upon expectations rather than alternative relationships concerning monetary policy for example, the inclusion of interest rates under CPI is unlikely to have a substantial role in the forthcoming analysis, particularly as the composition of the consumption basket is subject to intermittent adaptions. Nevertheless, this does impose an additional degree of interpretation upon agents in a similar manner to that reported by Bruine de Bruin et al. (2010b, 2010c). Moreover, the representative market basket employed for calculating CPI is argued by Roberts (1997) to be frequently out of date. Disparities between expectations and realised inflation values may consequently be magnified.

Furthermore, Bryan and Cecchetti (1993) highlight the presence of both measurement and weighting biases which are detrimental to the accuracy of CPI. The measurement bias potentially arises from transitory noise relating to specific economic sectors resulting in the inaccurate recording of individual prices. The weighting bias is more systematic. The relevance of CPI relative to consumption

[6] Moreover, interesting empirical results may arise from considering whether the change in the target variable alters the manner which agents form expectations. This is left for future investigation.

behaviour is maintained through intermittent updating. However, this process results in the attachment of inappropriate weightings to individual commodities. Whilst changes in consumer preferences may result in excessive weights being attached to included commodities, insufficient weight may be attached to others resulting from technological innovation. It would thus be interesting to determine whether agent expectations are able to appropriately respond to amendments to the consumption basket in a timely manner. Moreover, the immediate periods following the exclusion of interest rates may be of particular interest. These issues are however beyond the scope of this study.

Considering the advantages and limitations of these inflation measures, the CPI has been adjudged to be the most suitable for the empirical investigations of this study. Specifically, the CPI-U compiled by the BLS shall be employed as the measure of inflation in this study. This accounts for 80-90% of urban consumers in the US including wage earners, self-employed, unemployed, retirees and labour market non-participants. Furthermore, the CPI-U is the most widely reported inflation statistic by the media and is calculated from a basket of goods which is representative of the purchases of a typical American consumer living in an urban area.

Prior to evaluating expectations, the behaviour of inflation shall first be considered. As biases are embodied within CPI, alternative measures of inflation have been considered by the economic literature; CPI shall thus be compared to the GDP deflator (GDPD) which is frequently employed by economists in empirical analysis. Utilising a sample period consisting of quarterly inflation observations for 1982Q3 – 2011Q1 inclusive[7], Table 2.1.1 reports some elementary statistics of inflation whilst Figure 2.1.1 graphically illustrates the behaviour of both inflation measures:

Table 2.1.1: Inflation Statistics (1982Q3 – 2011Q1)

	CPI	**GDP Deflator**
Mean	2.994	2.491
Maximum	6.221	6.047
Minimum	-1.623	0.216
Std. Dev.	1.285	0.984

[7] The choice of sample period is dictated by the availability of survey data and shall be discussed in relation to the SPF and Michigan Survey in 2.1.1 and 2.1.2 respectively.

Figure 2.1.1: U.S. Inflation Rate (1982Q3 – 2011Q1)

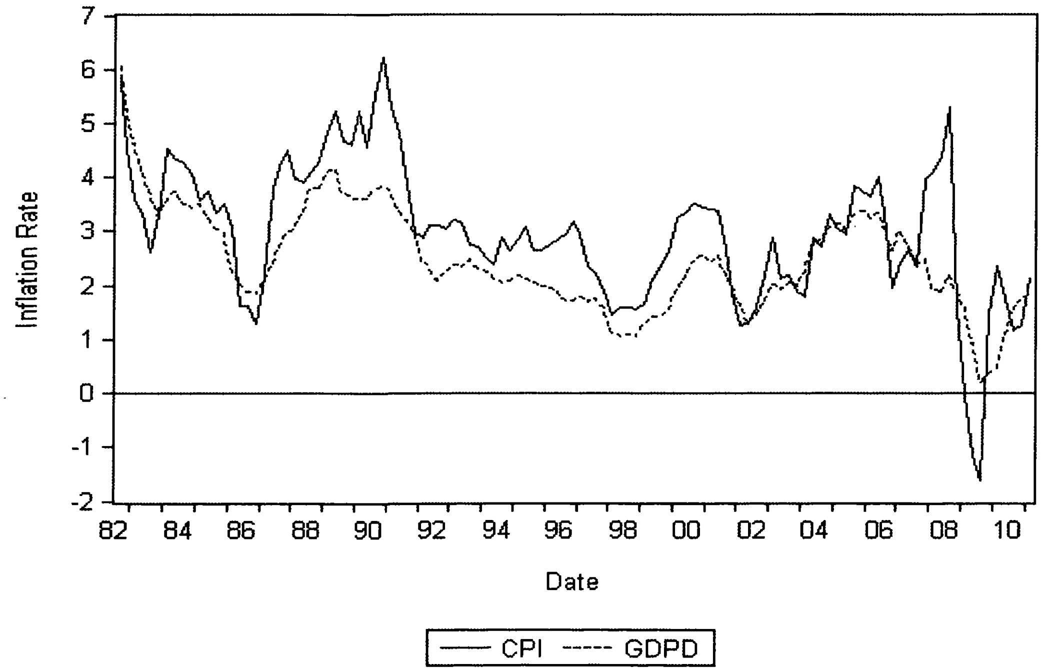


Figure 2.1.1 and Table 2.1.1 illustrate that both measures of inflation have varied dramatically over the sample period and unsurprisingly exhibit similar trends with the difference generally small. During the 1980's and from 2006 to the end of the sample inflation appears particularly volatile, with the latter period coinciding with the onset of the recent financial crisis and subsequent recession[8]. In contrast, inflation from the early 1990's to the mid-2000's appears more stable and lies within the 1% to 4% range. Furthermore, the range and standard deviation of CPI is larger than that associated with the GDP deflator indicating greater volatility within the former.

These observations prompt a disaggregation of the sample to analyse the behaviour of inflation and associated expectations over distinct macroeconomic environments in a similar manner to Thomas (1999) and Pfajfar and Santoro (2010). Identifying a structural break in the inflation process and associated expectations between pre- and post-1988, Pfajfar and Santoro (2010) split their sample period into two, with the earlier sub-sample accommodating the high inflation and subsequent disinflation of the late 1970's and early 1980's. In a similar manner, this study shall consider a

[8] Although the financial crisis did not become acute until the second half of 2007, for example large increases in money market interest rates arising in August 2007, economic conditions in the U.S. began to deteriorate approximately a year earlier for example the fall in house prices and associated increase in housing delinquencies commencing in mid-2006 (Taylor, 2009).

sample period comprising 1987Q2-2011Q1 which shall remove the period of Volcker chairmanship of the Federal Reserve, often associated with disinflation, from the whole sample period. This sub-period shall be classified as the Greenspan-Bernanke period referring to the chairmen of the Federal Reserve over this sub-period.

Nevertheless, inflation and associated expectations and forecast errors may be subject to significant skewness over the Greenspan-Bernanke sub-period. This arises from two periods of distinct macroeconomic volatility. The first is associated with the 1987 'Black Monday' stock market crash and subsequent recession; whilst the second concerns the recent period of macroeconomic uncertainty associated with the late 2000's global financial crisis. Therefore, two further sub-sample periods shall be investigated: the period 1990Q1-2006Q2 shall be identified as the stable sub-period whilst 2006Q3-2011Q1 shall be referred to as the volatile sub-period.

Table 2.1.2 below re-evaluates the summary statistics of inflation presented in Table 2.1.1 for the three sub-periods identified above:

Table 2.1.2: Inflation Statistics (Sub-Sample Periods)

	CPI			GDP Deflator		
	G-B	**Stable**	**Volatile**	**G-B**	**Stable**	**Volatile**
Mean	2.916	2.915	2.076	2.314	2.282	1.785
Maximum	6.224	6.224	5.303	4.175	3.838	3.083
Minimum	-1.623	1.252	-1.623	0.216	1.063	0.216
Std. Dev.	1.303	1.011	1.769	0.857	0.723	0.867

The elementary statistics presented above indicate that despite the exclusion of the deflationary Volcker period, both mean CPI and GDP deflator inflation rate remain substantially unchanged. In fact, CPI is slightly more variable during the Greenspan-Bernanke sub-period than for the whole sample period. Moreover, inflation is least dispersed for the stable period despite little change in mean CPI in comparison to either the whole or Greenspan-Bernanke periods. Despite macroeconomic uncertainty arising from the Global financial crisis, mean inflation is lower for the volatile sub-period in comparison to the other three sample periods. For CPI, this can be partly explained by three quarters of deflation occurring between 2009Q1-2009Q3, whilst the GDP deflator falls from 3.083 in 2006Q3 to 0.216 in 2009Q3 and remains low until the end of the sample. Nevertheless, the standard deviations of both inflation measures for the volatile sub-period are relatively large indicating greater inflation variability in comparison to the stable sub-period. This could consequently contribute to agents realising greater forecast errors, an issue that shall be returned to in empirical investigations to follow.

Over the sample the properties of inflation have been found to be changeable with distinct periods of greater stability and volatility being identified. Variation in inflation is likely to influence the formation and accuracy of expectations. Prior to formal empirical testing of expectation theory, the SPF and Michigan Survey shall be formally introduced including a brief examination of their respective inflation forecasts.

2.1.1 Professional Forecasts – An Introduction to the Survey of Professional Forecasters

Professional forecasts are extensively employed by macroeconomists for empirical analysis of expectations and provide a reliable measure of informed opinion from experts with sufficient knowledge and experience regarding economic conditions (Croushore, 1993). In obtaining professional expectations from the U.S. suitable for empirical analysis, three alternative candidates are considered: the Livingston Survey of Professional Economists, Consensus Economics and the Survey of Professional Forecasters (SPF), with the latter deemed the most appropriate[9].

Although the Livingston Survey shall be referred to intermittently, particularly with reference to previous studies, formal analysis of professional expectations shall be entirely conducted upon the SPF. Promising results concerning the Consensus Economics series have emerged, with Dovern and Weisser (2011) concluding that inflation forecasts are generally unbiased and efficient, the data comprises a shorter time span than the SPF. Furthermore, utilising the SPF shall also maintain compatibility with the quarterly Michigan Survey data and to allow for direct comparisons with a number of key studies in the ensuing analysis.

The SPF requires professional forecasters to provide predictions of a number of economic variables for six different horizons: the previous quarter, the current quarter and for the following four quarters ahead. As the forecast for the previous quarter is formed following the publication of actual data for that quarter[10] forecasts are found to be broadly accurate (Manzan, 2011). In Figure 2.1.2, professional expectations of period t inflation formed in period $t-4$ (SPF(-4)) are illustrated against the actual rate of inflation (CPI), whilst Table 2.1.3 presents summary statistics for SPF inflation forecasts:

[9] Appendix 2.2 discusses these alternative surveys of professional expectations.
[10] The data available concerns the first release and is therefore subject to revisions.

Figure 2.1.2: Actual Inflation and Expectations of Professionals

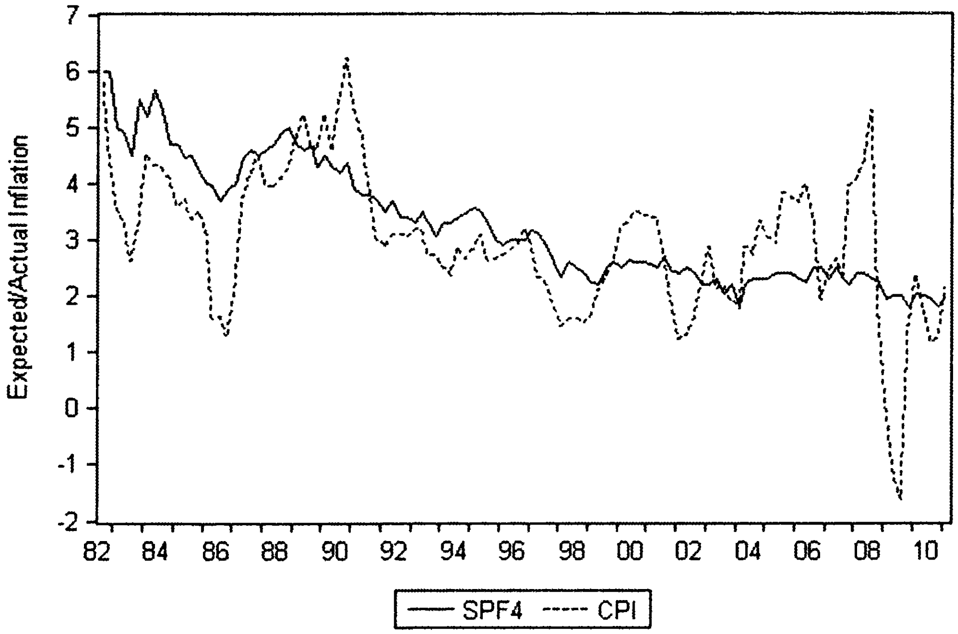


Table 2.1.3: Professional Inflation Forecasts – Elementary Statistics

	WHOLE	G-B	STABLE	VOLATILE
Mean	3.246	2.949	2.894	2.166
Maximum	6.000	5.000	4.500	2.500
Minimum	1.800	1.800	1.800	1.800
Std. Dev.	1.072	0.863	0.635	0.234

Table 2.1.3 indicates that over the past thirty years, professional inflation forecasts have tracked inflation reasonably well. Nevertheless, substantial deviations from inflation are observed during the early and mid-1980's and from the mid-2000's to the end of the sample[11]. Whilst the latter can be attributed to recent years of macroeconomic uncertainty during the volatile period identified in 2.1.1, Pfajfar and Santoro (2013) identify the earlier period with a lack of Federal Reserve credibility which was only gradually restored under the chairmanship of Paul Volcker. From Table 2.1.3 it is also possible to reconcile Pfajfar and Santoro's (2013) observation that expectations appear anchored from the early 1990's to the end of the sample; this is despite greater inflation volatility, as previously observed in Table 2.1.1.

The standard deviation of professional forecasts is also much lower than that associated with inflation itself, indicating that expectations tend to under predict fluctuations in actual inflation. Moreover, SPF forecasts do not appear sensitive to

[11] The properties of forecast errors realised by professionals shall be investigated in 2.2.2.

short-run inflation volatility; instead expectations appear to evolve slowly, in accordance with shifts to permanent inflation innovations. Indeed, from Table 2.1.3, the standard deviation of SPF CPI forecasts for the volatile sub-period is small indicating that forecasts are tightly dispersed around the mean despite large fluctuations in inflation consistent with transitory shocks.

The presence of the professional forecaster introduces several interesting questions regarding their evaluation of macroeconomic outcomes. At an elementary level, it shall be intriguing to determine whether the expectations of professionals outperform those of households or consumers in terms of accuracy and forecast errors. Furthermore, it shall be interesting to analyse whether professional forecasts are more consistent with conventional expectation theory. In addition, expectations may have some other role in influencing macroeconomic developments, depending upon their intended purpose and how they are employed and disseminated. A potential role of professional forecasts is to act as a focal point, informing households about future economic conditions and aligning their expectations appropriately (Ottaviani and Sørensen, 2006). The sensitivity of household expectations to the arrival of new information and macroeconomic disturbances is thus reduced, which in turn reduces the volatility of the forecasted variable (Bernanke, 2007, Beechey et al., 2011). The epidemiological model presented by Carroll (2003, 2006) is formulated upon the notion that information contained within professional forecasts slowly disseminates throughout the population; similarly, Easaw et al. (2011) present empirical evidence indicating that in the long-run, household expectations adjust in response to professional forecasts. Later chapters shall extensively examine these concepts in relation to information rigidity theories and models.

The use of professional forecasters should provide a series of expectations for empirical analysis with superior properties compared to those of households. Notably, in analysing epidemiological expectations, Carroll (2003) concludes that the SPF is more rational than Michigan Survey forecasts, allowing households to update towards the professional forecast. Professional expectations are however expected to exhibit a degree of inaccuracy. An objective of this study is to determine the manner which professional expectations are formed, the extent which they are erroneous in comparison to those of households and establish the efficiency with which expectations exploit available information.

2.1.2 Household Expectations – An Introduction to the Michigan Survey of Consumers

Although often considered an important indicator of future macroeconomic innovations, it can be argued that professional expectations are of lesser importance than those formed by private sector agents; indeed, Leung (2009) argues that the behaviour of household expectations provide an indication of the stability of the economy. Not only is the consumer population substantially larger than the number of professionals; in many macroeconomic theories and applications, the response of public expectations have a determining impact upon aggregate outcomes. It was identified in 2.1.1 however, that professional expectations may have some role in informing private sector opinion and aligning their expectations; analysis of this issue shall be the focus of later chapters. Firstly, a sample of expectations formed by private sector agents needs to be identified and analysed to determine the manner which non-professionals forecast inflation.

For compatibility with SPF data, and for comparability with several key studies (Thomas, 1999, Carroll, 2003, Mankiw et al., 2003, Coibion and Gorodnichenko, 2010), the subjective household expectations series employed throughout this study shall refer to those from the Michigan Survey[12]. One of the main advantages of the Michigan Survey over other surveys such as the Livingston survey, as identified by Branch (2004), is that it considers the expectations of households in preference to professionals. However, given the diverse nature of households across many demographic characteristics including age, gender, education and income, the distribution of expectations is likely to be wide which often results in distortions to some measures of central tendency including the mean. Indeed, that there are greater disparities between household expectations corresponds with conventional theory that a proportion of non-professionals produce less efficient forecasts (Branch, 2004) Nevertheless, as detailed in the following analysis, the Michigan Survey is often found to track the level of inflation reasonably well: in fact, it is often observed that median responses from the Michigan Survey outperform the forecasts of professionals (Bruine de Bruin et al., 2011b).

[12] The composition of Michigan Survey forecasters and the methodology employed to obtain household forecasts is discussed in Appendix 2.1.

There are substantial differences in the manner which the Michigan Survey obtains quarterly inflation expectations from households in comparison to the methodology employed by the SPF for professional expectations. SPF participants provide quantitative expectations to a mailed questionnaire for four specific measures of inflation for the current and four successive quarters[13]. Michigan Survey expectations can be considered more ambiguous as a given measure of inflation is not specified[14]. Moreover, many of the questions posed by the Michigan Survey have a generally qualitative nature[15]. Namely, rather than providing an exact value, households instead indicate whether they believe personal and general economic conditions will improve or worsen[16]. The procedure to extract inflation expectations does however have both a qualitative and quantitative component. The qualitative component precedes the quantitative component and verifies that the numerical forecast provided by the respondent is an accurate reflection of their expectation of future price behaviour. The presence of the quantitative component allows for direct empirical testing on consumer inflation forecasts and enhances the understanding of the formation of private sector inflation expectations.

As previously alluded to, empirical investigations to expectations often conclude that household expectations are superior to those formed by professionals (Thomas, 1999, Mehra, 2002, Mankiw et al., 2003). This shall be investigated in due course. Firstly, in Figure 2.1.3, household expectations of period t inflation formed in period $t-4$ (MS(-4)) are illustrated against the actual rate of inflation (CPI) with key elementary statistics presented in Table 2.1.4:

[13] See Appendix 2.1 for an example of a questionnaire mailed to SPF participants.
[14] It was noted in 2.1.1 that as information concerning CPI is most prominently available, expectations shall be analysed with respect to this inflation measure.
[15] As this methodology has been widely adopted by alternative surveys, Pesaran and Weale (2006) argue that it is evident that an advantage exists in obtaining qualitative responses and a trade-off exists between the precision provided by quantitative responses and the increased accuracy and reduced ambiguity provided by qualitative methods.
[16] See Appendix 2.1 for details regarding the procedure conducted by the Michigan Survey to obtain household inflation expectations.

Figure 2.1.3: Actual Inflation and Expectations of Households

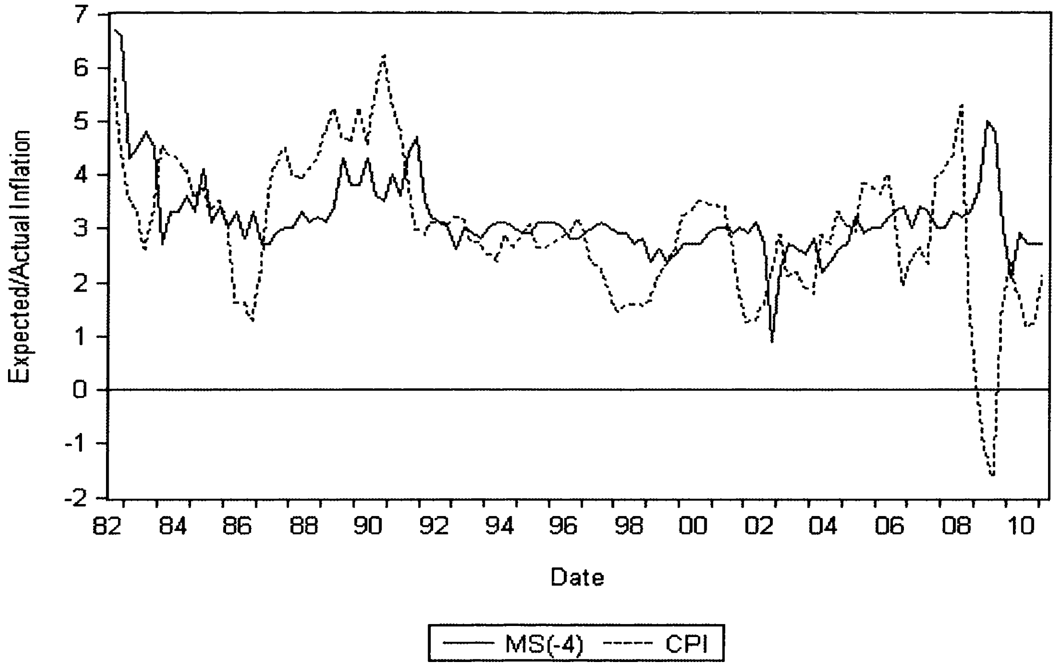


Table 2.1.4: Household Inflation Forecasts – Elementary Statistics

	WHOLE	G-B	STABLE	VOLATILE
Mean	3.103	3.063	2.933	3.211
Maximum	5.000	5.000	4.700	5.000
Minimum	0.900	0.900	0.900	2.100
Std. Dev.	0.578	0.570	0.488	0.711

Figure 2.1.3 indicates that household expectations have tracked inflation reasonably well over the past thirty years. Substantial deviations are however noted during the period of rising inflation during the late 1980's and for the recent period of greater macroeconomic uncertainty. In contrast to professionals, household expectations do not appear as well anchored, particularly during the recent volatile period with the standard deviation increasing as shown in Table 2.1.4; instead, household expectations appear to respond to realised values of inflation with forecasts appearing to lag inflation. The effect is evident across the whole and all three sub-periods.

From Figure 2.1.3, there are several episodes which appear to emphasise this point including the increase and subsequent fall in inflation in the early 1990's and during the volatile sub-period between 2007Q3 and 2009Q1. Furthermore, between

2001Q2 and 2002Q1, CPI falls from 3.38 percent to 1.25 percent, yet Michigan Survey forecast appear not to anticipate this; instead, households appear to incorporate the increase in inflation into future forecasts. Specifically Michigan Survey forecasts made between 2001Q2 and 2001Q4 for inflation four quarters later fall from 3.1 percent to 0.9 percent, approximately matching the fall in inflation observed over this period. Therefore, it appears that the direction of current inflation is a strong predictor of the future path of household expectations.

Furthermore, Michigan Survey forecasts also appear more sensitive to transitory shocks than professional forecasts; for the volatile sub-period, the standard deviation for household forecasts from Table 2.1.4 is much larger than that presented in Table 2.1.3 for professional forecasts. Nevertheless, the standard deviation associated with inflation, observed in Table 2.1.1, remains substantially greater indicating that households may fail to appropriately accommodate the variable nature of inflation into reported forecasts. Despite this, for the period of increased stability during the 1990's, household expectations appear relatively constant at approximately 3 percent[17]; yet following the stock market crash of 2000-2002 household expectations exhibit greater variation. Unlike professional forecasts which appear to remain fairly constant throughout the latter half of the sample, household expectations exhibit a rapid increase in mid to late 2002 and a sharp increase followed by a sharp fall in 2009, further suggesting that household forecasts are sensitive to transitory shocks.

Household expectations are extensively employed throughout economics and are useful in determining the manner which consumers make their economic decisions which in turn are essential for macroeconomic dynamics. Despite the issues highlighted regarding the Michigan Survey, this unique dataset shall enable analysis of pre-existing expectation theories and shall provide an indication to the manner in which consumers respond to information. Comparisons with the SPF may also be drawn to determine whether consumers exhibit a degree of sophistication in their forecasting techniques more accustomed to professionals.

[17] There may exist some focal point for expectations. It is not conjectured as to what the focal point may in fact be although a number of alternatives can be suggested including professional forecasts, an implicit inflation target, the actual inflation rate or consistent rises in the rate of individual commodities.

2.1.3 Issues with Survey Expectations

As discussed, throughout this study, empirical analysis shall be conducted upon forecasts sourced from surveys, namely the SPF and Michigan Survey. These surveys publish various statistics regarding agent expectations including individual responses and interquartile ranges. The expectations of individual respondents are used by several studies, notably the percentile time series approach employed by Pfajfar and Santoro (2008); however, in accordance with many empirical studies (Carroll, 2003, Mankiw et al., 2003, Coibion and Gorodnichenko, 2010) measures of central tendency shall be predominantly employed in the following investigations. Nevertheless, there is some scepticism regarding the use of survey expectations for empirical testing.

A common grievance is that surveys do not offer the appropriate incentives for agents to report accurate forecasts (Keane and Runkle, 1990, Roberts, 1998, Ottaviani and Sørensen, 2006). Despite many studies which empirically examine expectation theory utilising survey forecasts from non-professionals, Keane and Runkle (1990) argue that these agents lack the economic incentives to report precise expectations. Consequently, survey forecasts from non-professionals may be excessively noisy as indicated by Roberts (1998) Instead, Keane and Runkle (1990) deem professional forecasts more reliable as the reported survey forecasts are assumed to be the same as those sold on the market. Nevertheless, as the SPF is composed of forecasters from various industries, systematic differences in their expectations may still be observed, as demonstrated by Laster et al. (1999). Should all forecasters be solely motivated by ultimate accuracy, disagreement amongst professionals would be expected to be small; if instead there are industry specific incentives which trade-off accuracy with publicity for example, systematic differences across forecasters may arise as some forecasters seek to "stand out from the crowd" and express an extreme view regarding macroeconomic conditions (Laster et al., 1999).

A further criticism of the SPF and Michigan Survey is that the participants do not remain constant from period to period; both surveys instead exhibit rotating or pseudo-panel characteristics. Consequently, the distribution of expectations is not only subject to innovations in agent perceptions of future inflation but also to changes in the characteristics of respondents (Stark, 2004). Therefore, it is not possible to draw like-for-like comparisons over extended periods of time for individual participants. Assuming that the distribution of agents remains relatively constant, it is however possible to draw comparisons across average expectations which can be considered to be consistent with those of the representative agent. It is the latter approach which this study employs throughout. More specifically, the median expectation is employed which, as already discussed, is more robust to shifts in the distribution of expectations than alternative measures of central tendency.

A further issue regarding the use of survey data concerns the presence of cross-sectional heterogeneity and disagreement amongst respondents. These issues arise due to model uncertainty, diverse information sets, and variation in agent priors resulting in different interpretations of signals (Curtin, 2005, Manzan, 2011). As the Michigan Survey intends to provide opinions representative of a cross-section of the US population, these issues arise as consumers from distinct demographics have distinct past price experiences (Jonung, 1981), have contrasting consumption patterns (Bryan and Venkatu, 2001a) and encounter different relative price changes (Bruine de Bruin et al., 2011b).

In contrast, some may consider professionals to be sufficiently well informed regarding macroeconomic behaviour that their expectations would not exhibit significant heterogeneity. Nevertheless, Croushore (1993) notes that due to variations in expertise and experience, SPF forecasts remain subject to a degree of disagreement. Moreover, Mankiw et al. (2003) document that whilst household expectations exhibit larger levels of dispersion, the SPF remains subject to substantial disagreement and exhibits substantial co-movement with Michigan Survey disagreement.

As briefly noted in 2.1.1 and 2.1.2, there are issues pertaining to individual surveys. A prominent issue concerns the procedure employed to obtain price or inflation forecasts: whilst the SPF requests participants to forecast future levels of various price indices, the question relating to inflation and prices poised by the Michigan Survey is much more ambiguous, referring to prices in general[18]. Where the

[18] See Appendix 2.1 for more detail regarding the procedure employed by the SPF and Michigan Survey to obtain inflation or price forecasts from participants.

respondent provides a "Don't Know" response to question A12b the question is rephrased using the term "cents on a dollar"[19].

As the Michigan Survey does not state a specific price index, preferring to use the term 'prices in general' Bruine de Bruin (2010c, 2011b) and Coibion and Gorodnichenko (2010) argue that participants may interpret the survey question differently. Consequently, a range of responses arises, encompassing alternative economic definitions of inflation including aggregate measures and individual consumption bundles (Coibion and Gorodnichenko, 2012). Consequently, difficulty arises in establishing forecast errors for the Michigan Survey subject to a single definition of inflation[20] and may result in further heterogeneity and disagreement than in the presence of a specific inflation definition. Conversely, should consumer surveys of inflation expectations request a specific definition alternative issues arise. Mainly, the proportion of the sample population with relatively low levels of financial and economic literacy may thus fail to fully understand the concept of a particular definition of inflation (Bruine de Bruin et al., 2010c, Burke and Manz, 2010). Consequently, the percentage of "Don't Know" responses is likely to be greater whilst expectations from those participants providing a quantitative response are likely to be characterised by greater inaccuracies. The Michigan Survey question can thus be deemed appropriate for its target audience of consumers and households.

An alternative to using survey forecasts is to solve an economic model where expectations are explicit variables with certain assumptions. Comparing Phillips curve, term structure model, ARIMA models and survey forecasts Ang et al. (2007) show that SPF, Livingston and Michigan surveys outperform the three alternative sources of expectations. This is attributed to aggregation capturing large volumes of information which subsequently has a positive impact on forecast accuracy. The superiority of surveys over simple time-series forecasts has also been demonstrated by Thomas (1999) and Mehra (2002)[21]. The superior performance of surveys compared to econometric or term-structure forecasts may be considered surprising as surveys are less inclined to utilise the most up to date information (Ang et al., 2007). Nevertheless, survey participants possess the advantage of being able to exercise a

[19] See Appendix 2.1 for further details.
[20] The inflation definition used throughout this study shall be CPI as mentioned in 2.1.1.
[21] As shall be explored in more detail in section 2.2.1.

degree of judgement when forming expectations in conjunction with their employed forecasting model or rule-of-thumb behaviour.

Despite the common use of survey expectations by macroeconomists to empirically examine expectation theory, several issues with these data sources have been highlighted. These include the lack of appropriate incentives to ensure respondents report an accurate or true expectation and the prevalence of heterogeneity and disagreement across forecasters. Nevertheless, survey forecasts provide a useful proxy for expectations of various agent classes and thus enable the ability to empirically examine theoretical hypotheses concerning the formation of agent expectations in economics. Furthermore, it was noted that survey forecasts are frequently reported to outperform other sources of expectations (Thomas, 1999, Mehra, 2002, Ang et al., 2007). The empirical examination to follow shall thus reassess the relative performance of survey forecasts and provide an overview regarding the manner which agent expectations are formed, determining whether the SPF and Michigan Survey are consistent with the assumptions and predictions of conventional expectation theory.

2.2 Forecast Properties

Before attempting to model how heterogeneous agents form inflation expectations, it is useful to analyse the properties of their forecasts and determine whether significant and time variant disagreement exists between the expectations of professionals and households, as indicated by Mankiw et al. (2003). As reported in the data introduction above, median expectations shall be considered in preference to the mean or individual responses, thus mitigating the impact of outliers and heterogeneity; however, the degree of disagreement observed will still prove empirically and economically interesting.

One might expect professional forecasters to produce more accurate expectations than households due to the possession of greater economic knowledge and access to more sophisticated forecasting tools (Carroll, 2003, Mankiw et al., 2003). However, several studies have reported greater expectational accuracy amongst households (Thomas, 1999, Mehra, 2002, Mankiw et al., 2003, Nunes, 2009). These findings shall be re-examined; furthermore the analysis shall be extended to include specific focus upon recent years and examine the impact of the global financial crisis and economic aftermath upon inflation expectations.

This section shall firstly evaluate the debate concerning regarding the performance of household inflation forecasts relative to those of professionals, with particular attention to those studies which examine the properties of expectations across distinct sub-sample periods. Empirical tests shall then be performed on SPF and Michigan Survey inflation forecasts across the sample periods identified in the previous section to determine whether the performance of the two surveys is time-variant and dependent upon the prevailing macroeconomic conditions. Moreover, this section shall specifically focus upon how expectations evolve over time with particular reference to forecast errors. Finally, this section considers the dynamic properties of inflation, testing for stationarity and unit roots in inflation and expectations. The results from these tests have the potential to impact on the relevance of certain macroeconomic models and is thus crucial to prevent spurious results. The final section provides general conclusions founded upon the results of the preceding sections and identifies the intentions of the empirical investigations to follow which aims to advance the understanding of how agents form their expectations.

2.2.1 Literature Review

The properties of agent forecasts formed by agents is of paramount importance to macroeconomists, thus the existing literature concerning expectations has devoted some attention to analysing available data from surveys. Recurring themes include the comparative performance of household forecasts to those formed by professionals and whether forecast properties are affected by the presence of sustained periods of increasing and falling inflation. The literature acknowledges a degree of time-variant disagreement exists amongst agent forecasts. It is the intention of this section to provide an overview of the debate highlighting a number of important and interesting contributions and determining whether there exists some general agreement amongst economists concerning the properties of inflation expectations.

There is some general agreement that the expectations of both professionals and households exhibit some degree of accuracy. A degree of coherence between the Livingston and Michigan Surveys is observed by Thomas (1999) whilst Mankiw et al. (2003:213) the Livingston Survey, Michigan Survey and SPF as 'relatively accurate'. Moreover, Thomas (1999) and Mehra (2002) find that forecasts obtained from surveys are more accurate than Fisher forecasts or those generated from naïve rules. Survey forecasts therefore appear to contain information regarding the future path of inflation that naïve rule-of-thumb or backward-looking behaviour is unable to accommodate. This view is further advocated by Mehra (2002) who demonstrates that both SPF and Michigan Survey forecast Granger-cause inflation, thus indicating that survey forecasts contain information beyond that incorporated in past inflation rates.

The examination of forecast errors is frequently employed by economists to analyse the accuracy of expectations and the relative forecasting performance of various agent classes. There is however some debate concerning whether the forecasts of households outperform those formed by professionals. Several studies have compared forecast error statistics between the Livingston Survey, SPF and Michigan Survey. Comparing the mean absolute forecast error (MAFE) and root mean square forecast error (RMSFE) over 1960Q1-1997Q4, Thomas (1999) reports that the Michigan Survey outperforms the Livingston Survey; utilising a sample period comprising 1982Q3-2002Q2 these results are replicated by Mankiw et al. (2003) who also observe that the Michigan Survey outperforms the SPF[22]. In contrast, for 1961Q1-2000Q3, Mehra (2002) that the Livingston Survey mean forecast error (MFE) and MAFE is superior compared to the Michigan Survey. Moreover, using European data for a smaller and more recent sample period, Lamla and Lein (2008) find that in terms of mean square forecast error (MSFE) and RMSFE, the expectations of professionals outperform those reported by consumers[23]. The evidence thus suggests that the relative performance of these surveys is dependent upon the sample periods over which the survey, and the study, is conducted.

A key objective of this study is to determine the response of agent forecasts to distinct periods of macroeconomic stability and volatility. This shall extend the analysis of several studies which have examined whether the properties of agent expectations are sensitive to certain macroeconomic conditions. For 1960Q1-1980Q2 when inflation is upward trending, Thomas (1999) reports that both professionals and households under-predict inflation, realising positive forecast errors. Moreover, for the earlier sample period considered by Thomas (1999) the MFE, MAFE and RMSFE for the Livingston Survey are larger than those associated with the Michigan Survey. In contrast, for the later period of downward trending and low inflation comprising 1980Q3-1997Q4, both agent classes overpredict inflation, realising negative forecast errors; furthermore the Livingston Survey outperforms the Michigan Survey in terms of these statistics. Similar results are reported by Mehra (2002) who additionally observe that for the latter period comprising 1980Q3-2000Q3, median forecasts from the Michigan Survey are superior to both Livingston Survey and SPF forecasts. Agent inflation forecasts and associated errors therefore appear to be sensitive to macroeconomic conditions. Furthermore, the relative accuracy of surveys appears time-variant. This study shall thus re-evaluate the results of existing studies regarding the relative performance of agent forecasts over the previously identified sample periods, identifying the

[22] Considering the maximal samples of each survey Mankiw et al. (2003) again report that the MAFE and RMSFE relating to the Michigan Survey is again superior to that relating to the Livingston Survey. However, the maximal sample period of the Livingston Survey is considerably longer than for the Michigan Survey thus direct comparisons are imprudent.

[23] Household expectations employed by Lamla and Lein (2008) are taken from German consumers within the EU business and consumer survey whilst Consensus Economics provides professional expectations from Germany.

response of forecast errors to distinct periods of macroeconomic stability and uncertainty.

Although average household forecasts are found to exhibit superior accuracy over certain sample periods, the consensus forecast is likely to conceal the inaccuracies across individual expectations; in reality the typical professional is likely to produce superior expectations to the typical household or consumer (Zarnowitz and Braun, 1993, Thomas, 1999). Forecast error statistics based on measures of central tendency provide an overview regarding the performance of agent expectations but fail to reveal variations in expectations over time and the nature of disagreement across individuals. Considering these issues Mankiw et al. (2003) show that a degree of disagreement exists amongst both professionals and consumers with the Michigan Survey exhibiting a distribution with a much wider inter-quartile range and longer tails than the Livingston Survey and SPF. Similarly, Thomas (1999) observes that whilst mean forecasts from the Livingston Survey only marginally exceed those of the median across much of the sample, indicating few outliers, the difference between the Michigan Survey mean and median forecasts is generally much larger, averaging approximately 1 percentage point and is attributable to those households with excessively high expectations. These results clearly favour employing median forecasts for empirical analysis in providing a coherent evaluation of expectation formation, particularly for households.

Moreover, the level of disagreement among both agent classes is shown by Mankiw et al. (2003) to be greater during periods of high inflation. Furthermore, the disagreement within each series exhibits substantial co-movement with correlation coefficients between the SPF, Michigan and Livingston surveys for actual quarterly data shown to be in excess of 0.5[24]. Consequently, empirical studies need to consider the impact of macroeconomic conditions and differences amongst individuals to fully understand the manner which agents form expectations. Although this chapter shall primarily consider the differences between aggregate household and professional expectations, subsequent chapters shall examine the disagreement amongst agent forecasts in relation to the assumptions and predictions of expectation theories.

[24] The correlation coefficients associated with five-quarter centred moving averages are even higher.

2.2.2 Elementary Examination of Inflation Forecasts and Associated Forecast Errors

In 2.1.1 and 2.1.2, the SPF and Michigan Survey were introduced along with the examination of some key statistics regarding their respective inflation forecasts. The analysis of the two surveys shall now be advanced, focusing on the relative performance of forecasts reported by professionals and households. Specifically, the analysis shall consider differences between the consensus median forecasts, whilst forecast errors shall be defined and evaluated to assess accuracy between the two agent classes.

Firstly, the difference between the forecasts reported by the two surveys shall be considered. Specifically, the difference between the median four-quarter ahead forecasts reported by the Michigan Survey and the SPF shall be defined as: $\theta_t = E_t^H[\pi_{t+4}] - E_t^P[\pi_{t+4}]$, where $E_t^H[\pi_{t+4}]$ and $E_t^P[\pi_{t+4}]$ represent the four period ahead inflation forecasts of households and professionals respectively. Therefore, where θ_t is positive (negative) the median household expectations is greater (less) than the median professional expectation. Figure 2.2.1 illustrates the difference between the expectations of the two agent classes over the whole sample period whilst Table 2.2.1 presents elementary statistics concerning θ_t for the whole and the three sub-sample periods:

Figure 2.2.1: Difference between Household and Professional Inflation Forecasts (1982Q3-2011Q1)

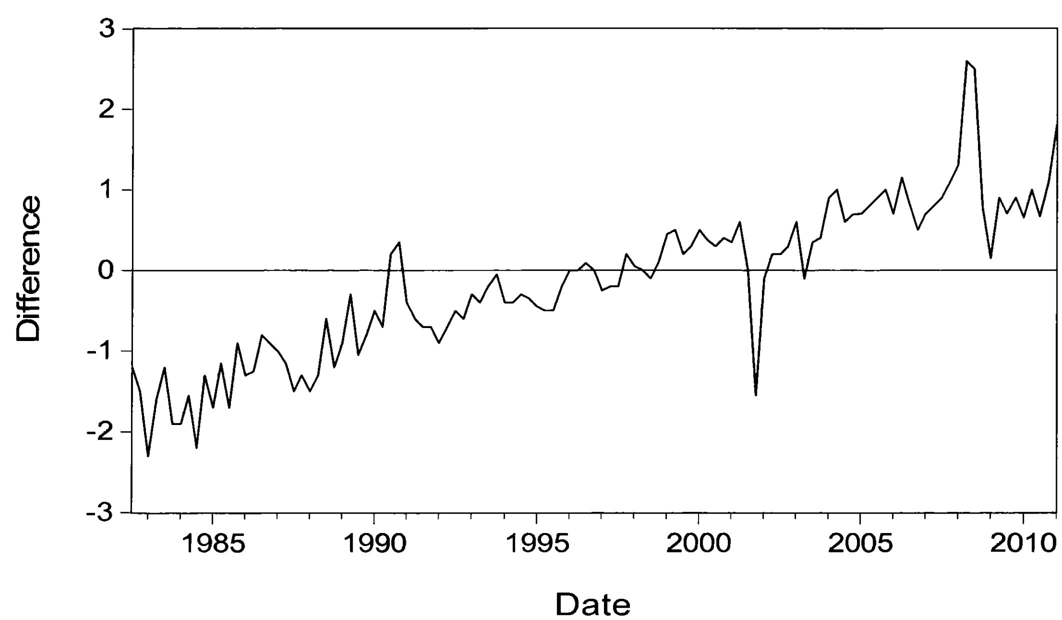


Table 2.2.1: Expectations Differences – Elementary Statistics

	WHOLE	G-B	STABLE	VOLATILE
Mean	-0.143	0.113	0.040	1.045
Maximum	2.600	2.600	1.150	2.600
Minimum	-2.300	-1.550	-1.550	0.150
Std. Dev.	0.938	0.786	0.531	0.626

From Table 2.2.1, the difference between SPF and Michigan Survey forecasts is generally negative for the 1980's and early 1990's indicating that households expect lower levels of inflation than professionals. From the late 1990's onwards the trend has been reversed. Nevertheless, during this period notable differences are observed in the latter half of 2001, early and mid-2008 and early 2011. The large differences are most likely to arise from variations in household forecasts which were observed in 2.1.2 to exhibit greater variation than professional forecasts which were observed in 2.1.1 to appear anchored between 2 and 3 percent across this period with a low standard deviation. Moreover, Coibion and Gorodnichenko (2013) identify the larger difference between the expectations of the two agent classes with household sensitivity to oil prices which experienced large increases between 2009 and 2011.

Of further interest is to establish whether the differences between household and professional forecasts observed in Figure 2.2.1 and Table 2.2.2: Equality of Means and Variances for Michigan Survey and SPF Inflation Forecasts are significant. Specifically, the ANOVA F-Test and Levene test shall be employed to respectively examine whether the mean and variance between household and professional forecasts, across the four sample periods, are equal[25], with the results presented in Table 2.2.2 below:

Table 2.2.2: Equality of Means and Variances for Michigan Survey and SPF Inflation Forecasts

		WHOLE	G-B	STABLE	VOLATILE
Mean	F-Statistic	1.594	1.147	0.160	37.015***
Variance	Levene Value	66.732***	29.224***	15.314***	6.434**

*,**,*** represent 10%, 5% and 1% significance levels respectively

[25] Both tests employ two numerator degrees of freedom and $N-2$ denominator degrees of freedom where N is the number of observations

For the whole, Greenspan-Bernanke and stable periods, the ANOVA F-test is unable to reject the null hypothesis thus indicating that, statistically, median SPF and Michigan Survey inflation forecast have equal means over these periods. This supports the findings of Mankiw et al. (2003) who report that differences between professional and household expectations are relatively small. However, for these three sample periods, the Levene test rejects the null hypothesis of equal variances[26]. Recalling from Table 2.1.3 and Table 2.1.4 that for these three periods, the standard deviation of SPF inflation forecasts is greater than that for the Michigan Survey, these results suggest that professionals may respond to news and adjust expectations more rapidly than households whose forecast may exhibit a degree of 'stickiness'. Nevertheless, for the volatile sub-period, the null hypothesis of both the ANOVA F-test and the Levene test are rejected[27]. Recalling that Michigan Survey forecasts are higher and exhibit a larger standard deviation than SPF forecasts, these results may further indicate that household expectations are more sensitive to transitory inflation innovations than professional expectations.

Although useful for simple comparative analysis, the raw survey data is not particularly informative in establishing the characteristics and differences across agent inflation forecasts. It is therefore common practice to examine the accuracy of expectations through the analysis of forecast errors. Consistent with statistical convention, can be defined as the difference between actual inflation and expectations, namely:

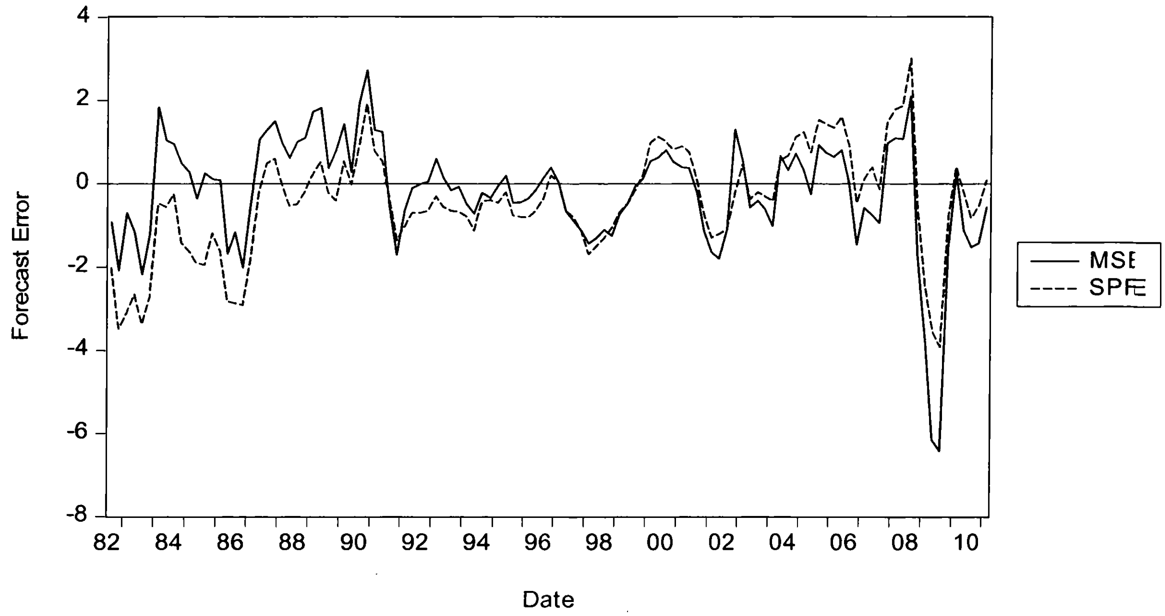
$$e_{t,i} = \pi_t - E_{i,t-j}[\pi_t] \qquad (2.2.1)$$

Again, period t inflation is defined as π_t, whilst $E_{i,t-j}[\pi_t]$ represents the j-period ahead forecast of π_t reported by agent i, and $e_{t,i}$ is the period t forecast error realised by agent i.

As indicated in 2.2.1, several recent studies (Thomas, 1999, Mehra, 2002, Mankiw et al., 2003) demonstrate that over certain sample periods, the forecasts of households are more accurate than those of professionals. SPF and aggregate Michigan Survey forecast errors are presented in Figure 2.2.2 below:

[26] Similar results are also obtained from employing the Brown-Forsythe test which analyses the equality of variances from the absolute median difference instead of the absolute mean difference employed by the Levene test.
[27] Similar results are once more obtained from employing the Brown-Forsythe test.

Figure 2.2.2 SPF and Michigan Survey Forecast Errors (1982Q3 – 2011Q3)



The forecast errors illustrated in Figure 2.2.2 follow a similar pattern to CPI depicted in Figure 2.1.1. Furthermore, the accuracy of both surveys has generally been similar over time, yet certain periods are noteworthy. During the early and mid-1980's when inflation was downward-trending, both surveys generally realised negative forecast errors, indicative of over-predictions whilst in the late 1980's and early 1990's when inflation was upward trending, peaking in excess of 6 percent, positive forecast errors were realised by both surveys, indicative of under-predictions. These observations are consistent with the behaviour observed by Mehra (2002). For the recent period of macroeconomic uncertainty both surveys realise large positive errors followed by large negative errors. As previously discussed in 2.1.1 and 2.1.2, these observations appear to indicate that both agent classes fail to anticipate the increase in inflation from 2007, and the subsequent period of deflation between 2009Q1 and 2009Q3. Moreover, the characteristics of forecast errors where inflation is more volatile suggest that both agent classes exhibit backward-looking behaviour in forming their forecasts during this period, and shall be extensively examined in later chapters.

Moreover previous studies frequently evaluate forecast accuracy utilising the mean forecast error (MFE), mean squared forecast error (MSFE), mean absolute forecast error (MAPE), root mean squared forecast error (RMSFE) and mean absolute percentage error (MAPE). The MFE provides an elementary indication of forecasting bias (Thomas, 1999) and shall be employed to determine the relative precision of agent forecasts. The MFE for agent i k-period ahead forecasts can be calculated by:

$$MFE_i = \bar{e}_i = E\left(\pi_{t+k} - E_{t+k-j,i}[\pi_{t+k}]\right) \tag{2.2.2}$$

The MFE is however a poor measure of the accuracy of expectations due to the cancelling out effect of positive and negative errors which have the potential to be relatively large. The MFE may indicate a degree of bias in expectations but provides little indication of the relative accuracy of the forecast series. More suitable tests of unbiasedness will nevertheless be considered in relation to the rational expectations hypothesis in following chapters. One alternative to the MFE is the MSFE which has quadratic loss characteristics which penalise larger forecast errors more heavily than smaller errors (Kennedy, 2003). Moreover, these statistics are not affected by the cancelling out of positive and negative errors. The MSFE and RMSFE for agent i k-period ahead forecasts is calculated by:

$$MSFE_i = \bar{e}_i^2 = E\left(\pi_{t+h} - E_{t+h-j,i}[\pi_{t+k}]\right)^2 \tag{2.2.3}$$

$$\begin{aligned} RMSFE &= \sqrt{MSFE} = (\bar{e}_i^2)^{\frac{1}{2}} \\ &= \sqrt{E\left(\pi_{t+k} - E_{t+k-j,i}[\pi_{t+k}]\right)^2} \end{aligned} \tag{2.2.4}$$

Although useful for assessing forecast accuracy, alternative measures to the MFE including the MAPE are commonly employed by economists when evaluating expectations. The MAPE can be calculated as follows:

$$MAPE_i = \frac{1}{n}\sum_{t=1}^{n} \frac{\left|\pi_{t+k} - E_{t+k-j}[\pi_{t+k}]\right|}{\pi_{t+k}} \tag{2.2.5}$$

Rather than penalising the numerical size of the error, the MAPE penalises percentage deviations of expectations to the realised value of the forecasted variable.

The MFE, MSFE, RMSFE and MAPE statistics for SPF and Michigan Survey inflation forecasts are presented in Table 2.2.3 below whilst simple hypothesis tests are presented in Table 2.2.4:

Table 2.2.3: Forecast Error Statistics for SPF and Michigan Survey Inflation Forecasts

		WHOLE	G-B	STABLE	VOLATILE
MFE	**SPF**	-0.433	-0.115	-0.114	-0.175
	MS	-0.194	-0.140	-0.050	-1.177
MSFE	**SPF**	1.778	1.128	0.777	2.913
	MS	1.820	1.893	0.760	6.103
RMSFE	**SPF**	0.889	0.564	0.388	1.456
	MS	0.910	0.947	0.380	3.051
MAPE	**SPF**	94.099%	97.603%	30.438%	382.745%
	MS	123.178%	140.058%	28.059%	595.520%

Table 2.2.4: MFE and MSFE Hypothesis Testing

		WHOLE	G-B	STABLE	VOLATILE
MFE	SPF T-Statistic	-3.664***	-1.064	-1.050	-0.437
	MS T-Statistic	-1.552	-0.994	-0.466	-2.299**
	ANOVA F-Statistic	1.927	0.019	0.172	2.377
MSFE	ANOVA F-Statistic	0.005	1.443	0.009	1.140

*,**,*** represent 10%, 5% and 1% significance levels respectively

For the whole period the MFE statistics presented in Table 2.2.3 are generally in accordance with those of previous studies (Thomas, 1999, Mehra, 2002, Mankiw et al., 2003, Nunes, 2009) with aggregate households on average realising smaller errors than professionals. Furthermore, the MFE's are negative indicating that both agent classes, on average, overestimate the future value of inflation. This is consistent with the results for the later periods presented by Thomas (1999) and Mehra (2002). Nevertheless, from Table 2.2.4 it is not possible at conventional significance levels to reject the null hypothesis that the Michigan Survey MFE is equal to zero; however, the null hypothesis of a zero SPF MFE is rejected at a very high significance level. Therefore for the extended sample period, Michigan Survey forecasts appear to outperform those of professionals. The Michigan Survey MSFE and RMSFE however is fractionally greater than that for the SPF; these results are in accordance with the later period presented by Thomas (1999). Nevertheless, the ANOVA F-test is unable to reject that the Michigan Survey and SPF MSFE's are equal indicating that the magnitude of forecast errors made by the two surveys are statistically similar.

In comparison to the whole sample period, the MFE from Table 2.2.3 for both professionals and households, across the Greenspan-Bernanke and stable sub-periods, is lower. This replicates the Greenspan period results presented by Mehra (2002) who attributes greater bias during the Volcker period to agents discrediting the deflationary nature of central bank policy. Furthermore, from Table 2.2.4 t-tests are unable to reject the null hypothesis of zero MFE's for either agent class whilst the ANOVA F-test is unable to reject the equality of MFE's.

For the volatile sub-periods, the MFE, MSFE and RMSFE of SPF forecasts is greatly superior to that of Michigan Survey forecasts. Although both agent classes overestimate inflation, the MFE for households is over six times greater than that realised by professionals whilst the Michigan Survey MSFE is more than twice as large as that for the SPF. These results appear to indicate that whilst household and professional expectations exhibit similar accuracy during periods of greater macroeconomic stability, in the presence of increased volatility professional expectations are greatly superior. The greater inaccuracy in household expectations over the volatile sub-period corresponds with Curtin (2009) who attributes greater forecast errors to negative values of CPI between 2009Q1-2009Q3 which households have greater difficulty in interpreting. Moreover, up to 2009, households had only encountered positive inflation, therefore, failing to experience deflation may have positively biased expectations (Malmendier and Nagel, 2009) with households placing an implicit zero bound on inflation expectations. However, as for the whole, Greenspan-Bernanke and stable periods, the ANOVA F-tests from Table 2.2.4 are unable to reject the equality of MFE's or MSFE's for the volatile period, thus implying that on average there is no significant difference in the size and magnitude of household and professional errors with the relationship persisting across a range of macroeconomic conditions.

To further analyse the predictive content of SPF and Michigan Survey forecasts, tests of Granger-causality between the surveys and CPI shall be examined akin to Mehra (2002). Tests of Granger-causality, initially proposed by Granger (1969), consider the predictive content of time-series. Specifically, these tests will be used to determine whether past values of survey forecasts improve upon the explanation of inflation, beyond that already contained within the past history of inflation, and vice versa. Results from Granger-causality tests between the two surveys and inflation across the four sample periods are presented in Table 2.2.5 below:

Table 2.2.5: Granger-Causality between Survey Forecasts and Inflation

	F-Statistic: $E_{i,t-4}[\pi_t] \rightarrow \pi_t$	F-Statistic: $\pi_t \rightarrow E_{i,t-4}[\pi_t]$
Whole Sample Period: 1982Q3 – 2011Q1		
SPF	3.926***	4.729***
MS	1.465	2.537**
Greenspan-Bernanke Sub-Sample Period: 1987Q2 – 2011Q1		
SPF	6.980***	5.529***
MS	1.645	0.843
Stable Sub-Sample Period: 1990Q1 – 2006Q2		
SPF	2.806**	3.363**
MS	3.483**	0.767
Volatile Sub-Sample Period: 2006Q3 – 2011Q1		
SPF	1.533	3.318
MS	1.634	0.248

*,**,*** represent 10%, 5% and 1% significance levels respectively

Table 2.2.5 illustrates that, for the whole Greenspan-Bernanke and stable periods, SPF forecasts Granger-cause inflation whilst Michigan Survey forecasts only Granger-cause inflation for the stable sub-period. As highlighted by Mehra (2002), this indicates that SPF forecasts contain information regarding future inflation beyond that incorporated into past inflation; yet for the whole and Greenspan-Bernanke periods, Michigan Survey inflation forecasts appear to have limited predictive power. Furthermore, inflation Granger-causes SPF and Michigan Survey forecasts for the whole sample period indicating that both professionals and household forecasters exhibit backward-looking behaviour in reporting their expectations.

For the volatile sub-period, Granger-causality is not observed in either direction between the two surveys and CPI. This indicates that for the most recent period of macroeconomic uncertainty, survey forecasts have limited predictive power, corresponding with the error statistics previously observed. Furthermore, survey forecasts over the volatile sub-period appear not to be consistent with backward-looking behaviour and shall be investigated in more detail in subsequent chapters.

The analysis of this section indicates that the differences between professional and household forecasts are generally small. Elementary statistics indicate that the forecasts of both agent classes have similar means; furthermore, forecasts track inflation closely, particularly over longer sample periods. Although the MFE and MSFE are generally lower for professionals, tests fail to reject the equality of MFE's and MSFE's across the two agent classes across all four sample periods. Nevertheless, it is apparent that the economic environment is crucial in determining the accuracy of expectations; for periods of greater stability, all measures of forecast accuracy are generally lower than for periods which are characterised by greater macroeconomic volatility. The properties examined in this section provide an overview and basic analysis of the formation of agent inflation expectations. These have however been targeted at an elementary level, thus following chapters shall consider more complex techniques to determine the dynamic properties of agent expectations.

2.2.3 Stationarity Properties

In addition to the elementary statistics analysed in 2.2.2, the dynamic properties of inflation and associated expectations also require consideration; of particular importance is whether the aforementioned time-series are characterised as unit-root or stationary processes. If stationarity is present, a time-series will fluctuate around a constant mean value, the variance will be constant across the sample period and the covariance between two values within the series will be dependent upon the time interval between the values rather than the date of observation (Hill et al., 2008). Nevertheless, Berk (1999) warns that where either inflation or associated expectations are non-stationary, parameter estimates from empirical experiments will be inconsistent even where standard errors are appropriately corrected. Moreover, Culver and Pappell (1997) recognise that various economic theories including sticky prices and standard Phillips-curve relationships are inconsistent with inflation exhibiting unit root properties.

The dynamic properties of inflation and expectations have been extensively investigated by economists. To examine inflation persistence, economists have analysed various tests. A simple measure as employed by Pivetta and Reis (2007) and Fuhrer (2009) concerns the first-order autocorrelation of inflation. Utilising rolling sample estimates, both Pivetta and Reis (2007) and Fuhrer (2009) identify that the first order autocorrelation coefficient is time-varying; specifically low levels of autocorrelation are observed during the 1960's, rising to approximately 0.8 during the 1970's, remaining high until the mid-1990's. During the late 1990's and early 2000's autocorrelation varies between 0.4 and 0.6 before falling again in the late 2000's.

A more stringent test of persistence as examined by Barsky (1987), Fuhrer and Moore (1995), Stock and Watson (2007) and Fuhrer (2009) concerns the autocorrelation function. For the post-war era, Barsky (1987) identifies that US CPI inflation exhibits greater levels of persistence than for the pre-war era; moreover autocorrelations for the 1960-1979 period are observed by Barsky (1987) to be particularly high. Similarly, for US inflation between 1965 and 1993, Fuhrer and Moore (1995) report that inflation is autocorrelated up to lags of about four years. Similarly, considering the univariate process of GDP price index inflation, Stock and

Watson (2007) observe that changes in inflation are significantly correlated with inflation at the first and forth lags. To re-examine the persistence properties of inflation, Figure 2.2.3 presents the correlation function for CPI across the whole sample period.

Figure 2.2.3: Correlation Functions for CPI Inflation 1982Q3 – 2011Q1

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.814	0.814	78.123	0.000
		2	0.578	-0.248	117.90	0.000
		3	0.377	-0.025	134.98	0.000
		4	0.210	-0.068	140.32	0.000
		5	0.228	0.430	146.66	0.000
		6	0.241	-0.217	153.86	0.000
		7	0.195	-0.097	158.60	0.000
		8	0.157	0.025	161.70	0.000
		9	0.092	0.123	162.78	0.000
		10	0.047	-0.096	163.07	0.000
		11	0.045	-0.024	163.33	0.000
		12	0.035	0.006	163.48	0.000

Comparable to the results presented by Barsky (1987) and Fuhrer and Moore (1995), the inflation rate is observed to be significantly autocorrelated up to the eighth lag. Inflation over the whole sample period can thus be classified as highly persistent, yet is much lower than the degree of autocorrelation reported by Fuhrer and Moore (1995), suggesting that inflation has been less persistent over recent years. Nevertheless, regressing inflation upon four lags of itself produces an $\bar{R}^2$ value of 0.688 indicating that inflation remains highly forecastable as previously observed for post-1960 inflation by Barsky (1987).

The correlation functions for the Greenspan-Bernanke, stable and volatile periods are presented in Appendix 2.3. Excluding the Volcker era appears to have little impact on the persistence of inflation with significant autocorrelation for the Greenspan-Bernanke sample period observed up to the eighth lag. Nevertheless, supporting the argument above that inflation has been less persistent in recent years, significant autocorrelation for the stable sample period is observed only up to the fourth lag. Moreover, for the volatile sub-period, inflation is significantly autocorrelated for the first lag only; the lower persistence of inflation for the most recent sample period associated with increased levels of macroeconomic uncertainty may have resulted in the inflation rate being less forecastable with agents resultantly realising larger forecast errors.

Additionally, the persistence properties of inflation forecasts with the correlation functions for professionals and households across the whole sample period presented in Figure 2.2.4 and Figure 2.2.5 respectively:

Figure 2.2.4: Correlation Functions for SPF CPI Forecasts 1982Q3 – 2011Q1

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.941	0.941	104.59	0.000
		2	0.889	0.023	198.66	0.000
		3	0.851	0.107	285.72	0.000
		4	0.824	0.082	367.98	0.000
		5	0.808	0.120	447.90	0.000
		6	0.766	-0.209	520.37	0.000
		7	0.733	0.072	587.22	0.000
		8	0.685	-0.183	646.21	0.000
		9	0.644	0.031	698.87	0.000
		10	0.619	0.042	747.93	0.000
		11	0.601	0.128	794.63	0.000
		12	0.588	0.011	839.78	0.000

Figure 2.2.5: Correlation Functions for Michigan Survey Inflation Forecasts 1982Q3 – 2011Q1

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.597	0.597	42.096	0.000
		2	0.345	-0.018	56.278	0.000
		3	0.307	0.169	67.638	0.000
		4	0.271	0.038	76.540	0.000
		5	0.191	-0.016	81.008	0.000
		6	0.247	0.178	88.528	0.000
		7	0.183	-0.099	92.723	0.000
		8	0.123	0.024	94.621	0.000
		9	0.089	-0.035	95.619	0.000
		10	0.070	-0.017	96.247	0.000
		11	0.082	0.073	97.111	0.000
		12	0.065	-0.061	97.667	0.000

In accordance with the results presented in Figure 2.2.3, for the whole sample period, the inflation forecasts of both professionals and households exhibit positive and significant levels of autocorrelation; nevertheless, whilst for households significant autocorrelations are observed up to the eighth lag, a much higher order of correlation is observed for professionals. Forecasts reported by professionals thus exhibit greater levels of persistence and suggest that they are less sensitive to shocks relative to those reported by households. Similarly, correlograms for forecast errors indicate that the forecast errors realised by professionals are more persistent than those associated with household expectations; this however is not necessarily informative regarding the comparative degrees of accuracy exhibited by either agent class.

The presence of autocorrelation amongst inflation and expectations data has potential consequences for empirical analysis, particularly under the assumptions of ordinary least squares (OLS). To ensure that estimates remain efficient, robust standard errors will thus be required; specifically, standard errors will thus be corrected utilising the heteroskedasticity and autocorrelation consistent coefficient matrix proposed by Newey and West (1987).

To examine whether the inflation and surevy forecast series are stationary, the augmented Dickey-Fuller (ADF) test shall be employed for each of the three seriesacross the four sample periods. Following Culver and Papell (1997), ADF tests shall be specified to include a constant but no linear trend, consistent with a non-accelerating but positive inflation rate, providing the following regression:

$$\Delta y_{i,t} = \gamma + \alpha y_{i,t-1} + \sum_{j=1}^{k} \beta_j \Delta y_{i,t-j} + \epsilon_t \qquad (2.2.6)$$

The current inflation rate and forecasts from the two agent classes are denoted $y_{i,t}$, representative of π_t, $E_{P,t}[\pi_{t+h}]$ and $E_{H,t}[\pi_{t+h}]$, whilst the lag length k is automatically selected in accordance with Culver and Papell (1997), using a Schwarz information criterion with $k_{max} = 16$.

The ADF test assumes a null hypothesis of non-stationarity; however, due to the low power of the ADF test to distinguish between a stationary series and those characterised by a unit-root, Campbell and Perron (1991), Kwiatkowski et al. (1992) Berk (1999), and Fujihara and Mougoué (2007) highlight that the rejection of the null hypothesis does not necessarily signify a non-stationary series. Therefore, in addition to ADF tests, the stationarity properties of inflation and associated survey forecasts shall be further analysed utilising the Phillips-Perron (1988) and KPSS LM-tests proposed by Kwiatkowski et al. (1992). The Phillips-Perron (PP) test employs a modified ADF test equation to prevent serial correlation impacting upon the t-statistics, whilst the KPSS contrasts to the ADF in that the null hypothesis concerns stationarity rather than the presence of a unit-root. Nevertheless, as thew sub-periods employed in this study have relatively small sample sizes, the KPSS test will also be of low power. Therefore, due to the inherent limitations of these tests, some judgement may be required in determining whether the series are stationary or otherwise.

The stationarity properties of inflation and associated expectations have been examined by various existing studies; Nelson and Schwert (1977), Barsky (1987), Ball and Cecchetti (1990), Hassler and Wolfers (1995), and Berk (1999) have indicated that inflation is non-stationary and instead exhibits unit-root properties. These results are supported by Culver and Pappel (1997) and Lee and Wu (2001) who both report that the ADF null hypothesis of a unit-root is only rejected for 4 out of 13 OECD countries. In contrast, analysing US CPI between 1953 and 2004, Lanne (2006) is unable to reject the ADF unit root null hypothesis; similarly between 1947 and 2005, Fujihara and Mougoué (2007) argue that the US inflation rate is stationary after accommodating infrequently changing means.

The conclusions regarding stationarity and unit roots may however be dependent upon the test employed, as demonstrated by, Hassler and Wolters (1995) and Brissimis and Migiakis (2011). Analysing the US price index between 1969 and 1992, Hassler and Wolfers (1995) report that high lag order ADF, and KPSS tests indicate the presence of a unit root, whilst low lag order ADF, and Phillips-Perron tests favour stationarity[28]. Similarly, Brissimis and Migiakis (2011) report that whilst standard Dickey-Fuller and PP tests are unable to reject the unit root null hypothesis, GLS modified tests favour the alternative of stationarity[29]. There is thus some disagreement amongst economists regarding the dynamic properties of inflation; consequently, US inflation data and the two survey forecasts shall be analysed to determine whether these series exhibit stationarity or unit root properties, using the ADF, PP and KPSS tests detailed above.

To determine whether inflation observations are characterised by stationarity, the ADF test identified by (2.2.6), and the Phillips-Peron and KPSS tests shall be performed on the CPI data explored in 2.1.1 across the four sample periods with the

[28] Hassler and Wolfers (1995) report similar evidence for the UK, France, Germany and Italy.
[29] Lein and Maag (2011) also report differences between the ADF and KPSS tests for various European countries.

results presented in Appendix 2.4[30]. For CPI across both the whole and Greenspan-Bernanke sample periods, the ADF and PP tests reject their respective null hypotheses indicating that inflation does not have a unit root[31] and is instead stationary. In contrast, for the stable and volatile sub-periods, both the ADF and PP tests are unable to reject the unit root null hypothesis; for these sub-periods, inflation is $I(1)$ and can thus be classified as difference stationary. Nevertheless, these results appear to be dependent on the test employed as the KPSS test rejects the null hypothesis that inflation is stationary, in favour of a single unit root, for both the whole and Greenspan-Bernanke sample periods. Moreover, the KPSS test is unable to reject the null hypothesis for the stable and volatile sub-periods.

These results support the argument by Hassler and Wolters (1995) and Fujihara and Mougoue (2007) that evidence of stationarity, or otherwise, is dependent upon the methodology employed and the sample period examined. Nevertheless, given the general low power of unit root tests, the disparity between the results could indicate that inflation exhibits near unit root properties as previously indicated by Barsky (1987) and Brissimis and Migiakis (2011). Moreover, the relatively small sample sizes, particularly for the volatile sample period, further contributes to the low power of these tests, and, as argued by Gagnon (2008), may be representative of short-term regime shifts.

The persistence properties relating to the SPF and the Michigan Survey are also presented in Appendix 2.4. For SPF forecasts, neither the ADF or Phillips-Perron tests are able to reject the unit root null hypothesis for the whole, Greenspan-Bernanke and stable periods, whereas for these three periods the results relating to Michigan Survey forecasts favour stationarity; the results relating to the KPSS support these observations. The presence of unit roots amongst professional forecasts is consistent with the results from various previous studies including Evans and Wachtel (1993), Luoma and Luoto (2009), however, they contrast with the recent work by Hubert and Mirza (2014); moreover, the observation that Michigan Survey forecasts are stationary contrasts with the results of Evans and Wachtel (1993) and Luoma and Luoto (2009) who observe that household forecasts contain

[30] Throughout this thesis, larger tables shall be presented in the appendies.
[31] For the Greenspan-Bernanke sample period, the ADF test rejects the unit root null hypothesis at a 10% level of significance.

unit roots. Again these results may be influenced by the low power of unit root tests induced by the relatively short sample periods employed throughout this study.

The results presented in Appendix 2.4 are consistent with the argument presented by Fujihara and Mougoue (2007) and Brissimis and Migiakis (2011) that evidence regarding the presence of unit roots or stationarity of inflation and expectations is dependent upon the methodology employed and the sample period for which the test is performed. Nevertheless, due to the low power of these tests, particularly for small sample periods there are some questionability regarding the reliability and significance of these results. The conflicting results from the various tests, particularly amongst inflation may thus indicate that the data contains near unit root properties as previously highlighted by Barsky (1987) and Brissimis and Migiakis (2011).

As highlighted by Culver and Papell (1997), the timespan of the data may result in conventional stationarity analyses, including ADF tests, to reject the unit-root null hypothesis. To further examine the stationarity properties of inflation and survey forecast series, the GLS modified Dickey-Fuller test (ADF-GLS), as proposed by Elliott, Rothenberg and Stock (1996) shall be employed across the four sample periods "which has substantially improved power when an unknown mean or trend is present" (1996:813). In accordance with the initial ADF tests, rejection of the unit root null hypothesis would be indicative of stationarity for the given series.

The ADF-GLS test is performed using (2.2.7) which is again specified to include a constant but no linear trend whilst $y_{i,t}^T$ denotes the detrended inflation and survey forecast series employed, representative of π_t^T, $E_{P,t}^T[\pi_{t+h}]$ and $E_{H,t}^T[\pi_{t+h}]$. The results from these tests are presented in Table 2.2.6.

$$\Delta y_{i,t}^T = \gamma + \alpha y_{i,t-1}^T + \sum_{j=1}^{k} \beta_j \Delta y_{i,t-j}^T + \epsilon_t \qquad (2.2.7)$$

Table 2.2.6: ADF-GLS Tests

		W	G-B	S	V
Significance Critical Values	10%	-1.615	-1.615	-1.614	-1.607
	5%	-1.944	-1.944	-1.946	-1.960
	1%	-2.585	-2.589	-2.600	-2.692
ADF-GLS t-Statistics	CPI	-0.083	-2.526**	-1.187	-2.473**
	SPF	0.192	-0.205	-0.240	-1.525
	MS	-0.493	-4.257***	-2.949***	-3.251***

***,**,* denote significance at the 1, 5 and 10 percent significance levels

For CPI, the results presented in Table 2.2.6 indicate that CPI has unit root properties for the whole and stable periods; in contrast, the unit root null hypothesis is rejected for the Greenspan-Bernanke and volatile periods at the 5 and 10 percent levels respectively. Similarly, for Michigan Survey expectations, rejection of the unit root null hypothesis, in favour of stationarity, is observed for the Greenspan-Bernanke, stable and volatile periods but not for the whole sample period. However, supporting the results from the baseline ADF tests presented in Appendix 2.4, across all four sample periods, it is not possible to reject the presence of unit roots for the SPF.

As for the baseline unit root tests presented in Appendix 2.4, the ADF-GLS tests are unable to provide conclusive evidence regarding whether the three series need be treated as unit-root or stationary processes. Moreover, the use of individual unit-root tests are generally appreciated to be of low power (Levin et al., 2002). To further assess whether inflation and the two survey forecast series can be deemed to be collectively stationary, the Levin, Lin and Chu (2002) unit-root test for panel data shall be performed on the three aforementioned series. The test evaluates the null hypothesis that the individual series are integrated versus the alternative of stationarity with the results presented in Table 2.2.7 below:

Table 2.2.7: Levin, Lin and Chu (2002) Panel Unit-Root Test

	W	G-B	S	V
t-Statistics	-3.793***	-0.215	-1.549*	-2.028**

The results presented in Table 2.2.7 indicate that for the whole, stable and volatile periods, the unit-root null hypothesis is rejected in favour of collective stationarity amongst the three series at a 1, 10 and 5 percent significance level respectively. For the Greenspan-Bernanke period, the Levin, Lin and Chu (2002) unit-root null hypothesis cannot be rejected at any reasonable level of significance; therefore whilst for periods of relative macroeconomic stability there is again some evidence in favour of the presence of unit-roots, conclusions are not entirely unambiguous.

The results presented in this section are fairly inconclusive; consistent with the arguments presented by Fujihara and Mougoue (2007) and Brissimis and Migiakis (2011) the presence of unit-roots or stationarity of inflation and survey expectations is dependent on both the sample period and methodology employed. Whilst the evidence generally supports the stationarity hypothesis, particularly for the whole sample period, for the SPF and periods of greater macroeconomic stability, evidence favouring the presence of unit-roots is observed. These conflicting results may be indicative of near unit-root properties as highlighted by Barsky (1987) and Brissimis and Migiakis (2011). As the panel unit-root tests presented in Table 2.2.7 are more in favour of stationarity, the subsequent analysis shall be conducted under the premise that the series do not contain unit-roots; moreover, this shall maintain consistency with the methodology conducted by the extant literature concerning models of expectation formation. Nevertheless, the use of non-stationary time-series may lead to spurious analysis, therefore, a level of caution within the following empirical analysis must be exercised.[32].

[32] To alleviate the concerns of OLS analysis, various studies including Luoma and Luoto (2009) advocate the use of vector autoregressive models. These shall be employed with relation to professional expectations in Chapter 6.

2.3 Discussion

The objective of this chapter has been to introduce the SPF and Michigan Survey and establish key differences between the properties of household and professional inflation forecasts over a period of approximately 30 years. The analysis has also identified distinct periods of macroeconomic stability and volatility and investigated whether forecast properties are time-variant and sensitive to macroeconomic conditions. From tests of SPF and Michigan Survey forecasts, and associated errors, there is insufficient evidence to robustly conclude that household forecasts are significantly different to those of professionals.

In accordance with previous studies (Thomas, 1999, Mehra, 2002, Mankiw et al., 2003, Nunes, 2009), the MFE associated with household forecasts outperforms that for professionals for the whole sample period and the stable sub-period, however, for the Greenspan-Bernanke and volatile sub-periods the SPF MFE is smaller than that associated with the Michigan Survey. Furthermore, professional MSFE's are consistently smaller than those for households. Nevertheless, it is generally not possible to reject the null hypothesis that the MFE's and MSFE's are equal across agent classes, and questions whether the SPF or Michigan Survey is superior to the other. This has potential implications for numerous economic models which employ expectations or directly concern the formation of agent forecasts and shall be discussed in more detail in subsequent analysis.

Moreover, despite identifying the similarities and differences between two agent classes, disagreement may also prevail between individual professional forecasters and also between individual households as highlighted by Mankiw et al. (2003). Rather than analysing the expectations of individual agents[33], an interesting direction would be to consider whether expectations sustainability differ amongst heterogeneous groups such as between academic and business economists or between households with differing demographic characteristics. Heterogeneity and disagreement across household expectations shall be analysed in Chapter 4 whilst disagreement amongst professional expectations shall be examined in relation to information rigidities in Chapter 6.

[33] Difficulties would arise under such analysis due to the pseudo-panel structure of the Michigan Survey.

The performance of agent expectations, as investigated in this chapter, has established the relative accuracy of professional and household inflation forecasts across an extended time-period and various macroeconomic environments. Although interesting for macroeconomists, this analysis is not particularly informative regarding the manner which agents form their expectations. Instead, economists have devoted substantial attention to the derivation and empirical examination of various models to explain expectation formation. Several key models shall be evaluated in the following chapters to determine whether they are able to adequately accommodate the forecasting process employed by agents across various macroeconomic conditions. The next chapter introduces some traditional theories of expectation formation and empirically evaluates whether SPF and Michigan Survey inflation forecasts are consistent with the assumptions and properties of these models.

CHAPTER 3: TRADITIONAL THEORIES OF EXPECTATION FORMATION

The previous chapter analysed the elementary properties of survey expectations, finding evidence that the accuracy of agent inflation forecasts is time-variant. Furthermore, the accuracy of household forecasts relative to those reported by professionals is dependent upon the statistical test employed and the sample period examined. This chapter extends the analysis of agent expectations by examining traditional expectation theories which have received widespread attention through the economic literature. The theoretical modelling of agent expectation formation was extensively developed throughout the latter part of the last century, and to date remains of keen interest for economists in terms of theory, application and empirical consistency.

Keynes brought expectations to the forefront of economic debate, yet his approach relied principally upon the concept of animal spirits, thus formal modelling of expectations was omitted. Nevertheless, various approaches have since been adopted by economists to mathematically model the formation of agent expectations. Early methods considered backward-looking approaches including static expectations which postulated that agents predict that the current value of an economic variable shall persist into the future. Models of adaptive expectations, which advocated that agents extrapolate past information in predicting the future value of some variable, became prominent during the 1950's and 1960's. In the 1970's, the forward-looking rational expectations hypothesis (REH) revolutionised the modelling of agent expectations. Initially proposed by Muth (1961), the REH was advanced by Lucas (1972, 1973, 1976), Sargent and Wallace (1975), Fischer (1977) and others and has since been widely employed in economic theory, providing the foundations for numerous important contributions throughout the macroeconomic literature and beyond.

This chapter shall reassess the theory upon which these approaches have been developed and empirically evaluate whether survey forecasts are consistent with the properties and assumptions of these models. Traditional backward-looking approaches to expectation formation are considered in 3.1 whilst 3.2 examines the rational expectations hypothesis. Both these sections analyse empirical tests to determine whether survey forecasts are consistent with the properties and assumptions implied by these theories. Section 3.3 introduces several alternate models of expectation formation and discusses the approach taken to overcome the issues concerning traditional theories prior to more detailed analysis in subsequent chapters. The final section provides a discussion of the preceding analysis and assesses whether survey forecasts are consistent with the predictions of traditional theories.

3.1. Backward Looking Expectations

The modelling of agent expectation formation has been developed throughout the 20th century and to date remains a matter of keen theoretical and empirical interest to economists. This section considers conventional backward-looking approaches to the modelling of expectations. The intuition and theory upon which these models are founded shall be examined, and their relevance shall be analysed by empirically testing whether survey forecasts are consistent with the assumptions and predictions of these models.

The importance of expectations in determining economic outcomes was established by classical economists. However, Keynes (1937:212) argues "that at any given time facts and expectations were assumed to be given in a definite and calculable form" suggesting that expectations were exogenously determined with forecasted variables taken to be known with some degree of certainty. Moreover, as current levels of macroeconomic variables were assumed to persist over the forecast horizon, expectations were not considered sufficiently significant to require direct modelling. Instead, to achieve market clearing equilibria, economists implicitly assumed that agents possessed static expectations with movements around some fixed level (Minford, 1986:103).

The manner which classical theory approaches expectations is argued by Keynes to be overly abstract, assuming that agents lack knowledge of the future when making decisions concerning the present. In *The General Theory*, Keynes (1936) departs from classical theory by suggesting that expectations are formed purely upon current economic conditions; past expectations only matter in the sense that they are embodied in past decisions which determine the current economic state. Moreover, Keynes (1936:51) highlights that economic conditions "remain substantially unchanged from one day to the next". Expectations are subsequently modelled under the assumption that the economy evolves as a sequence of static equilibria, equated to the most recently observed value, synonymous with static approaches, except in the knowledge of foreseeable changing circumstances.

Despite proposing that short-term expectations exhibit properties akin to static formulations, in relation to long-term expectations, Keynes (1936) further recognised the requirement for agents to possess higher order beliefs. Specifically, Keynes

(1936:156) famously likened decisions to those of a beauty contest "where [agents] devote [their] intelligences to anticipating what average opinion expects average opinion to be". Some may argue that the beauty contest analogy and the requirement to accommodate the behaviour of other agents as a factor for the expected path of the forecast variable pre-empts certain aspects of rational expectations theory. Indeed, Townsend (1978:482) argues that " a concern with the beliefs of others is consistent with rationality". Moreover, Begg (1982:28) demonstrates that Keynes's approach of exogenously determined expectations can be re-interpreted such that in the absence of unanticipated shocks, *The General Theory* could be amendable to accommodate rational expectations. Similarly, Gerrard (1994) illustrates that Keynes's analysis can encompass the implications of the REH. Nevertheless, as Minford (1986:104) highlights, despite accommodating certain aspects of rational expectations, Keynes's use of 'animal spirits' in determining expectations, as explained below, cannot be considered synonymous with RE.

Nevertheless, despite Keynes's greater appreciation of expectations than his classical predecessors, the mathematical derivation of expectations remains unexplained. Some, including Sargent (1983), blame this omission on the lack of analytical tools available to Keynes which have since been developed. Instead, *The General Theory* makes repeated references to 'animal spirits', defined as "a spontaneous urge to action rather than inaction" (Keynes 1936:161). Keynes thus argues that the economic decisions taken by some agents are independent of any mathematical structure; actions are instead characterised by greater subjectiveness, motivated by spontaneous instincts which quantitative measures are unable to accommodate.

This treatment of expectations is argued by Begg (1982) and Bray (1985) to result from the acknowledgement by Keynes that agents possess incomplete information thus cannot specify the statistical distribution of random economic variables required for creating a cohesive model of expectations formation. Furthermore, associating the formation of expectations to 'animal spirits' is interpreted by Minford (1986) and Koppl (1991:204) as a *deus ex machina*[34], an arbitrary solution to avoid the expectations issue. This would imply that economic outcomes are sensitive to autonomous fluctuations in individual sentiment and instinct (Blinder, 1987).

[34] The term "*diabolus ex machina*" is preferred by Koppl (1991:204).

Moreover, despite the acknowledgement of higher-order beliefs, the notion of 'animal spirits', and the proposition that "positive activities depend upon spontaneous optimism rather than mathematical expectation" (1936:161) appears to indicate that Keynes would have been a critic of rational expectations theory.

Whilst Keynesian economists generally adopted static approaches to expectation formation, the adaptive expectations hypothesis derived in the 1950's by Cagan (1956), Friedman (1957) and Nerlove (1958), introduced formal mathematical modelling to expectation theory. These models proposed that agents would adjust their expectations upon the observation of forecast errors. These models suggest that expectations are predictably adjusted relative to past conditions and are unaffected by news or by individual sentiment as embodied in Keynesian 'animal spirits'. Nevertheless, in accordance with static approaches, expectations maintain a degree of persistence, and are often found to be a reasonable explanation of inflation and associated expectations (Ball, 2000). Despite being neglected following the advent of rational expectations in the 1970's, interest in backward-looking models which employ elements of the adaptive expectations hypothesis, has been renewed in recent years[35].

This section shall analyse several backward-looking approaches to expectation modelling. The discussion in 3.1.1 shall introduce the theoretical framework upon which these models are founded and establish whether previous studies consider forecasts to be consistent with backward-looking behaviour. Sub-section 3.1.2 introduces formal empirical tests of backward-looking theories and examines whether survey forecasts are consistent with the predictions of these models. Moreover, these tests shall be conducted across the four previously identified sample periods to determine whether the prevalence of backward-looking behaviour is dependent upon macroeconomic conditions. The final sub-section discusses the appropriateness of backward-looking expectation hypotheses, analysing their limitations for wider macroeconomic models and evaluates whether survey forecasts empirically conform to the predictions of the various hypotheses.

[35] These models shall be formally introduced in 3.3 with a certain class of models extensively analysed in Chapter 5 and Chapter 6.

3.1.1. Theoretical Development of Backward-Looking Expectations and Literature Review

The importance of expectations for macroeconomic theory, in particularly for determining output and employment outcomes, was acknowledged by Keynes (1936); the mathematical modelling of expectations was however omitted. In the following decades, macroeconomists have since devoted attention to deriving formal models to explain the manner of agent expectation formation which have included theories of static, regressive and adaptive expectations. Prior to analysing whether survey forecasts are consistent with the assumptions and predictions of these models, the theoretical foundations on which these theories are established shall be presented whilst previous studies which assess the empirical validity of these models shall also be reviewed.

The static expectations hypothesis is often considered as the most primitive theory of expectation modelling. This theory assumes that agents expect the current level of the forecasted variable to be maintained over the forecast horizon and implies that the economy has achieved a steady state equilibrium. Static expectations of inflation can thus be represented by (3.1.1) and (3.1.2):

$$E_{t-h}[\pi_t] = \pi_{t-h} = p_{t-h} - p_{t-2h} \tag{3.1.1}$$

$$E_t[\pi_{t+h}] = \pi_t = p_t - p_{t-h} \tag{3.1.2}$$

This specification consequently assumes that expectations of the h-period ahead inflation rate are equal to the current level of inflation. However, the expected rate of change in the price level p in period t is non-zero, and is instead equal to the rate of change observed between period $t - h$ and t. If instead agents expect the price level to remain constant over the forecast horizon, expectations of inflation would equal zero:

$$E_{t-h}[p_t] = p_{t-h} \tag{3.1.3}$$

$$E_{t-h}[\pi_t] = E_{t-h}[p_t] - p_{t-h} = 0 \tag{3.1.4}$$

The specification of the static expectations hypothesis in (3.1.1) and (3.1.2) thus assumes that there is no relationship between current expectations $E_t[\pi_{t+h}]$ and lagged inflation π_{t-h}. Therefore, the static expectations hypothesis assumes that only current inflation enters the information set; all other information, including the past history of inflation, is ignored, thus "The static expectations individual not only suffers from myopia but also an extreme form of amnesia" (Shaw, 1984:24).

As mentioned in the previous chapter, survey forecasts have been observed to outperform those of static forecasts. Both Thomas (1999) and Mehra (2002) report that forecasts from the Livingston Survey, SPF and Michigan Survey realise smaller MAE's and RMSE's than those from naïve forecasting rules[36]. Consequently, survey forecasts are deemed to utilise wider information than that embodied within past inflation, and thus are considered more sophisticated than the restrictive assumptions implied by the static expectation hypothesis. Several alternative backward-looking models were thus proposed by economists in attempt to better characterise expectation formation.

An extension of the static expectations model proposed by Hicks (1939) concerns the regressive expectations hypothesis. This theory proposes that expectations will equal the most recently observed inflation rate, including some adjustment to allow for the trend over the forecast horizon as represented by (3.1.5):

$$E_{i,t}[\pi_{t+h}] = \pi_t + \gamma(\pi_t - \pi_{t-h}) \qquad (3.1.5)$$

The manner which expectations respond to inflation trends is represented by γ; where $\gamma > 0$, illustrates that agents expect current inflation trends to be extrapolated, whereas $\gamma < 0$, the trend is expected to be reversed and expectations can thus be considered regressive. Two interesting cases arise where $\gamma = -1$ and $\gamma = 0$. Considering the former, current expectations of the h-period ahead inflation rate are equal to the h-period lagged inflation rate; expectations thus assume that inflation trends will be entirely reversed. For the latter, the static expectations model (3.1.2) arises. Consequently, static expectations can be considered an extreme version of (3.1.5) which entirely discounts the past such that expectations are solely formed upon current experiences.

Empirically testing a regressive expectations model for Livingston Survey data between 1947 and 1975, Figlewski and Wachtel (1981) find $0 < \gamma < 1$ for both

[36] Both Thomas (1999) and Mehra (2002) identify the contemporaneous CPI inflation rate as the one-year ahead naïve forecast.

consensus and individual forecasts. Professional expectations are thus deemed to evolve in response to, and in the same direction as, recent inflation trends. Examining Livingston Survey data for 1952-70, Lahiri (1976) in contrast observes a negative γ coefficient indicating that professional inflation forecasts exhibit regressive behaviour. These results thus suggest that backward-looking behaviour on the part of professionals is time-variant. Splitting the sample period, time-variant behaviour is further observed by, Turnovsky (1970). Whilst the extrapolative coefficient is positive for the earlier 1954-1964 sub-period associated with relatively high inflation, the coefficient is negative for the latter 1962-1969 period associated with more stable inflation. These results thus suggest that backward-looking behaviour is not only time-variant but dependent upon macroeconomic conditions.

As previously discussed, the static expectations hypothesis assumes that agents are excessively myopic. During the 1950's and 1960's, in response to this criticism, economists developed the adaptive expectations hypothesis (AEH) as an alternative theory. Initially developed by Cagan (1956), Friedman (1957) and Nerlove (1958), the AEH continued to assume that agents employ backward-looking rules in forming expectations. Specifically, Cagan (1956:37) advocates that *"The expected rate of change in prices is revised per period of time in proportion to the difference between the actual rate of change in prices and the rate of change that was expected."* Consequently, in accordance with the static expectations hypothesis, agent expectations remain determined by the past value of inflation.

For the h period forecasting horizon, Cagan's hypothesis can be formally represented by:

$$E_{i,t}[\pi_{t+h}] - E_{i,t-h}[\pi_t] = \lambda\left(\pi_t - E_{i,t-h}[\pi_t]\right) \qquad (3.1.6)$$

The rate which expectations are updated period to period is determined by λ which Cagan defines as the "coefficient of expectation". Expectations of the h period ahead inflation rate are determined by h-period lagged expectations for current inflation and some adjustment for the most recently realised forecast error. Consequently, where forecast errors are zero, expectations remain unchanged.

Through simple rearrangement of (3.1.6), the adaptive expectations hypothesis can be represented by a weighted average model of current inflation and h-period lagged expectations:

$$E_{i,t}[\pi_{t+h}] = \lambda\pi_t + (1-\lambda)E_{i,t-h}[\pi_t] \qquad (3.1.7)$$

Once more, two extreme scenarios can be envisaged: should $\lambda = 0$, expectations are insensitive to changes in inflation, whereas should $\lambda = 1$, (3.1.7) reduces to the static expectations model (3.1.2). Moreover, the value of the adaptive coefficient is also demonstrated by Figlewski and Wachtel (1981) to illustrate agent beliefs regarding the inflation process. Where forecast errors are believed to have arisen in response to permanent innovations, λ will be much larger than if the inflation process is largely driven by transitory shocks.

Alternatively, one may wish to consider adaptive forecasting behaviour by analysing the change in expectations over the forecast horizon. From (3.1.7) the same relationship must hold h-periods earlier as illustrated by (3.1.8) below:

$$E_{i,t-h}[\pi_t] = \lambda\pi_{t-h} + (1-\lambda)E_{i,t-2h}[\pi_t] \qquad (3.1.8)$$

Subtracting (3.1.8) from (3.1.7) the change in expectations between periods $t-h$ and t can be expressed as a weighted average of the change in inflation and the previous change in expectations:

$$\begin{aligned} E_{i,t}[\pi_{t+h}] - E_{i,t-h}[\pi_t] \qquad (3.1.9) \\ = \lambda(\pi_t - \pi_{t-h}) \\ + (1-\lambda)\big(E_{i,t-h}[\pi_t] - E_{i,t-2h}[\pi_t]\big) \end{aligned}$$

The two extreme scenarios $\lambda = 0$ and $\lambda = 1$ can again be considered: the former suggests that forecast updates are equal to the h-period lagged forecast update whilst the latter proposes that the change in expectations is equal to the observed change in inflation over the forecast horizon.

The initial model proposed by Cagan (1956) is extended by Carlson and Parkin (1975) who propose that rather than solely adapting expectations to accommodate the most recent inflation observation, agents also respond to the rate of change in inflation akin to regressive expectations. Formally, they propose that expectations are subject to second-order error-learning mechanisms with agents responding to the previous two forecast errors as demonstrated by (3.1.10) below:

$$\begin{aligned} E_{i,t}[\pi_{t+h}] - E_{i,t-h}[\pi_t] & \\ &= \lambda_1\left(\pi_t - E_{i,t-h}[\pi_t]\right) \\ &+ \lambda_2\left(\pi_{t-h} - E_{i,t-2h}[\pi_{t-h}]\right) \end{aligned} \tag{3.1.10}$$

Examining data from the Livingston Survey, Lahiri (1976), Turnovsky (1970) and Figlewski and Wachtel (1981) test whether professional forecasts are consistent with the predictions of adaptive expectations. The value of the adaptive coefficient reported by Lahiri (1976) and Figlewski and Wachtel (1981) is positive and significant indicating that professionals adjust their expectations to accommodate previous errors. In contrast, for the earlier 1954-1964 sub-period, Turnovsky (1970) reports that the adaptive coefficient associated with both 6- and 12-month ahead expectations is insignificant; instead, expectations are argued to be solely a function of past forecasts. Nevertheless, for the later 1962-1969 period, the adaptive coefficient reported by Turnovsky (1970) is positive and significant, with a value greater than 0.70 for both 6- and 12-month forecasts implying that professional expectations are highly sensitive to current inflation.

Analysing SPF CPI forecasts for a more recent 1985-2009 period, the adaptive coefficient observed by Maugeri (2012) is insignificant. Instead, professional forecasts are more consistent with static expectations, with the coefficient attached to one-period lagged expectations close to one. Similarly, analysing Bloomberg expectations of US CPI for 1999-2010, the adaptive coefficient observed by Arnold (2013) is again insignificant. Moreover, the null hypothesis that the coefficients add to one is rejected in favour of the coefficients summing to less than one which Arnold (2013) claims to indicate that expectations are regressive, with professionals expecting inflation trends to be reversed over the forecast horizon.

A key objective of this study is to examine the time-variant properties of survey forecasts; this shall extend the analysis of several previous studies which have evaluated whether macroeconomic conditions impact upon the relevancy of backward-looking models. As highlighted above, Turnovsky (1970) observes that whilst the adaptive coefficient for the earlier period is insignificant, Livingston Survey forecasts are highly sensitive to inflation for the more stable latter sub-period. Moreover, during periods of increased inflation volatility, Figlewski and Wachtel (1981) observe that the value of the adaptive coefficient falls, consistent with Livingston Survey professionals recognising that the inflation process is primarily driven by transitory shocks. Similarly, utilising the error-learning model (3.1.10), Carlson and Parkin (1975) find that when UK inflation rates were low, expectations exhibit greater autoregressive behaviour, yet when UK inflation was much higher, expectations exhibit second-order error-learning characteristics. There is thus some agreement that professional forecasts are consistent with adaptive behaviour however, the sensitivity of forecasts to current inflation appears dependent upon the sample period and macroeconomic conditions.

Moreover, the adaptive principle identified in (3.1.7) must also hold for expectations of π_t formed in previous periods:

$$E_{i,t-h}[\pi_t] = \lambda(\pi_{t-h}) + (1-\lambda)E_{i,t-2h}[\pi_{t-h}] \qquad (3.1.11)$$

By extending (3.1.11) to the n-period forecast horizon and substituting back into (3.1.7), adaptive expectations hypothesis can be represented by the following geometrically distributed lag model:

$$E_{i,t}[\pi_{t+h}] = \lambda(\pi_t) + \lambda(1-\lambda)\pi_{t-h} + \lambda(1-\lambda)^2\pi_{t-2h} + \cdots + \lambda(1-\lambda)^n\pi_{t-nh} \qquad (3.1.12)$$

$$E_{i,t}[\pi_{t+h}] = \lambda(\pi_t) + \sum_{j=1}^{n} \lambda(1-\lambda)^j \pi_{t-jh} \qquad (3.1.13)$$

Furthermore as $0 < \lambda < 1$, the weight on lagged inflation values decreases, the more distant it was realised. The Cagan type model demonstrated by (3.1.12) and (3.1.13) thus asserts that whilst the most recent experiences are highly prominent when forming current expectations, past experiences enter the information set albeit with a lesser effect the more distant is the past.

The distributed lag model demonstrated by (3.1.12) and (3.1.13) has been subject to empirical testing by various studies. Analysing Livingston Survey forecasts, Tanzi

(1980) reports that the distributed lag model has a high $\bar{R}^2$ for both six- and twelve-month expectations. However, Turnovsky (1970) reports that for the earlier 1954-1964 sample period, the $\bar{R}^2$ associated with the distributed lag model was considerably lower than for the latter 1962-1969 sample period. Moreover, whilst Turnovsky (1970) argues that the distributed lag model provides a worse fit to Livingston Survey forecasts than comparative adaptive or extrapolative models, Lahiri's (1976) results slightly favour the former. The distributed lag properties of professional expectations may thus be sensitive to the sample period.

Furthermore, whilst (3.1.12) and (3.1.13) indicate that the weight on lagged values of the forecast variable the more distant in the past, the results presented by Turnovsky (1970), Lahiri (1976) and Tanzi (1980) do not appear to satisfy this property. The coefficient associated with current, inflation is generally larger than that associated with one-period lagged inflation, the coefficient for $j = n$ is generally larger than for $j = n - 1$. However, as these studies restrain n to either 2 or 3, the larger coefficient associated with $j = n$ may indicate a role for higher order lags, and the past history of inflation, for the formation of professional expectations. Moreover, extending (3.1.13) to also include the unemployment rate and treasury bill rate, Mankiw et al. (2003) reject the null hypothesis that Livingston Survey, SPF and Michigan Survey expectations are formed in accordance with to adaptive approaches. Instead, both professional and households are deemed to possess more sophisticated expectations than assumed by simple backward-looking rules.

Utilising a percentile time-series, Pfajfar and Santoro (2010) consider whether Michigan Survey forecast are consistent with adaptive expectations. Adaptive behaviour in expectations is observed by Pfajfar and Santoro (2010) to generally be larger for forecasts greater than the median, with a peak of approximately 0.4 around the 60th percentile. Furthermore, the R^2 associated with the Pfajfar and Santoro's (2010) approach exhibits a hump-shaped pattern between the 40th and 99th percentile, peaking at approximately the 75th percentile. In contrast the adaptive coefficient between the 1st and 10th percentiles and between the 30th and 40th percentiles is insignificant[37]. Consequently, the results presented by Pfajfar and Santoro (2010)

[37] Between the 10th and 30th percentiles, the adaptive coefficient is negative.

question the relevancy of adaptive behaviour on an aggregate level, with forecasts below the median inconsistent with the assumptions of the AEH.

Previous empirical studies of traditional backward-looking models appear to indicate that survey forecasts are more sophisticated than these theories predict. However, as expectations are concerned with a variables future value, economists have attempted to accommodate simple forward-looking rules into adaptive expectations models. Analysing whether expectations are backward or forward-looking, Curtin (2005) regresses Michigan Survey forecasts on past, current and future inflation rates. Whilst lagged inflation is observed to be insignificant, both the contemporaneous and future inflation rates are significant. Consequently, Curtin (2005) dismisses the AEH for Michigan Survey forecasts indicating that households employ more sophisticated techniques than extrapolating past outcomes. In contrast, Madeira and Zafar (2012) find that the coefficient on current inflation is much larger than that associated with future inflation, thus Michigan Survey forecasts are suggested to be more consistent with adaptive expectations than forward-looking rules. However, as the contemporaneous inflation rate is published with some lag, and future inflation is significant at the 1% level, household forecasts can be considered more sophisticated than predicted by backward-looking models. Empirical tests in 3.1.2 and 3.2.2 shall re-evaluate these arguments.

Despite the foundations of the AEH remaining fairly simplistic and continuing to assume that agents utilise backward-looking rules to formulate expectations, it is a theoretical improvement on the static expectations hypothesis. Firstly, it assumes that agents are sufficiently sophisticated to learn from past errors, adapting their expectations accordingly. Furthermore, it asserts that where inflation is relatively stable, expectations will progressively adjust towards the prevailing inflation rate whilst errors converge towards zero (Shaw, 1984). Therefore, providing that $0 \leq \lambda < 1$, expectations will eventually achieve a close approximation of inflation, with the rate of adjustment more rapid for larger values of λ; nevertheless, full convergence and the realisation of zero errors will never be achieved. Moreover, empirical studies have generally found that the AEH is a reasonable approximation of post-war expectations; nevertheless, as post-war US inflation has been highly persistent, Ball (2000) argues that these results are unlikely to extend to other economies or monetary regimes.

Although conventional backward-looking theories are often criticised for imposing overly restrictive information assumptions and excessive agent myopia, these models are useful for establishing differences in the formation of household and professional inflation forecasts. Empirical studies have generally refuted excessively naïve models including the static and regressive expectation theories, however, evidence concerning the AEH is more mixed. Whilst studies from the 1980's and 1990's appear generally supportive of adaptive behaviour, more recent studies (Mankiw et al., 2003, Curtin, 2005) are less inclined to support any form of backward-looking model. The remainder of this section presents formal empirical tests of these traditional theories to determine whether survey forecasts are consistent with the assumptions and predictions across a period of approximately 30 years.

3.1.2. Empirical Examination of the Consistency of Survey Forecasts with Backward-Looking Expectation Theory

The literature review in 3.1.1 indicated that there is a general consensus that traditional backward-looking models are insufficiently sophisticated to adequately accommodate the formation of agent expectations. Utilising SPF and Michigan Survey inflation forecasts, these conclusions shall be reassessed across the previously identified sample periods. Specific attention shall once more be devoted to whether the forecasts of either agent class are more consistent with these models and determine if backward-looking behaviour is more prominent for periods of increased macroeconomic stability or volatility.

In 3.1.1 the static expectations hypothesis was identified as the most basic theory of expectation formation. Given the multi-horizon forecasting structure adopted by these two surveys, to examine the performance of the static expectations hypothesis (3.1.14) shall be estimated across the four sample periods for both agent classes:

$$E_{i,t-h}[\pi_t] = \alpha_0 + \alpha_1 \pi_{t-h} + \epsilon_t \qquad (3.1.14)$$

Specifically, (3.1.14) asserts that the h-period ahead inflation forecast for agent i is determined by the current level of inflation; all other information relating to past macroeconomic conditions and the future path of inflation is ignored. To determine whether agent forecasts are consistent with the predictions of static expectations, the Wald χ^2 test shall examine the joint hypothesis $\alpha_0 = 0; \alpha_1 = 1$. The non-rejection of the Wald null hypothesis would indicate that agent inflation forecasts employ static behaviour, exclusively extrapolating the current rate of inflation. The analysis of previous studies in 3.1.1 would however suggest that (3.1.13) will be too restrictive to accommodate the manner in which both agent classes formulate expectations. The rejection of the Wald test null hypothesis would instead indicate that agents exploit wider information regarding macroeconomic conditions.

The results from testing (3.1.14) by OLS with Newey-West corrected standard errors for four-period ahead SPF and Michigan Survey forecasts ($h = 4$), are presented in Appendix 3.1 Panel A. For all four sample periods, Panel A clearly illustrates that neither the SPF or Michigan Survey forecasts are consistent with the predictions of static expectations; the Wald χ^2 tests is rejected at a very high level of significance.

The results from Panel A are, however, useful in understanding differences in the behaviour of households in comparison to professionals.

Firstly, across all four sample periods, R^2 and $\bar{R}^2$ are greater for the Michigan Survey than for the SPF indicating that (3.1.14) better accommodates the formation of household forecasts and supports the hypothesis that professional forecasts exhibit greater sophistication. Secondly, α_0 is invariably significant, potentially indicating that agent forecasts are anchored to a positive inflation rate, incorporating inflation innovations from observations of the current level. Nevertheless, this argument has little economic appeal due to the simplistic structure of static expectations; instead α_0 may be indicative of missing variables suggesting that more sophisticated models of expectation formation are required.

Considering the coefficient values, the SPF exhibits a greater α_1 value for the whole, Greenspan-Bernanke and stable periods; professional forecasts thus appear more attentive to the current inflation rate than those of households. The attentiveness of both agent classes to macroeconomic news shall be extensively evaluated in later chapters. Focusing on the volatile sub-period, α_0 for both agent classes is particularly large whilst α_1 is relatively small, albeit significant. Nevertheless, α_1 is larger for households than for professionals. Recalling that the standard deviation of inflation for the volatile period is high, this may indicate that household forecasts are more sensitive to transitory inflation shocks than professionals.

Tests of (3.1.14) evidently indicate that survey forecasts are inconsistent with the properties of static expectations. The assumption of the simultaneous arrival of new information regarding inflation and its incorporation into information sets which agents form expectations appears unrealistic. Inflation news may instead enter information sets with a short lag. Recalling from the previous chapter that survey forecasts were observed to peak several quarters after inflation, and that US inflation data is released halfway through the following month to which it is realised (Curtin, 2005), the information assumptions concerning static expectations appear to provide an over-simplistic representation of agent behaviour. One alternative would be to replace the contemporaneous inflation rate with the one period lagged inflation rate as demonstrated by (3.1.15) below:

$$E_{i,t-h}[\pi_t] = \alpha_0 + \alpha_1\pi_{t-h-1} + \epsilon_t \qquad (3.1.15)$$

The results from testing (3.1.15) for four-period ahead SPF and Michigan Survey forecasts ($h = 4$), are presented in Appendix 3.1 Panel B, however, only marginal differences are observed relative to Panel A. Specifically, α_0 remains invariably significant across both agent classes and all four sample periods, whilst for the whole, Greenspan-Bernanke and stable periods, α_1 remains larger for professionals than households.

Interestingly, whereas the baseline model (3.1.14) appears to perform better in terms of R^2 and $\bar{R}^2$ for Michigan Survey forecasts, the lagged specification (3.1.15) appears a superior explanation of SPF forecasts. Therefore relative to the contemporaneous static model (3.1.14), professional forecasts appear to be better represented by lagged values of the forecast variable; this may further indicate that professional expectations are more backward-looking relative to those formed by households. Nevertheless, the Wald χ^2 statistics relating to (3.1.15) again reject the null hypothesis $\alpha_0 = 0, \alpha_1 = 1$ across the four sample periods for both agent classes. Consequently, survey forecasts can be considered inconsistent with the properties of static expectations.

As noted in 3.1.1, an agent whose forecasts are consistent with the properties of static expectations not only behaves myopically, but also ignores all other information, including the past history of inflation. An alternative backward-looking theory introduced in 3.1.1 concerns regressive expectations (Hicks, 1939, Turnovsky, 1972). Rather than expectations simply extrapolating past inflation, agents adjust forecasts to account for the past trend in inflation occurring between $t - h$ and t, specifically:

$$E_{i,t}[\pi_{t+h}] = \alpha_0 + \alpha_1[\pi_t] + \alpha_2[\pi_t - \pi_{t-h}] + \epsilon_t \qquad (3.1.16)$$

To carefully examine the response of expectations to inflation trends, the unrestricted form of (3.1.16) shall be compared to the restricted model which imposes full extrapolation of expectations, implying $\alpha_1 = 1$. Where a significant value of α_2 is observed, agent forecasts expect the inflation trend observed over the previous four quarters to be replicated over the following four quarters. Tests of (3.1.16) are presented in Appendix 3.2.

Tests of (3.1.16) and the regressive expectations hypothesis again reveal differences in the formation of professional and household inflation forecasts. For SPF forecasts, the value of α_2 across the four sample periods is invariably negative and highly significant; yet, for the Michigan Survey, it is not possible to reject the t-test null hypothesis $\alpha_2 = 0$ for any sample period[38]. This indicates that whilst professionals anticipate a reversal of inflation trends, households do not incorporate inflation trends into expectations. Furthermore, whilst regressive expectations are an improvement upon static hypotheses for professionals, increases in $\bar{R}^2$ are small. Both professionals and households thus appear to utilise wider information than the inflation rate and associated trends when forming expectations; consequently, survey forecasts appear more sophisticated than the regressive expectations hypothesis.

In accordance with previous studies, the results from Appendix 3.1 and Appendix 3.2 indicate that survey forecasts are not fully compatible with the predictions of either static or regressive expectations. Nevertheless, the discussion in 3.1.1 suggested these naïve models were overly restrictive and assumed agents exercised excessive myopia in forming expectations, and instead proposed the adaptive expectations hypothesis as a credible alternative. The AEH proposes that agents update previous expectations in proportion to forecast errors as demonstrated by (3.1.6) and (3.1.7). The AEH shall be formally examined using SPF and Michigan Survey forecasts across the four sample periods using the following empirical models:

$$E_{i,t}[\pi_{t+h}] = \alpha_0 + \alpha_1 E_{i,t-j}[\pi_t] + \alpha_2[\pi_t] + \epsilon_{i,t} \qquad (3.1.17)$$

$$E_{i,t}[\pi_{t+h}] = \alpha_0 + \alpha_1 E_{i,t-j}\left[\pi_{t-j+h}\right] + \alpha_2\left(\pi_t - E_{i,t-h}[\pi_t]\right) + \epsilon_t \qquad (3.1.18)$$

[38] For the whole and volatile sub-periods, the t-test null hypothesis is rejected at a 10% level of significance.

Given the four period ahead structure of survey forecast employed in this study ($h = 4$), (3.1.17) and (3.1.18) shall be analysed for both one-period ($j = 1$) and four period ($j = 4$) adjustments.

The results for the Cagan specification (3.1.17) are presented in Appendix 3.3. For both agent classes, α_2 is invariably significant across all for sample periods, indicating that expectations are updated as new information regarding inflation is revealed. Interestingly, the value of α_2 is invariably larger for Michigan Survey forecasts; this may indicate that household forecasts exhibit greater sensitivity to current conditions and transitory shocks while professional forecasts appear more anchored[39]. Moreover, comparing α_2 for $j = 1$ and $j = 4$, the adjustment to four-period ahead forecasts is notably larger thus indicating that agents expect inflation to steadily evolve over the forecast horizon. Nevertheless, expectations do not fully conform with the weighted average predictions of the AEH as Wald χ^2 tests generally reject the null hypothesis $\alpha_1 + \alpha_2 = 1$. Furthermore, for both $j = 1$ and $j = 4$, (3.1.17) the R^2 and $\bar{R}^2$ values indicate that (3.1.17) is a relatively good explanation of survey forecasts, with the values particularly high for SPF forecasts across the whole, Greenspan-Bernanke and stable sample periods. Furthermore, for both agent classes, the adaptive expectations model (3.1.16) outperforms the regressive model (3.1.18). These results are analogous to Pfajfar and Santoro (2010) and indicates that error adjustment better captures expectation revision than trend extrapolation. For both agent classes however, the value of the constant remains, in general, large and significant. Therefore, although (3.1.17) is less restrictive than naïve models, survey forecasts appear to be more sophisticated, utilising wider information sets than assumed by the Cagan hypothesis.

As demonstrated by (3.1.18), the AEH can also be specified to consider the evolution of expectations with respect to forecast errors. However, given the four period structure of survey data employed in this study, there are complications regarding the appropriate lag j with empirically testing (3.1.18). For both $j = 1$ and $j = 4$, both α_1 and α_2 are positive and significant for both agent classes; however, the value of α_2 is larger for Michigan Survey forecasts consistent with agents exhibiting larger

[39] Greater anchoring behaviour on the part of professionals also conforms with the observation of low standard deviation values previously observed for the SPF in the previous chapter.

errors making larger adjustments (Madeira and Zafar, 2012). Moreover, the smaller value of α_2 associated with the error adjustment of SPF forecasts may further indicate that professional expectations are less sensitive to transitory shocks. Furthermore, for both agent classes the adaptive coefficient is larger for longer forecast horizons ($j = 4$) than for shorter horizons ($j = 1$); however, this is unsurprising as agent forecasts react to a greater volume of new information, or 'news', in the intervening period.

Moreover, as with the initial Cagan specification, the R^2 and $\bar{R}^2$ values indicate that the variance amongst survey forecasts is reasonably well explained by (3.1.18). Interestingly, whereas SPF forecasts for $j = 1$ exhibit larger R^2 and $\bar{R}^2$ values than for $j = 4$, the reverse is observed for Michigan Survey forecasts. As previously suggested, this may indicate that households respond to new information with some lag, whilst professionals have the processing capability to immediately incorporate new information into expectations. Despite the apparent pervasiveness of adaptive backward-looking behaviour, to be consistent with the AEH, survey forecasts must satisfy the Wald null hypothesis of $\alpha_0 = 0, \alpha_1 + \alpha_2 = 1$. The χ^2 statistics presented in Appendix 3.4 however indicate that for both $j = 1$ and $j = 4$, neither SPF nor Michigan Survey forecasts are consistent with this property of the AEH. Nevertheless, there is some evidence suggesting that professional forecasts are consistent with a weighted average of past forecasts and forecast errors. However, as α_0 is generally positive and significant, survey forecasts again appear more sophisticated than the assumptions of adaptive expectations.

For the whole, Greenspan-Bernanke and stable periods, the values of α_1 and α_2 associated with SPF forecasts are generally analogous suggesting that the adaptive behaviour of professional expectations is fairly insensitive to macroeconomic conditions. In contrast, whilst the adaptive behaviour of Michigan Survey forecasts is approximately identical for the whole and Greenspan-Bernanke sample periods, the value of α_1 for the stable sub-period is substantially lower; this is accompanied by increases in both α_0 and α_2. This could indicate that information during periods of reduced macroeconomic uncertainty is more widely available; consequently, the information acquisition and processing costs associated with the formation of household expectations are reduced.

For the volatile sub-period, where the magnitude of forecast errors was previously observed to be large, it may be expected that agents employ greater error adjustment behaviour to expectation behaviour. However, although for both agent classes the adaptive coefficient remains positive and significant, the value of α_2 conforms with the three alternative sample periods. This may indicate that both agent classes do not believe that large forecast errors result from permanent shocks; moreover, as α_1 remains significant and relatively high, agents may consider forecast errors a result of transitory shocks. Nevertheless, the constant α_0 for both agents is generally much larger than for the three alternative sample periods, whilst the Wald χ^2 statistics also reject the Wald null hypotheses. Consequently, survey forecasts can again be considered inconsistent with the predictions of the AEH, which for the most recent period of macroeconomic uncertainty, remains insufficiently sophisticated to fully distinguish the formation of agent expectations.

Although both agent classes were deemed to exhibit more sophisticated than the initial Cagan specification of the AEH, it was further observed in Appendix 3.4 that professional forecasts exhibited some consistency with a weighted average structure of past forecasts and errors. In 3.1.1 however, the baseline adaptive model was identified with a more general geometrically distributed lag specification of past inflation. To assess whether survey forecasts are compatible with the distributed lag specification of the AEH, the following model, akin to those presented by Turnovsky (1970), Lahiri (1976), Tanzi (1980) and Mankiw et al. (2003), shall be empirically examined:

$$E_{i,t}[\pi_{t+h}] = \alpha_0 + \alpha_1\pi_t + \sum_{j=1}^{n} \alpha_{j+1}\pi_{t-j} + \epsilon_t \qquad (3.1.19)$$

Results from testing (3.1.19) for SPF and Michigan Survey forecast across the four sample periods are presented in Appendix 3.5 and Appendix 3.6 respectively; specifically, due to the four-period horizon of inflation forecasts the last four ($n = 3$) and eight ($n = 7$) inflation observations are considered[40]. Unlike the specification identified in (3.1.12), the coefficients on lagged inflation clearly do not follow a geometric progression with steadily declining weights the more distant is

[40] Furthermore, $n = 7$ is synonymous to the tests employed by Mankiw et al. (2003).

the past. Furthermore, the Wald χ^2 test null hypothesis that expectations are a weighted average of past inflation observations $\sum_{i=1}^{n} \alpha_i = 1$ is invariably rejected at very high levels of significance. Moreover, as previously highlighted regarding the results presented in Appendix 3.3 and Appendix 3.4, the constant α_0 remains large for $n = 3$ and $n = 7$ for both agent classes across all four sample periods. Again, in accordance with the conclusions of Mankiw et al. (2003) and Curtin (2005), these results indicate that survey forecasts are more sophisticated than the solely backward-looking assumptions of adaptive expectations.

The adaptive expectations hypothesis has proven empirically useful for analysing the manner which agents formulate expectations. Primarily, the AEH appears most relevant for professional expectations with the adaptive coefficient invariably significant whilst high values of R^2 and $\bar{R}^2$ were also observed. Interestingly, whilst tests of the baseline adaptive model indicate that professional forecasts are best associated with adjustments to one-period lagged expectations in response to errors, adjustments to four period lagged expectations in response to errors appear to better characterise the adaptive forecasting behaviour of households. This suggests that whilst professional expectations evolve period to period in response to new information, this information slowly diffuses into household information sets. Furthermore, it may indicate a seasonality effect within the evolution of household expectations. The former is an issue that shall be returned to in later chapters with particular reference to sticky information and epidemiological models of Mankiw and Reis (2002) and Carroll (2003).

3.1.3. Discussion of Backward-Looking Expectations

Until the latter decades of the 20^{th} century, macroeconomic theory predominantly employed backward-looking techniques of expectation formation; these models induce a degree of persistence and are often found to be a reasonable explanation of inflation and associated expectations (Ball, 2000). These models restrict an agents information set to consist exclusively of contemporaneous and lagged values of the forecast variable, expectations and associated errors; all other information regarding economic conditions is implicitly assumed to be embodied within these variables. This section has reconsidered several key theories relating to backward-looking expectations and has examined whether survey forecasts are consistent with the predictions of these models.

In accordance with previous studies, the forecasts of both professionals and households are deemed inconsistent with the properties of static expectations. The assumptions of static forecasting can thus be considered as excessively myopic and furthermore, fails to acknowledge the variable nature of inflation established in the previous chapter. In contrast, tests concerning the AEH indicated that the expectations of both professionals and households exhibit significant adaptive behaviour across all four sample periods.

The results indicate that professional forecasts are more consistent with simple backward-looking rules during periods of greater macroeconomic stability, when forecasting errors are less costly, but employ more sophisticated techniques during periods of greater macroeconomic uncertainty. In contrast, the results further suggest that household expectations utilise wider information when it is more freely available during periods of greater stability whilst backward-looking rules are reverted to when there are greater costs associated with the acquisition and processing of information.

The AEH illustrated by (3.1.17) and (3.1.18) assumes that agents expectations evolve steadily through extrapolating past values of actual and expected inflation and associated forecast errors. The AEH improves upon static modelling of expectations, recognising that agents are able to learn from experiences, adjusting expectations in response to forecast errors. Adaptive behaviour appears most relevant for professional expectations during periods of greater macroeconomic stability; nevertheless, the adaptive coefficient was also significant for household forecasts across all four sample periods. However, it was concluded that survey forecasts exhibit greater sophistication than predicted by the AEH.

Utilising four-period ahead survey expectations from the SPF and Michigan Survey, the AEH under (3.1.18) was examined considering both one-period ahead ($j = 1$) and four-period ahead ($j = 4$) forecast updates. These specifications may however be considered unable to accurately accommodate modifications to agent forecasts. Firstly, whilst $j = 1$ attempts to analyse the period-to-period evolution of forecasts, the error of the one-period lagged forecast error has yet to be realised; instead, the contemporaneous forecast error relates to four-period lagged forecasts. Nevertheless, utilising $j = 4$ is also unsatisfactory as (3.1.18) consequently implies that expectations across a four-period horizon evolve independently of each other[41].

One solution to these issues would be to consider how agents adapt their expectations across the forecast horizon for a given target period. Empirically, this can be examined by varying both h and j within a specification akin to (3.1.18) and also requires the employed survey data to exhibit multi-horizon properties. As noted in Chapter 2, whilst the SPF provides multi-horizon inflation forecasts, the Michigan Survey is only concerned with year ahead forecasting; therefore, whilst it would be possible to examine the consistency of SPF forecasts with the AEH, subject to forecast revisions, the structure of the Michigan Survey is not compatible with a similar empirical strategy. As a key objective of this study is to compare the forecast properties across the two agent classes, the analysis of the AEH subject to forecast revisions is left for future research[42].

A limitation of backward-looking expectation theories is that they require the forecast variable to exhibit a substantial degree of persistence. Due to the persistence of post-war US inflation, as demonstrated in the previous chapter, backward-looking behaviour is likely to perform reasonably well. Thus, it is not particularly surprising that survey forecasts from the past thirty years are fairly consistent with the properties of the AEH. However, in accordance with the Lucas

[41] This specification does however assume that information arising across the intervening three periods is embodied within the forecast error upon which expectations are modified.
[42] In later chapters associated with professional forecasts and information rigidity, the multi-horizon structure of the SPF shall be analysed and examined in greater detail.

Critique, where an economy is characterised by an alternative monetary regime where inflation is less persistent, backward-looking expectation models are likely to be greatly inferior. For example, in the presence of an inflation target, Ball (2000) demonstrates that inflation would exhibit negative serial correlation as policy will act to reverse deviations from target; consequently, expectations which exhibit backward-looking behaviour will realise systematic forecast errors. The Lucas Critique instead implies that agents are more forward-looking and incorporate the objectives of policy into their information set and subsequently their expectations. Therefore, to accommodate agent behaviour across various monetary regimes and inflation dynamics, a more comprehensive approach to expectation formation is required.

Despite traditional backward-looking models being a key contribution of expectation theory, the empirical analysis in this section indicates that backward-looking expectation theory is unable to fully characterise the formation of survey inflation forecasts. Nevertheless, these models have been useful in distinguishing differences in the manner which various agent classes form expectations. Whilst Michigan Survey forecasts exhibit greater consistency with static behaviour, SPF forecasts are more consistent with adaptive expectations. Nevertheless, survey forecasts appear to be more sophisticated than the simplistic assumptions of traditional backward-looking models allow.

An alternative strategy is thus required to capture the manner which agents form expectations. The restrictive and myopic nature of backward-looking models could be relaxed, permitting agents to form expectations on a range of macroeconomic variables or some proxy which incorporates this information[43]. Considering forward-looking models is another option where agents can rationally accommodate information regarding future macroeconomic innovations into expectations. Nesting backward-looking behaviour into these models has previously been productive (Curtin, 2005, Madeira and Zafar, 2012) and provides an alternative option. More recent models, including the sticky-information and epidemiological models (Mankiw and Reis, 2002, Mankiw et al., 2003, Carroll, 2003) have also applied backward-looking behaviour to expectation theory and shall be analysed in Chapter

[43] The epidemiological model of Carroll (2003) which shall be examined in the following chapter is a prominent example that accommodates this concept.

5. In 3.2, the prominent forward-looking rational expectations hypothesis shall be formally introduced whilst empirical tests shall examine whether survey forecasts are consistent with various properties required for rationality.

3.2. Rational Expectations

In 3.1.3, a number of criticisms with backward-looking expectation theories were identified, questioning their suitability for macroeconomic analysis. As survey forecasts are not robustly consistent with the predictions of these models, particularly across periods associated with increased macroeconomic volatility, a more general theory of expectation formation is required. In the latter 20th century, the rational expectations hypothesis (REH) was proposed and developed; it has since become widely employed throughout the macroeconomic literature with many theoretical implications which include generating efficient labour and capital markets, and providing the necessary conditions for policy neutrality.

The notion of RE was first proposed by Muth (1961:316) indicating that "expectations, since they are informed predictions of future events, are essentially the same as the predictions of relevant economic theory". In the 1970's, the concept was widely adopted by macroeconomists, revolutionising new classical theory, with notable contributions by Robert Lucas and Thomas Sargent amongst others. Despite recognising that past decisions are irrelevant for forming current expectations, Keynes' *General Theory* appears to refute the theoretical foundations of the REH; specifically, Keynes argues that the resources required for agents to acquire and process information would be sub-optimal given the assumption of substantially unchanging circumstances. Nevertheless, despite advocating a backward-looking expectation regime, Keynes appreciates that expectations may depart from the path of static equilibria in the event of foreseeable circumstances.

The properties of the REH assume the efficient utilisation of all available information; consequently, agent expectations consistent with RE are devoid of systematic errors with deviations from actual outcomes resulting entirely from unanticipated disturbances. The economic literature has thus established a number of properties which forecasts are required to satisfy to be deemed consistent with RE theory.

This section discusses the theory behind the concept of RE and analyses whether survey forecasts are consistent with the properties required for rationality. Sub-section 3.2.1 defines the concept of RE within economics, identifying the various properties of the REH and their applicability to survey forecasts. The empirical results of previous studies are also considered in 3.2.1 to determine whether economists have established a consensus regarding the empirical relevancy of the REH. Sub-section 3.2.2 presents formal empirical tests of the REH and examines whether survey forecasts satisfy the conditions required for rationality. Specifically, the results shall be analysed to identify similarities and asymmetries between the rationality of SPF and Michigan Survey forecasts. Furthermore, these tests shall be conducted over the four previously identified sample periods to ascertain whether consistency with the various properties of the REH is time-variant and dependent upon prevailing macroeconomic conditions. The final sub-section provides a discussion of the results presented in this section, determining whether the REH is applicable to survey forecasts and examines various criticisms associated with RE.

3.2.1. The Theoretical Background of the Rational Expectations Hypothesis

As the REH states that agents utilise all available information, such that expectations mirror those derived by economic theory, a rational forecast must exhibit the following properties: unbiasedness, efficiency and consistency. The economic literature has proposed and examined various tests to determine whether agent expectations conform to the predictions of the REH. This sub-section shall formally introduce these properties, identify the appropriate empirical predictions and determine whether previous empirical studies have established a general consensus regarding the rationality of agent expectations.

The first key property of the REH concerns the unbiasedness of expectations. For expectations to be consistent with this property, unpredictable and randomly distributed forecast errors are required; expectations are therefore not permitted to systematically deviate from actual values. Although expectations are not required to exhibit full accuracy, errors must be consistent with white noise residuals which, by definition, have zero mean and finite variance. Unlike the AEH, current expectations are therefore independent of past errors, as their random nature does not contain any relevant information regarding the future path of the forecast variable.

Following Brown and Maital (1981), Gramlich (1981) and Adam and Padula (2011), (3.2.1) presents the unbiasedness property for h-period ahead forecasts:

$$\pi_t = \alpha_0 + \alpha_1 E_{i,t-h}[\pi_t] + \epsilon_{i,t} \qquad (3.2.1)$$

For expectations to be consistent with the unbiasedness property $\alpha_0 = 0, \alpha_1 = 1$ must be satisfied, whilst $\epsilon_{i,t}$ must be a white noise residual. Should agent forecasts be inconsistent with this elementary property, expectations cannot be considered as fully rational[44].

Despite being a fairly weak test of rationality, empirical studies commonly analyse whether expectations are consistent with the unbiasedness property. Moreover, failure to conform to this simple property of the REH would indicate that

[44] Keane and Runkle (1990) note that in the presence of differential costs between positive and negative forecast errors, expectations may still be formed rationally despite inconsistency with the unbiasedness property. Similarly, Lai (1990) report that where the mechanisms generating the forecast variable change over time, violations of the unbiasedness property are not sufficient to reject the rationality of expectations.

expectations are non-rational and be unable to conform to the predictions of stronger requirements of rationality. Early empirical studies which considered the rationality of professional expectations often rejected the unbiasedness property. Analysing the Livingston Survey, Figlewski and Wachtel (1981), Gramlich (1983) and Bryan and Gavin (1986b) reject the null hypothesis of unbiasedness, whilst Zarnowitz (1985)[45] and Bagehstani and Kianian (1993) also report that SPF forecasts do not conform to this elementary property of the REH. However, the results of these studies may be dependent upon the sample period employed. More recent studies which analyse the SPF, including Keane and Runkle (1990), Romer and Romer (2000), Mehra (2002), Mankiw et al. (2003)[46], Coibion and Gorodnichenko (2010), Croushore (2010), Adam and Padula (2011), and Brissmis and Migiakis (2011) report that professional inflation forecasts are consistent with the unbiasedness property.

Despite Thomas (1999) and Mehra (2002) being unable to reject the unbiasedness of Livingston Survey expectations for their respective full sample periods, this property of the REH is not observed by either study when examined for sub-periods characterised by either increasing and decreasing inflation. This suggests that professional forecasts deviate from the predictions of RE during periods with distinct macroeconomic conditions. Moreover, extending the analysis of unbiasedness to consider the individual expectations of the SPF, Capistrán and Timmerman (2009) reject the unbiasedness null hypothesis for over 50% of professional forecasters. However, bias at an individual level is not necessarily an indicator that average professional forecasts violate the unbiasedness property and the REH in general.

Similarly, there is some debate regarding whether household expectations are empirically consistent with the unbiasedness property. Although Gramlich (1983) and Mankiw et al. (2003) report that household expectations violate the unbiasedness condition, there is some general consensus that Michigan Survey inflation forecast are consistent with this property of RE. Indeed, Bryan and Gavin (1986b), Batchelor and Dua (1989), Rich (1989), Baghestani (1992), Thomas (1999), Mehra (2002)[47] and Curtin (2005) are unable to reject the unbiasedness null hypothesis for the

[45] The rejection of the unbiasedness property reported by Zarnowitz's (1985) is argued by Keane and Runkle (1990) to arise from the use of revised data.
[46] The unbiasedness null hypothesis for the Livingston Survey is rejected by Mankiw et al. (2003).
[47] Although Mehra (2002) does not observe systematic bias across median Michigan Survey forecasts, the χ^2 null hypothesis of unbiasedness is rejected for the mean series

Michigan Survey over various sample periods. Thus, despite often being considered less informed than professionals, there is some general agreement amongst previous studies that consensus household forecasts are not systematically biased.

There is however some disagreement amongst empirical studies concerning whether the unbiasedness of household forecasts is time-variant. Despite being unable to reject the unbiasedness of the Michigan Survey for a period of approximately 25 years, Gramlich (1983) finds that for the 1970-80 sample period household inflation forecasts violate this property of the REH. Nevertheless, for earlier sample periods encompassing the 1970's, neither Thomas (1999) nor Mehra (2002) are unable to reject the unbiasedness condition for mean Michigan Survey forecasts; however, both studies reject the unbiasedness null hypothesis for later sample periods. The unbiasedness of mean Michigan Survey forecasts thus appears to be time-variant. Similarly, Thomas and Grant (2008) find that whilst median Michigan Survey forecasts satisfy the unbiasedness property for the whole sample and early sub-periods, the null hypothesis is violated for the latter period associated with low and stable inflation. Moreover, conclusions appear dependent upon the series employed. Although median inflation forecasts were unavailable from the Michigan Survey until 1978, Thomas (1999) nor Mehra (2002) are able to reject the unbiasedness of median Michigan Survey, albeit solely for more recent sample periods.

Despite being a key indicator of whether agent forecasts are consistent with the REH, tests of unbiasedness are often considered fairly weak in classifying expectations as rational. The efficiency property has broader scope, requiring expectations to make use of the available information set ensuring that forecast errors are unpredictable (Mankiw et al., 2003), and is thus considered a stronger indicator of the rationality of expectations. Although previous empirical studies have employed various tests of efficiency, the orthogonality property, implying that forecast errors are necessarily uncorrelated with any information available when agents form their expectations, is commonly analysed. This can be mathematically represented as follows:

$$\pi_t - E_{i,t-h}[\pi_t] = \alpha_0 + \sum_{j=1}^{N} \alpha_j I_{t-h} + \epsilon_t \tag{3.2.2}$$

The available information set available in period $t-h$ is represented by I_{t-h}. To conform to the orthogonality property, the non-rejection of the joint null hypothesis $\alpha_0 = 0, \alpha_j = 0$ for all j is required. Many economists however consider these assumptions to be overdemanding of agent expectations; empirical studies, including Figlewski and Wachtel (1981) and Rich (1989), have thus replaced I_{t-h} and the assumption of all available information with the most recent forecast error. Consequently, (3.2.3) requires respecifying as follows:

$$\pi_t - E_{i,t-h}[\pi_t] = \alpha_0 + \alpha_1\left(\pi_{t-1} - E_{i,t-h-1}[\pi_t]\right) + \epsilon_t \qquad (3.2.3)$$

Again, orthogonality requires the non-rejection of the joint null hypothesis $\alpha_0 = 0, \alpha_1 = 0$; otherwise, information embodied within past errors is not fully exploited, violating the efficiency property required by the REH[48]. Although evidence of serially correlated forecast errors is often considered sufficient of the rejection of the REH, the length of the forecast horizon needs to also be considered. Indeed, expectations may be considered rational despite the presence of serially correlated forecast errors, providing that the order of correlation does not exceed the forecast horizon.

Early empirical studies of the REH often reject the rationality of the Livingston Survey, primarily for the failure to satisfy the efficiency property. Whilst Brown and Maital (1981) find that both 6-month and 12-month ahead forecasts are unable to efficiently exploit the available information set, Figlewski and Wachtel (1981) and Gramlich (1983) observe serially correlated forecast errors. Moreover, despite respecifying Gramlich's (1983) model to resolve inconsistencies regarding the forecast horizon and sampling frequency, the results presented by Bryan and Gavin (1986b) continue to reject the efficiency property for Livingston Survey expectations. Similarly, Zarnowitz (1985) observes that SPF errors are autocorrelated suggesting that professional forecasts are robustly inconsistent with the error orthogonality condition for earlier sample periods.

More recent studies have also analysed whether professional forecasts are consistent with the efficiency property. Despite Thomas (1999) observing weak form

48 Should agents be unable to distinguish between permanent and transitory shocks, Cukierman (1986) suggests that' the observation of serially correlated forecast errors is not a clear violation of the REH.

efficiency for Livingston Survey expectations, Mankiw et al. (2003) find that both Livingston Survey and SPF forecast errors are persistent. Moreover, Mehra (2002) and Mankiw et al. (2003) find that neither the Livingston Survey nor the SPF exhibit strong-form efficiency; instead, correlation between forecast errors and various macroeconomic variables is observed[49]. Similarly, Molnar and Reppa (2009) report that SPF forecasts are strongly inefficient with respect to a range of macroeconomic variables. Due to failure to satisfy the efficiency criteria, these studies thus conclude that professional forecasts are not fully rational. Similarly, Thomas (1999) rejects the efficiency of Livingston Survey forecasts due to failure to accommodate information regarding the output gap. However, Thomas's (1999) results are based on real time information, but as Mehra (2002) and Orphanides and van Norden (2005) demonstrate, real-time data concerning the output gap is subject to significant revision. Consequently, Thomas's (1999) results can be interpreted to show that the Livingston Survey is in fact consistent with the efficiency property subject to the information available to agents at the time that forecasts were formed.

Moreover, Thomas (1999) reports that Michigan Survey forecast errors are also uncorrelated with all macroeconomic information except the output gap. Similarly, Roberts (1997) and Mehra (2002) cannot reject χ^2 null hypothesis that median Michigan Survey forecasts are efficient with respect to past information. These results are in accordance with those of Rich (1989) who observes that Michigan Survey forecasts do not violate various GMM tests of orthogonality and efficiency. In comparison to professional forecasts, there thus appears greater evidence that household expectations are more consistent with the efficiency criteria required for rationality; however, this view is far from unanimous. For example, Mankiw et al. (2003) find that Michigan Survey forecast error are persistent and jointly correlated with various macroeconomic variables. There thus appears some debate regarding whether household expectations satisfy the efficiency criteria required for rationality.

The failure to satisfy the error orthogonality condition strongly indicates that expectations are not rational; however, other attributes of expectations also contribute to the efficiency property. One additional feature concerns the

[49] Whilst Livingston Survey forecasts are found to be correlated with revised data concerning economic variables, Mehra (2002) is unable to reject the efficiency of the Livingston Survey when real-time data is employed.

consistency condition. To conform with this property, expectations over multiple forecast horizons for the same target date must be generated recursively (Mullineaux, 1978). Specifically, the period t forecast for inflation in period $t + h$ must equal the forecast formed in period $t - k$ for the same target date (Pesaran and Weale, 2006); revisions are thus solely dependent upon the arrival of new information. The consistency property can be represented as:

$$E_{i,t}[\pi_{t+h}] = E_{i,t-k}[\pi_{t+h}] + \epsilon_t \qquad (3.2.4)$$

Under the simplifying assumption that the relevant information set comprises of the past history of inflation, Pesando (1975) examines an alternate specification of the consistency property. Specifically, expectations are required to consistently apply the information embodied in past inflation rates across multi-horizon forecasts as demonstrated by (3.2.5):

$$\begin{aligned} E_t[\pi_{t+h}] &= \alpha_1\pi_t + \alpha_2\pi_{t-1} + \cdots + \alpha_n\pi_{t-n} + u_t \\ E_{t-1}[\pi_t] &= \beta_1 E_{t-1}[\pi_t] + \beta_2\pi_{t-1} + \cdots + \beta_n\pi_{t-n} + u_{t-1} \end{aligned} \qquad (3.2.5)$$

For expectations to be consistent with the consistency property requires $\alpha_i = \beta_i$ for all $i = 1, \dots, n$. Despite being unable to reject the efficiency condition of utilising information in past inflation rates, Pesando (1975) rejects the null hypothesis of the rationality of Livingston Survey expectations due to failure to satisfy the consistency condition. In contrast, Mullineaux cannot reject the consistent condition for either adjusted or unadjusted Livingston Survey forecasts. A more recent study by Patton and Timmermann (2012) utilising Federal Reserve Greenbook CPI and GDP deflator forecasts rejects the consistency property. Consequently, there appears limited evidence that professional forecasts satisfy the consistency condition required for efficiency and rationality[50].

Although tests of the unbiasedness, error orthogonality and consistency conditions are useful in ascertaining whether agent expectations are consistent with the REH, economists are additionally interested in determining whether the forecasts of one agent class are more rational relative to their counterparts. Several studies including Bryan and Gavin (1986a) and Batchelor and Dua (1989) have analysed the relative

[50] Due to the structure of the Michigan Survey and the need for multi-horizon forecasts to examine tests akin to (3.2.4), empirical evidence concerning the consistency of household forecasts is limited.

efficiency of competing forecasts. To be considered efficient, an agents forecast cannot be improved by utilising information embodied within the forecast of some other agent. To examine whether the Michigan Survey forecast is 'conditionally efficient' to those reported by the Livingston Survey, Bryan and Gavin (1986a) evaluate the following model:

$$\pi_t = \alpha_0 + \beta_1 E_{P,t-h}[\pi_t] + \beta_2 E_{H,t-h}[\pi_t] + \epsilon_t \qquad (3.2.6)$$

Where $E_{P,t-h}[\pi_t]$ and $E_{H,t-h}[\pi_t]$ denote the h-period ahead forecasts of professionals and households respectively. The efficiency of professional forecasts requires the non-rejection of the joint null hypothesis $\alpha_0 = 0, \beta_1 = 1, \beta_2 = 0$, whilst the efficiency of household forecasts requires $\alpha_0 = 0, \beta_1 = 0, \beta_2 = 1$. Evaluating (3.2.6), Bryan and Gavin (1986a) conclude that between 1949-1985, Michigan Survey forecasts are efficient relative to the Livingston Survey; however, professional expectations reported by the Livingston Survey could be improved by utilising information embodied within household forecasts. However, for 1978 – 1985, Baghestani (1992) observes that monthly Michigan Survey forecasts have less predictive power than adaptive forecasts. Consequently, whilst the results of Bryan and Gavin (1986a) appear to indicate that the expectations of households exhibit greater rationality than those of professionals, the greater predictive power of adaptive expectations, as observed by Baghestani (1992), also questions the relevancy of Michigan Survey forecasts.

A similar test of efficiency to determine whether the expectations of one agent class are more informative than the other is presented by Batchelor and Dua (1989). Specifically, Batchelor and Dua (1989) regress the professional (household) forecast error upon the contemporaneous household (professional) forecast as demonstrated below:

$$\pi_t - E_{P,t-h}[\pi_t] = \alpha_0 + \beta_1 E_{H,t-h}[\pi_t] + \epsilon_t \qquad (3.2.7)$$

$$\pi_t - E_{H,t-h}[\pi_t] = \alpha_0 + \beta_2 E_{P,t-h}[\pi_t] + \epsilon_t \qquad (3.2.8)$$

If the forecasts of the other agent class contain some additional information, the null hypothesis $\beta_i = 0$ will be rejected. Analysing Michigan Survey and Livingston

Survey forecasts between 1956-1983, Batchelor and Dua (1989) do not find any evidence that the forecasts of either professionals or households are significantly more informative than the other[51].

For the last forty years, the REH has been widely employed by macroeconomists and has important theoretical implications for various models. However, to be classified as 'rational', expectations are required to satisfy the various properties and conditions as identified above. Nevertheless, previous empirical studies which have analysed survey forecasts have indicated that both professional and household expectations are, at best, partially rational. Moreover, the results from previous studies appear dependent upon the sample period employed indicating that the rationality of survey forecasts is sensitive to prevailing macroeconomic conditions.

Despite the empirical conclusions of previous studies identified above, opponents of RE question whether the strong form Muthian hypothesis, advocating that expectations mirror the actual structure of the economy, is over-restrictive to be considered as an appropriate assumption of agent forecasts. Moreover, Prescott (1977) and Sargent (1982) argue that the theoretical foundations and policy implications of RE are deliberately abstract, and not derived from direct empirical evidence. Furthermore, Pesaran (1987) argues that testing the REH based on any form of empirical data is unable to provide a reliable evaluation as observed expectations, including survey forecasts, only consider a small sample of the population and are likely to be error ridden. However, to assume that RE is empirically artificial implicitly asserts that real-world forecasts, including those reported in surveys, are irrational, which has uncomfortable implications for macroeconomic modelling (McCallum, 1979). Furthermore, Lucas (1980) and Lovell (1986) acknowledge that the relevance of any theory can only be judged upon its empirical performance. Yet, whilst the empirical analysis of RE is essential, rather than determining whether agent forecasts support the theory of RE, testing must instead consider whether forecast observations are consistent with the predictions of the RE (Prescott, 1977).

Considering various tests akin to those identified in this sub-section, 3.2.2 empirically re-examines whether SPF and Michigan Survey inflation forecasts are

[51] Similar results are also presented by Batchelor and Dua (1989) for various sub-periods.

consistent with the properties of the REH and determine the relative rationality of professional and household expectations. Furthermore, following Thomas (1999) and Mehra (2002) it shall be identified whether violations of the various criteria required for rationality are time-variant and dependent upon the sample period and underlying macroeconomic conditions.

3.2.2. Empirical Examination of the Consistency of Survey Forecasts with REH Properties: Methodology and Results

Given the theoretical structure of RE, and the results of previous studies, discussed in 3.2.1, models to test the validity of the REH shall now be considered. This sub-section analyses whether survey forecasts satisfy the aforementioned properties required by RE and shall investigate whether professional forecasts are more consistent with the predictions of RE than those formed by households. These relationships shall also be examined across the four previously identified sample periods and determine whether macroeconomic conditions impact upon the degree of rationality exhibited by agent expectations.

The first property of the REH identified in 3.2.1 concerned unbiasedness; this condition examines whether expectations systematically deviate from the actual values of the forecasted variable, resulting in predictable forecast errors. To examine whether survey forecasts are consistent with the unbiasedness property, (3.2.1) shall be examined utilising four-period ahead SPF and Michigan Survey inflation forecasts ($h = 4$) with the results presented in Appendix 3.7[52]. To be consistent with the unbiasedness property, 3.1.1 identified that expectations are required to satisfy the joint null hypothesis $\alpha_0 = 0, \alpha_1 = 1$.

For the whole sample period, the slope coefficient in Appendix 3.7 significantly differs from unity for both agent classes; however, for the Greenspan-Bernanke and stable sub-periods, which are associated with reduced levels of macroeconomic uncertainty, $\alpha_1 = 1$ cannot be rejected for either professionals or households. Moreover, whilst the joint Wald χ^2 test of $\alpha_0 = 0, \alpha_1 = 1$ associated with SPF forecasts is rejected for three of the four sample periods, the null hypothesis of unbiasedness associated with Michigan Survey forecasts is only rejected for the volatile sub-period. In accordance with various studies (Gramlich, 1983, Thomas, 1999, Mehra, 2002, Thomas and Grant, 2008), the results presented in Appendix 3.7 thus indicate that compliance with the unbiasedness condition for both agent classes is time-variant and dependent upon macroeconomic conditions.

[52] Tests of the predictive power of forecast errors, as employed by Mankiw et al. (2003), yields synonymous results.

Furthermore, Magueri (2012) highlights that tests of unbiasedness should have limited predictive power. From Appendix 3.7, the R^2 and $\bar{R}^2$ valuesassociated with SPF forecasts for the whole, Greenspan-Bernanke and stable periods are larger than those associated with the Michigan Survey, again indicating that household forecasts are more consistent with this property of the REH. The observation that household forecasts are less biased than those formed by professionals for the whole, Greenspan-Bernanke and stable sample periods is consistent with the results for the later period (1980Q3-2000Q3) presented by Mehra (2002).

The only period in which forecasts from both agent classes are consistent with the unbiasedness property is the Greenspan-Bernanke sub-period; similarly, removing the era of Volcker chairmanship of the Federal Reserve, Mehra (2002) cannot reject the null hypothesis of unbiasedness for either SPF or (median) Michigan Survey forecasts for the Greenspan era (1987Q4 – 2000Q3)[53]. Contrastingly, for the volatile sub-period, neither agent class forms expectations consistent with the unbiasedness property. These results appear to confirm the arguments of Mehra (2002) and Croushore (2010) that the unbiasedness of expectations is dependent upon the sample period and the economic environment in which expectations are formed. Consequently, during the most recent period of macroeconomic volatility, survey forecasts appear less likely to be formed 'rationally' than for periods characterised by greater stability. Nevertheless, in the presence of differential costs between positive and negative forecast errors, the failure of survey forecasts to comply with the unbiasedness property is not sufficient to comprehensively reject the REH (Keane and Runkle, 1990).

Although tests of the unbiasedness condition indicate that survey forecasts are not invariably consistent with this elementary property of the REH, the rationality of expectations necessarily requires evaluation upon a range of properties, which unbiasedness is just the first[54]. The second theoretical property of RE identified in 3.2.1 concerns error orthogonality and examines whether forecast errors are independent of information embodied within past errors. To examine whether

[53] For the same sample period, the χ^2 null hypothesis of unbiasedness is however rejected by Mehra (2002) for both Livingston Survey and mean Michigan Survey forecasts.
[54] The rejection of the unbiasedness null hypothesis for both agent classes is however a strong indication that expectations formed during the volatile sub-period are non-rational.

survey forecasts are consistent with this property of the REH, the following model shall be tested:

$$\pi_{t+h} - E_{i,t}[\pi_{t+h}] = \alpha_0 + \alpha_1(\pi_t - E_{i,t-h}[\pi_t]) + \epsilon_t \qquad (3.2.9)$$

To evaluate whether survey forecasts are consistent with the error orthogonality condition, the joint null hypothesis $\alpha_0 = 0, \alpha_1 = 0$ shall be examined utilising the Wald chi-square test. The results from testing (3.2.9) for $h = 4$ are presented in Appendix 3.8.

For all four sample periods, it is not possible to reject the joint χ^2 null hypothesis $\alpha_0 = 0, \alpha_1 = 0$ for either agent class; SPF and Michigan Survey forecast error are thus uncorrelated with their respective four-period lagged errors, which were the most recently available at the time forecasts were formed. The results therefore indicate that both professionals and households are able to exploit the information embodied in past errors across various macroeconomic conditions, conforming to the error orthogonality condition associated with efficiency and the REH. This appears to refute the observations of Adam and Padula (2011) who observe autocorrelated SPF forecast errors and Mankiw et al. (2003) who observe robust evidence of autocorrelated forecast errors for the SPF, Livingston Survey and Michigan Survey .

The error orthogonality condition examined in (3.2.9) is however a weak test of the efficiency property. Many empirical studies consider stronger tests which analyse whether expectations efficiency incorporate a variety of macroeconomic information using a model akin to (3.2.2). However, there are issues with examining this class of models. Firstly, as agents utilise a wide range of information sources and macroeconomic indicators in forming their expectations, some discretion would be required in determining which variables to include. Consequently, rather than examining the efficiency of expectations to the available information set, empirical tests will only examining whether forecast errors are correlated with a distinct set of macroeconomic variables. Furthermore, should I_{t-h} be sufficiently specified, including a wide variety of variables, Coibion and Gorodnichenko (2010) demonstrate that it will not be possible to reject the joint null hypothesis $\alpha_j = 0$ for all j. However, testing for the presence of serial correlation between forecast errors is thus able to determine whether current expectations incorporate the omitted information associated with previous forecast errors.

3.2.3. Discussion of Rational Expectations

The REH has been extensively employed by macroeconomic models for the last forty years; however, the notion of RE, where agents are required to form expectations consistent with economic theory remains a theoretical rather than an empirical observation. Moreover, Minford (1986:115) highlights that there are some who argue that rational expectations are an unbelievable concept. Firstly, critics may argue that agents are unable to efficiently exploit the available information set, and thus resort to backward-looking rule-of-thumb behaviour, akin to adaptive expectations. Secondly, whilst agents may report informationally efficient expectations, uncertainty regarding the structural economic relationships results in systematic forecast errors. The conditions necessary for rationality are however more reasonable from an aggregate expectations perspective. Despite the restrictive assumptions and stringent requirements of RE, the concept remains widely employed throughout economics, provides a useful rule of thumb for economists in deriving consistent models and generates powerful results particularly in relation to monetary policy.

As previously noted in 3.2.1, any debate concerning the empirical relevance of the REH is misguided. Rather than interpreting violations of the various properties as a rejection of the REH, analysis should instead question the degree which agent forecasts conform to the predictions of rationality. Consequently, rather than seeking a model which explains the manner which agents form expectations, future research may instead wish to devote attention into improving survey measures to provide expectations consistent with economic theory[55].

In accordance with previous studies, including Figlewski and Wacthel (1981), Thomas (1999), Mehra (2002) and Mankiw et al. (2003), the empirical examinations of this section indicate that both professional and household inflation forecasts do not invariably consistent with the criteria and predictions required under RE. For the whole, Greenspan-Bernanke and stable sample periods, whilst the forecasts reported by the SPF violate various properties required under rationality, Michigan Survey forecasts appear more consistent with the REH. Nevertheless, greater deviations

[55] Bruine de Bruin et al. (2010a, 2010b) analyse whether inflation expectations can be improved by alterations to survey questions.

from RE are observed for both agent classes for the volatile sub-period, thus reinforcing the results of Thomas (1999), Mehra (2002), Souleles (2004) and Pfajfar and Santoro (2010) that the degree of rationality exhibited by agent expectations is dependent upon prevailing macroeconomic conditions.

In Chapter 2, it was previously noted that as the volatile sub-period extends over a relatively short time span of 19 quarters, the results need to be interpreted with some caution. For example, violations of the unbiasedness property imply that agents repeatedly realise one-sided forecast errors; yet, over short horizons, agents may be unable to distinguish permanent inflation innovations and accommodate these into their expectations (Cukierman and Meltzer, 1982). Consequently, agent expectations would violate the unbiasedness condition required under RE during the short-run; yet, in the long-run, as agents learn about permanent innovations, appropriately incorporating them into information sets, expectations become free from systematic error. Moreover, Souleles (2004) suggests that a sample period of roughly five years would not be long enough to comprehensively determine whether agent forecasts exhibit systematic bias, and further questions that even twenty years may remain insufficient to allow forecast errors to fully average out[56]. Therefore given the short time span and the macroeconomic uncertainty associated with the volatile sub-period, confusion regarding whether innovations are permanent or transitory may contribute to short-run deviations from rationality.

In 3.2.1 it has highlighted that the REH implicitly assumes that agents can freely exploit the available information set to form model consistent expectations. This assumption is often considered artificial and abstract; agents are instead faced with information acquisition and processing costs[57]. An agents optimal decision, or expectation, thus involves equating information costs to the perceived benefit from forecast improvements (Pesaran, 1987). Consequently, empirical examinations may conclude that agent forecasts deviate from the theoretical predictions of the REH; however, economists may still consider these expectations as conditionally rational. Therefore, the larger deviations from rationality observed for the volatile sub-period

[56] The rejection of the unbiasedness property for a period of twenty years, as highlighted by Souleles (2004), would however be noteworthy and provoke interesting debate amongst economists regarding the causes and consequences of systematic forecast bias amongst agents.

[57] The concept of non-zero information acquisition and processing costs shall be examined in greater detail in relation to incomplete information in 3.3.1 and information rigidities and inattentiveness in Chapter 5 and Chapter 6.

in 3.2.2 may have resulted from conceivably higher costs associated with the acquisition and processing of information arising from increased levels of macroeconomic uncertainty.

Although the evidence suggests that Michigan Survey forecasts are more consistent with the predictions of the REH than those reported by the SPF, the results need to be interpreted with some caution. Investigating the accuracy of average survey forecasts, Batchelor and Dua (1989) report that the Michigan Survey consistently outperforms the Livingston Survey; however, individual RMSE's for the Livingston Survey are much lower reflecting greater disagreement or forecast dispersion amongst households. Additionally, Zarnowitz and Braun (1993) and Thomas (1999) acknowledge that whilst tests of consensus forecasts may indicate that households outperform professionals, individual professional forecasts are likely to be more consistent with RE than those formed by the typical non-professional. In preference to utilising consensus forecasts, future research may thus wish to extend the analysis of this section by examining the rationality of individual forecasts from various agent classes akin to Pfajfar and Santoro's (2010) percentile time-series approach. Alternatively, in a similar manner to Souleles (2004), Pfajfar and Santoro (2008), Curtin (2005) and Bruine de Bruin et al. (2010c, 2011a), the rationality of disaggregate survey data may be analysed, considering the forecasts of professionals with varying experience or expertise in specific industries, and those from households with heterogeneous demographic characteristics.

As noted by Lai (1990), forecasts may violate the unbiasedness property yet may still be considered rational providing that the mechanisms generating the forecast variable change over time[58]. To resolve these issues, there has been interest in determining whether expectations are directionally rational. The concept of directional rationality was introduced by Merton (1981) and Henriksson and Merton (1981) and is based on the premise that "A forecast is said to be *rational* if, given the forecast, no investor would modify his prior in the opposite direction of the forecast" (Merton, 1981:384). In contrast to much of the analysis presented in this section which examined the size of forecast errors, these studies are highlighted by Pons

[58] As previously noted, Keane and Runkle (1990) similarly report that in the presence of differential costs between positive and negative forecast errors, expectations may be formed rationally, despite violating the unbiasedness condition.

(2001) consider the predicted and actual directional change of the forecast variable. In a similar manner to Patton and Timmerman (1992), Ash et al. (1998), Pons (2001) and Easaw and Heravi (2009), the tests of rationality examined in this section may be re-evaluated to consider whether survey forecasts are directionally rational. This may prove interesting particularly over sample periods characterised by distinct macroeconomic conditions; however, this is beyond the scope of this study.

In accordance with previous empirical studies which analyse direct tests of the REH, the results in this chapter are fairly mixed; violations of the various RE criteria are agent-specific, time-variant and dependent upon macroeconomic conditions. However, it is interesting to note that both the SPF and Michigan Survey satisfied the error orthogonality condition across all four sample periods. This suggests that there is some minimum level of forecast efficiency, or rationality, attainable by both agent classes regardless of prevailing macroeconomic conditions. Nevertheless, further research is required to determine the how longer periods of macroeconomic volatility and uncertainty impact upon the rationality of survey forecasts. Additionally, it may be of interest to examine the rationality of agent expectations in response to a range of distinct macroeconomic shocks. As the REH is subject to a number of criticisms, including assumptions regarding freely available information, the economic literature has investigated various alternative models of expectation formation. The next section introduces various criticisms regarding the RE paradigm and considers several alternative approaches to the modelling of expectations theory.

3.3. Beyond Rational Expectations – Macroeconomic Forecasting for the 21st Century

The empirical results presented in 3.1.2 and 3.2.2 reveal that traditional expectations theory is unable to fully accommodate the manner which professionals or households formulate inflation forecasts reported in prominent surveys. Indeed, Pesaran (1987:xi) argues that the adaptive expectations and the REH "represent two different extremes [of expectation formation], both of which are based on untenable assumptions and are empirically unsatisfactory." Attention thus needs to be devoted to alternate theories which mitigate the issues and limitations concerning standard approaches. Of particular interest is the utilisation of information in expectation formation under the aforementioned theories and selected alternatives, and forms the general foundations of the forthcoming discussion.

The REH has been influential in the development of macroeconomic theory and debate. Despite the prevalence of RE, a number of criticisms and limitations have been highlighted. Although it is not unreasonable to assume that, on average, agents can correctly predict the future path of inflation, the underlying assumptions of the REH regarding information and individual foresight are artificial. Furthermore, the manner which agents ascertain and process the required knowledge to from model consistent expectations is left unexplained (Friedman, 1979, Pesaran, 1987). Thus, despite the contributions of RE, including Sargent and Wallace's (1975) policy ineffectiveness proposition, there has been marked interest in deriving models which mitigate the perceived limitations of RE. Moreover, several new concepts have been introduced which extend the understanding of expectation theory. Nevertheless, Roberts (1998) warns that RE should not be abandoned lightly due to the compatibility of the theory with standard optimising behaviour of agents.

This section proposes to highlight the key issues regarding traditional expectations hypotheses, specifically with RE, and how economists have attempted to overcome them with particular reference to the signal extraction literature and islands analogy (Phelps, 1970, Lucas Jr., 1972, 1973). Subsequently, the applicability of several interesting alternative theories shall be introduced with particular attention devoted to models of adaptive learning. These models relax the stringent assumptions of RE but are sufficiently sophisticated to avoid suffering from the simplicity of naïve expectation hypotheses (DeCanio, 1979, Blume and Easley, 1982, Evans and Honkapohja, 2001). Finally, theories of information rigidity including sticky information (Mankiw and Reis, 2002), information epidemiology (Carroll, 2003, 2006) and noisy information (Sims, 2003, Woodford, 2003, Maćkowiak and Wiederholt, 2009) shall be introduced prior to more detailed analysis and empirical evaluation in the subsequent chapters of this study.

3.3.1. Incomplete Information

The most common and pronounced limitations which question the validity of the aforementioned expectation hypotheses concern the assumptions regarding information. Whereas traditional backward-looking models utilise overly restrictive information sets, consisting of past inflation rates, expectations and errors, it can be argued that the REH assumes that agents possess too great knowledge regarding the structural parameters characterising the economy (Pesaran, 1987). Indeed, the Muthian hypothesis implies that as agent expectations mirror those predicted by economic theory, information is assumed to be used efficiently such that aggregate expectations are free from systematic error. To resolve these informational issues, economists have devoted substantial attention to developing models which incorporate incomplete information. These models are founded upon assumptions less restrictive than those of naïve expectation hypotheses but are not as substantial as those required for rationality. Key contributions to incomplete information theory include signal extraction and the Lucas-Phelps islands model, and bounded rationality.

The REH implicitly assumes that information is freely available, thus allowing agents to form model consistent expectations by exploiting the available information. Replacing this with the more realistic assumption of costly information acquisition and processing implies that agents face an additional decision regarding the quantity of information to utilise in forming expectations. In economics, where profit or utility maximising is an agent's ultimate objective, the optimal decision requires equating marginal benefit to marginal costs; applying this concept to expectation theory assumes that agents will acquire information to the point where the cost is equivalent to the perceived improvement in forecast errors[59]. Consequently, agents possess incomplete information regarding macroeconomic conditions and formulate sub-optimal expectations. Even if information is exploited efficiently, systematic errors shall ensue; consequently expectations cannot be consistent with the unbiasedness property required under rationality.

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[59] The relevance of the information is unknown prior to acquisition therefore the perceived value of a given piece of information is related to a probability distribution and the *a priori* economic model employed by the individual (Pesaran, 1987).

In response to the critics of RE, McCallum (1979) argues that any alternative implies that agents are irrational which many economists consider uncomfortable. To mitigate the issues regarding unreasonably large information requirements imposed by the REH without succumbing to the shortfalls of naïve backward-looking expectation frameworks, the notion of bounded rationality has been presented as an alternative theory of expectation formation. Initially proposed by Simon (1955) to explain discrepancies in organisational behaviour between economic models and reality, bounded rationality can also be applied to expectation theory and explain departures from RE theory. Compared to RE, bounded rationality is a less demanding assumption regarding expectations with agents possessing less *a priori* knowledge; instead, agents are assumed to behave 'artificially intelligent' (Sargent, 1993), acting as econometricians who are able to adapt their expectations model in response to new information.

Despite introducing more realistic assumptions regarding the formation of agent expectations subject to incomplete information, bounded rationality theory is not devoid of issues. Firstly, as some adjustment is required regarding the imperfection of agent rationality, bounded rationality introduces a degree of arbitrariness to expectation modelling. Moreover, as agents form expectations utilising a 'plausible rule' whilst learning the structural economic parameters given their limited perceptions, two models must therefore exist: the model employed by agents, and the true model representative of the economy. Consequently, neither model provides the equilibrium mutually established by both models. Furthermore, bounded rationality does not allow agents to modify their learning rule; consequently, Pesaran (1987) illustrates that in the absence of *a priori* knowledge of the structural parameters, expectations will not converge to a rational expectations equilibrium. Therefore, despite being more a more intuitively plausible theory of agent foresight, there are distinct issues regarding bounded rationality theory.

An alternative approach to incomplete information in expectation formation concerns the utilisation of signal extraction procedures. Rather than estimating the parameters of the model, signal extraction is concerned with obtaining optimal estimates for unobservable components of economic variables. Specifically, to predict the future path of the forecast variable, agents utilise the observable components of economic variables which convey information regarding the unobservable components. More formally, signal extraction refers to the decomposition of a noisy signal s_t^* into the perceived value of the variable x_t and some noise component n_t where $s_t^* = x_t + n_t$. Where the noise component has zero variance, McCafferty (1990) identifies that the optimal estimate of the signal $\hat{x}_t$ is equal to the observed value of the signal, yet as the noise component increases, the optimal estimate of the variable converges towards the mean value.

A well-known example of signal extraction within an adaptive expectations framework is presented by Muth (1960). Namely, Muth (1960) assumes that agents are faced with forecasting some time-seriesy_t which comprises both a permanent component y_t^* and a transitory component η_t; moreover, η_t is assumed to be independently distributed with mean zero and variance σ_η^2, whilst the permanent component is a linear function $y_t^* = y_{t-1}^* + \epsilon_t = \sum_j^t \epsilon_j$ [60]. Forecasts thus take the adaptive form $E_i(y_t) = \sum_{j=1}^{\infty} y_{t-j}$ which is shown by Muth (1960) to be optimal in minimising the error variance. However, from the single set of past observation of the permanent component, Muth (1960) identifies that it is not possible to determine both the transitory component η_t and the random disturbance ϵ_t. Instead, where disturbances to the permanent component are small relative to the noise, Muth (1960) identifies that the transitory component cancels out and forecasts are formed on approximately equal weighted past observations. In contrast, where disturbances to the permanent component are much larger, forecasts apply greater weight to more recent information, exponentially decreasing the more distant the past.

An interesting application of signal extraction methodologies is employed by Hey (1994) who undertakes an experimental analysis to determine the expectation formation behaviour of agents. Specifically, agents are requested to forecast three simplistic first-order autoregressive time-series with varying parameters given information regarding the series past history[61]; specifically, the first series is designed as a practice series, the second is relatively stable, whilst the third series includes some structural break. The results presented by Hey (1994) indicate that

[60] The random disturbance ϵ_j is assumed to be serially independent with mean zero and variance σ_ϵ^2

[61] Hey (1994) argues that where agents are unable to identify the properties of the time-series under these conditions, it is reasonable to suggest that they would also be unable to identify the properties of more complex time-series.

agents do not form expectations arbitrarily, but instead make use of simple signal extraction procedures, including fitting patterns to lagged data, and utilising this information to forecast the future values of the time-series.

Indeed, Hey (1994) observes that some agents almost perfectly extrapolate past values with regressive analysis indicating that the weight upon the one-period lagged actual is insignificantly different from unity for 36 of 48 individuals, whilst other extrapolate recent trends. The weighting upon lagged actual values thus appears consistent with the various backward-looking expectation models examined in section 3.1. Consequently, where lagged values of the forecast variable act as reliable signals of the future path, Hey's (1994) analysis suggests that agents employ suitable signal extraction procedures and formulate statistically accurate forecasts. However, as Hey (1994) identifies dispersion amongst the adjustment procedure employed by agent forecasts for the stable series, one may suggest that where previous trends act as signals, they are not necessarily fully extracted. Nevertheless, for the more volatile series, Hey (1994) observes larger weights upon previous trends being employed more uniformly across agents; however, agents generally fail to identify the structural break. Therefore, where a series is more volatile, agents may devote greater resources to signal extraction procedures, but do not necessarily possess the techniques which are sufficiently sophisticated to fully identify and extract the relevant signals.

The islands model of Phelps (1970) and Lucas (1972) introduces the signal extraction problem to a RE setting. The 'islands' analogy is metaphorical for the independent actions of agents forming economic decisions without the ability to obtain and observe complete information concerning aggregate economic activity and the actions of all other agents[62]. It is assumed by Phelps (1970) that information flows across islands are costly, hence each island specific information set is incomplete. Consequently, when forming expectations regarding aggregate outcomes, a weak form of RE prevails with agents efficiently utilising their available information set. However, as an agent's information set is likely to differ from the

[62] Indeed, Morris and Shin (2006) later note that agents are only able to observe a small sliver of information regarding economic activity, and that only when this information is aggregated 'mosaically' will complete information regarding economic activity be revealed.

process generating macroeconomic outcomes, systematic errors shall result, violating the assumptions of strong form Muthian RE.

A key contribution of the Lucas-Phelps islands model is the impact of shocks under incomplete information. Where some shock is consistently recognised and understood by all islands, Phelps (1970) demonstrates that complete signal extraction results with no real impact upon expectations or aggregate outcomes. In contrast, where a shock is perceived as partially island specific, Phelps (1970) illustrates that signal extraction across some agents is incomplete with some islands misinterpreting the impact of the disturbance on other islands. Consequently, expectations across islands are inconsistent as agents adapt their perceptions less than proportionally to the shock, resulting in real impacts and non-neutrality in macroeconomic outcomes.

Similarly, Lucas (1972) allocates agents to two structurally identical markets (or islands) with relative prices and real disturbances determined by the allocation of agents, whilst the economy is also subject to stochastic monetary disturbances. Where only one shock is in operation, Lucas (1972) demonstrates that rational agents can fully extract the relevant signals and short-run neutrality arises with equilibrium levels of macroeconomic variables remaining unchanged. Considering the general case of both real and monetary disturbances, Lucas (1972) demonstrates that whilst agents are informed of the ratio of real and monetary disturbances through observations of the current price level, they are unable to distinguish between the individual shocks, resulting in some impact to macroeconomic outcomes.

Despite formally introducing incomplete information and signal extraction theory to a RE framework, the Lucas-Phelps islands model has been subject to some criticism. Notably, Woodford (2003) argues that the Lucas (1972) model does not fully accommodate the extent of differential information considered by Phelps (1970). Whilst Lucas (1972) only considers uncertainty regarding the aggregate money supply, Phelps (1970) highlights the additional uncertainty arising from higher-order beliefs in a similar manner to Keynes' (1936) beauty contest[63]. In addition, Woodford (2003) and Trabandt (2007) argue that the islands model is unable to account for the observed persistence across macroeconomic variables. As the Lucas

[63] Specifically, this concerns imperfect information regarding the information sets expectations and decision processes on other 'islands' and requires the formation of expectations with respect to the expectations of others.

model assumes that aggregate information is costlessly available with a one-period lag, shocks are highly transitory. Moreover, as the Lucas model assumes that aggregate information is costlessly available with a one-period lag, shocks are highly transitory. Consequently, Woodford argues that the islands-model is unable to replicate long-run persistence of aggregate disturbances as identified by Christiano et al. (2005). Therefore, although the Lucas-Phelps model provides an explanation of macroeconomic dynamics in the presence of imperfect information, the predictions do not appear empirically plausible.

The literature regarding incomplete information provides some useful departures from traditional expectation theories and employs more realistically pleasing information assumptions. Moreover, models of bounded rationality and signal extraction introduce new issues regarding the acquisition and utilisation of information in forming model consistent expectations; these models may however lack empirical plausibility. Subsequently, expectation theory has advanced with economists devoting particular attention to models of adaptive learning, assuming that agent expectations evolve dynamically to converge towards rational expectations equilibria.

3.3.2. Expectations and Adaptive Learning

As previously discussed, the modelling of expectations in recent decades has attempted to mitigate the issues and limitations relating to RE. Two crucial issues regarding RE concern firstly, the process under which the true structural model of the economy arises, and secondly, the manner in which agents ascertain the knowledge required to form model consistent expectations. In an attempt to provide an asymptotic justification of RE, contemporary macroeconomic theory has thus devoted attention to deriving dynamic models where expectations and economic outcomes mutually influence each other (Evans and Honkapohja, 2001). More specifically, these models that the structural parameters of the economy are unknown to agents; learning thus arises through feedback from the relationship between incorrectly specified parameters and actual outcomes (Pesaran, 1987).

Early applications of learning processes, including Cyert and De Groot (1974), Townsend (1978) and Friedman (1979) assume that agents possess correctly specified models but learn the values of the coefficients through repeated observations of actual outcomes. These models thus derive a consistent rationale for convergence to the rational expectations equilibrium (REE). An alternate approach, advocated by Blume and Easley (1982) and De Canio (1979) assumes that agents do not possess correctly specified rules thus have to modify or adapt their forecasting rules given observations of actual outcomes. However, Blume et al. (1982) note that convergence may arise to either rational or non-rational equilibria which may or may not be stable. More recently, the general approach employed by advocates of these dynamic mechanisms assume that agents are artificially intelligent (Sargent, 1993), acting as Bayesian econometricians to optimise their diverse *a priori* models, undertaking a process of adaptive learning given the constraints of the available information.

Learning mechanisms thus relax the stringent assumptions associated with RE in a similar manner to bounded rationality concepts; akin to a trial-and-error process, expectations formed under dynamic learning principles are adapted as new information becomes available. Nevertheless, rather than being an alternative theory of expectation formation, the adaptive learning approach instead justifies the REH. This is illustrated by Evans and Honkapohja (2001) using the cobweb model with unobserved i.i.d. shocks: where agents form expectations using the mean of past prices, convergence upon the RE value will gradually emerge. The two principal issues surrounding adaptive learning mechanisms concerns whether agents can establish the appropriate learning rules, and whether this process is dynamically stable, to enable expectations to converge upon RE.

To model expectations under learning it is assumed that agents possess knowledge of the underlying economic model yet the structural parameters are unknown (Evans and Honkapohja, 2001). Mathematically, it is assumed that the rational expectations equilibrium (REE) of inflation is characterised by[64]:

$$\pi_t = a + bw_{t-1} + \varepsilon_t \qquad (3.3.1)$$

The structural parameters a and b are unknown whilst w_{t-1} represents a vector of observable exogenous shocks. This expression is often referred to as the 'perceived law of motion' (PLM). An agents objective is to estimate the values of a and b subject to their preferred econometric technique. Given information acquired up to period $t-1$ and the premise of bounded rationality, agents subsequently formulate expectations of π_t which take the form:

$$E[\pi_t] = a + bw_{t-1} + \varepsilon_t \qquad (3.3.2)$$

The parameters a and b are thus approximated appropriately and are revised on a period by period basis as the information set develops. The economic structure (2.2.1) and expectations derived under (3.3.2) establish the dynamic process to which the economy evolves, otherwise referred to as the 'actual law of motion' (ALM).

The critical issue concerns whether the PLM maps towards the ALM; that is whether $a_t \to \bar{a}$ and $b_t \to \bar{b}$ as $t \to \infty$, where $\bar{a}$ and $\bar{b}$ denote the optimal values that characterise the REE. Following the implications of early studies concerning convergence, as detailed above, Bray and Savin (1986) and Marcet and Sargent (1989) proclaim that convergence cannot arise to any equilibrium other than the REE. More generally, where a and b slowly converge to the ALM parameters implied by the REE, forecasts are defined as expectationally stable (E-stable).

[64] The following notation follows the representation presented by Evans and Honkapohja (2001).

Recently, a consensus has developed that for E-stable convergence to the REE, the differential equations concerning the mapping of the ALM to PLM are locally asymptotically stable (Evans and Honkapohja, 2001).

Despite the intuition behind the adaptive learning literature which assumes that agents have a correctly specified PLM which will converge towards the ALM as $t \rightarrow \infty$, several key issues have been noted. Firstly, De Canio (1979) and Evans and Ramey (1992) report that the costs associated with econometric learning, may prevent agents obtaining a PLM with consistent mapping to the ALM[65]. Additionally, for convergence to the REE to arise, agents must possess a PLM that is not only correctly specified, but is appropriately parameterised to include at least all the variables which make up the ALM, such that the true values of the model can be learned (Berardi, 2007). Given that adaptive learning theories recognise that agents possess bounded knowledge, it appears implausible that agents are aware of the true ALM. In these cases, the learning process would thus be incomplete and the PLM misspecified. Consequently, convergence to the REE does not occur as agents instead realise systematic forecast errors. Nevertheless, Bray and Savin (1986), Evans and Ramey (1992), Evans and Honkapohja (2001) and Berardi (2007) demonstrate that the PLM may still converge; however, rather than the REE, the PLM converges to a range of Pareto inefficient restricted perceptions equilibria[66].

From a disaggregate or individual viewpoint, adaptive learning appears a more realistically pleasing methodology for modelling expectations compared to RE, acknowledging both incomplete information and bounded rationality whilst also accommodating broader information and greater sophistication than traditional backward-looking models. However, in order for expectations under learning to establish an efficient long-run equilibrium, several rigorous requirements including the E-stability principle need to be satisfied. Despite this additional sophistication and complexity, adaptive learning provides a useful extension to the development of the REH, providing some indication regarding the process undertaken by agents to achieve expectations consistent with RE. Future studies may wish to empirically evaluate the relative learning behaviour of professionals and households, establishing

[65] The costs are assumed to be positively related to the difficulty in obtaining a PLM with consistent mapping to the ALM.

[66] These may also be referred to as misspecification or incomplete convergence equilibria.

whether PLM's of the two agent classes' map towards the ALM and determine the response of learning to structural shocks. Nevertheless, other intriguing extensions to the RE analysis have also been developed including models of predictor choice (Brock and Hommes, 1997, Branch, 2007) information rigidities (Mankiw and Reis, 2002, Mankiw et al., 2003, Coibion and Gorodnichenko, 2010, 2012) and rational inattentiveness (Sims, 2003).

3.3.3. Introduction to Information Rigidities

It is commonly observed that agents act inertially to new information as "in reality ordinary people only have finite information processing capacity; consequently they cannot observe and process all available information about the state(s) perfectly when making economic decisions" (Luo, 2008:366). This distinction is vital for macroeconomics in determining the behaviour of various variables, particularly the adjustment of expectations or prices. Rather than assuming agents continuously optimise in response to macroeconomic conditions, information rigidity models acknowledge that agents are constrained by information acquisition and processing costs. Consequently, agents cannot make fully accurate inferences regarding the macroeconomic state which thus leads to sub-optimal responses and forecast errors following some shock (Sims, 2006).

These constraints upon agent behaviour had not however been brought to prominence in the economic literature until the 21st century with the development of information rigidity models. Important contributions to the information rigidity literature include sticky information (Mankiw and Reis, 2002, Reis, 2006a, 2006b), noisy information (Sims, 2003, Woodford, 2003, Maćkowiak and Wiederholt, 2009), information diffusion (Carroll, 2003) and heterogeneous priors and signals (Capistrán and Timmermann, 2009, Patton and Timmermann, 2010). These models further relax the information constraints inherent within the RE framework, yet each have distinctive characteristics which are worth examining further. The concept encompassing all these models concerns the assumption that in any given period, information is incomplete; instead, information diffuses slowly through the economy.

The approach advocated by models of noisy information, as proposed by Woodford (2003), Sims (2003) and Maćkowiak and Wiederholt (2009) asserts that whilst information sets are continuously updated by agents, information is in some way imperfect. Departing from Lucas's (1973) assumptions that information is publicly available following a one-period lag, Woodford (2003:30) proposes that agents receive news regarding economic conditions through some "noisy channel"; consequently, expectations of future conditions, formed on the basis of this information will be imperfect. Moreover, in the presence of higher-order beliefs and strategic complementarity, Woodford (2003) demonstrates that noisy information results in sluggish agent actions; whilst own expectations are shown to adjust fairly rapidly to disturbances, as the degree of strategic complementarity and the uncertainty regarding the predictions of others increase, the average response exhibits greater inertia.

Similarly, Sims (2003) presents a model of rational inattention where agents face an optimisation problem given a probability distribution of information and limited processing capacity. Specifically, Sims (2003) proposes that agents receive a signal regarding the macroeconomic state, which is assumed to be random; agents thus process the signal through a channel to formulate expectations. Where endogenous noise enters the channel, Sims (2003) demonstrates that agents cannot make full inferences regarding the macroeconomic state and thus following some exogenous shock, sub-optimal responses arise. However, comparing the welfare implications of rationally inattentive consumers to those of RE, Luo (2008) demonstrates that the utility improvement from acting attentively to new information is trivial; specifically, the rational expectations and rational inattention consumption functions are found to have similar volatilities even where the channel capacity is low. Consequently, Luo (2008) argues that it is reasonable for agents to devote reduced channel capacity to the processing of information in formulating economic decisions. Furthermore, Sims (2006) argues that in addition to the intuitive appeal that agents are confronted by more information that they can realistically process, rational inattention can also explain the smooth and delayed behaviour of macroeconomic time-series without the necessity of an arbitrary device such as the Lucas-Phelps 'islands' metaphor[67].

Utilising a similar approach to Sims (2003), Maćkowiak and Wiederholt's (2009) present a model which is able to replicate persistent real effects in response to nominal aggregate demand shocks. The model assumes that agents are required to devote attention to both aggregate and idiosyncratic conditions, and proposes that the degree of attention is related to the variance in relative conditions. Despite firms being able to adjust prices each period, impulse response function indicate that prices act with inertia to shocks; Maćkowiak and Wiederholt (2009) thus propose that the

[67] Considering the permanent income hypothesis (PIH), Luo (2008) demonstrates that rational inattention theory may also explain excessive sensitivity to anticipated changes in income.

idiosyncratic component of decisions is more variable relative to the aggregate component. Consequently, Maćkowiak and Wiederholt (2009) demonstrate that decision profiles respond with greater inertia to aggregate disturbances in comparison to those from idiosyncratic conditions. Moreover, due to feedback effects with the price level responding less to aggregate shocks than under perfect information, Maćkowiak and Wiederholt (2009) suggest that the attention of individual firms are strategic complements. Namely, the less attention devoted to aggregate conditions, the larger becomes the relative volatility of idiosyncratic conditions, resulting in a reduced incentive for firms to remain attentive to aggregate information. Noisy information and rational inattention can thus be shown to replicate persistence amongst macroeconomic variables in the presence of shocks.

An alternative approach advocated by Mankiw and Reis (2002), concerns models of sticky information. Responding to criticisms of the new Keynesian Phillips curve, including Fuhrer and Moore's (1995) observation that it cannot explain observed inflation persistence, Mankiw and Reis's (2002) model is derived from replacing standard sticky price assumptions with the concept that macroeconomic information slowly diffuses across the population. The sticky information model proposed by Mankiw and Reis (2002) combines imperfect information, akin to Lucas (1973) with elements of Calvo's (1983) random adjustment sticky-price model. The combination is motivated by conflict between Calvo's (1983) prediction that inflation responds immediately to aggregate disturbances and empirical studies which generally observe a delayed response of inflation to shocks.

The sticky information model presented by Mankiw and Reis (2002) propose that despite being able to undertake price adjustment in any given period, firms do not necessarily make pricing decisions upon the most up-to-date information. Namely, in each period, all firms reset their prices, however, only a proportion λ of firms update their information[68], computing optimal current and future prices. The remaining proportion $1 - \lambda$ is inattentive to news and set prices according to information acquired in previous periods. Information is thus 'sticky' with agents only gradually updating expectations in response to news.

[68] Where agents update, Mankiw and Reis (2002) assume that information is noiselessly incorporated into optimal decision profiles.

The attentiveness parameter λ is proposed by Mankiw and Reis (2002) to be fixed and exogenously determined. Consequently, within Sims's (2003) methodology, Mankiw and Reis's (2002) sticky information model is argued by Trabandt (2007) to assume that agents have either unlimited or zero information processing capacity, dependent upon whether they exogenously receive information updates. Moreover, whilst Mankiw and Reis (2002) postulate that expectations are formed rationally, the infrequent updating of information is argued by Begg and Imperato (2001) to result in a weakening of the orthogonality property as although individual forecast errors are unpredictable, they may be correlated with information available to other agents.

Furthermore, Mankiw and Reis (2002) do not formally model the arrival of new information which is instead assumed to follow a Poisson process where each firm has an identical probability of updating their information regardless of the interval since their previous update. The process which agents update information is argued by Carroll (2006a) however to be likely to differ from a Poisson process. More formally, Reis (2006a) introduces assumptions of costly information acquisition and processing in expectation formation; although expectations are formed rationally, information and decision profiles are proposed to be updated infrequently. As only a fraction of agents are attentive in any given period, Reis (2006a) demonstrates that consumption is excessively smooth, failing to adequately respond to income shocks. Moreover, the degree of inattentiveness and sensitivity to shocks is shown by Reis (2006a) to be determined by the extent of information costs which are argued to be dependent upon the volatility of macroeconomic conditions.

Comparing sticky information and various noisy information hypotheses, Coibion and Gorodnichenko (2012) recognise that these theories all predict that agent forecasts exhibit slower responses to shocks relative to the respective forecast variable. Forecast errors are thus identified by Coibion and Gorodnichenko (2012) to exhibit serial correlation and possess the same sign as the forecast variable. In contrast, noisy information models propose that an agents' behaviour is formed on information that is subject to a common signal and an idiosyncratic private signal, both of which are noisy. Forecast errors are thus dependent upon the signal-to-noise ratio; given idiosyncratic differences in private signal noise, agents may thus be sensitive to some class of shock. Consequently, Coibion and Gorodnichenko (2012) demonstrate that the response of forecast errors to shocks is dependent upon the properties of the disturbance.

Furthermore, Coibion and Gorodnichenko (2012) identify asymmetries concerning the response of disagreement to disturbances between noisy information and sticky information models; the former are shown to predict that disagreement does not respond to shocks, whilst the latter predict a positive response. Namely, under noisy information, as agents continuously update, dispersion of beliefs only arises from idiosyncratic noise which is independent of shocks. In contrast, as sticky information assumes that agents infrequently update, those without the latest information lack knowledge of shocks and thus possess different beliefs from those who recently updated. From empirical analysis of both SPF and Michigan Survey data, Coibion and Gorodnichenko (2012) deem both household and professional inflation forecasts to be most consistent with the predictions of noisy information[69].

In an attempt to provide microfoundations for Mankiw and Reis's (2002) sticky information hypothesis, Carroll (2003, 2006) devises an epidemiological model where information regarding the forecast variable, embodied within the news media, diffuses to agent expectations akin to a disease. This information is assumed to reflect professional opinion. The stickiness implicit in Carroll's model is derived from the assumption that households infrequently absorb the informational content within the news media with probability λ[70]; the remaining $1 - \lambda$ proportion of households, whom fail to absorb the latest news, formulate their expectations upon outdated information. The model presented by Carroll (2003) offers a relatively simple methodology to empirically assess information stickiness embodied within agent expectations and further provides a potential explanation for the lagged behaviour and persistence of expectations relative to inflation, as previously demonstrated in Chapter 3.

As identified by Coibion and Gorodnichenko (2012), various extensions to the prominent information rigidity hypotheses have been proposed including heterogeneous priors or signals (Patton and Timmermann, 2010) and asymmetric

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[69] Utilising Livingston Survey forecasts from individuals in commercial banking, consulting and business, Coibion and Gorodnichenko (2012) present similar findings for firms.
[70] This assumption relies on Carroll's (2003) observation that Michigan Survey inflation forecasts are Granger-caused by SPF forecasts.

loss (Capistrán and Timmermann, 2009). Whilst these models provide interesting analysis regarding agent expectation formation, and shall be discussed in more detail in Chapter 6 in relation to professional forecasts, the focus shall primarily focus on the more prominent noisy information and sticky information theories.

The development of information rigidity theory is an intriguing development in expectation modelling, acknowledging the costs in the acquisition and processing of information faced by agents in forming expectations. The following chapters aim to explore these models in greater detail with particular attention to the analysis of Carroll (2003, 2006) and Coibion and Gorodnichenko (2010, 2012). Empirical tests shall be constructed and examined to determine whether survey forecasts are consistent with the predictions of these models and determine whether information rigidity theory can reasonably accommodate the manner which agents form expectations.

3.4. Concluding Remarks

The theoretical modelling of agent expectations has been subject to extensive macroeconomic research. Various theories have been extensively analysed and developed throughout the latter half of the last century, and to date remains a topic of keen interest to economists. This chapter has assessed the assumptions and validity of several prevalent expectation hypotheses, and has empirically analysed whether professional and household inflation forecasts reported in prominent surveys are consistent with the predictions implied by these theories.

Traditional backward-looking models of expectation formation, examined in section 3.1 were judged to be unable to fully characterise the formation of survey forecasts. Neither professional nor household expectations were deemed consistent with the properties of static expectations, as implicitly adopted by classical and Keynesian economists. Instead, static forecasting behaviour was deemed to assume excessive myopia on the part of agents. In contrast, the adaptive expectations hypothesis provided a more reasonable account of survey forecasts. However, whilst professional forecasts are more consistent with adaptive behaviour for periods of greater macroeconomic stability, backward-looking models appear more relevant for household forecasts across periods of increased macroeconomic uncertainty. As alluded to in section 3.3, and as shall be discussed in Chapter 5 and Chapter 6, this suggests that for periods of distinct macroeconomic stability or uncertainty, there are asymmetries in the manner which professionals and non-professionals utilise information to formulate expectations.

Despite backward-looking theory being unable to fully characterise the formation of survey forecasts, agent expectations were found not to be fully consistent with the predictions of the rational expectations hypothesis either. Nonetheless, in accordance with Mehra (2002), the results presented in 3.2.2 indicated that household expectations exhibit greater consistency with the properties of the REH relative to those reported by professionals. Violations of the required criteria were however observed to be agent-specific, time-variant and dependent upon macroeconomic conditions. Nevertheless, for the whole Greenspan-Bernanke and stable sample periods, Michigan Survey forecasts were observed to exhibit greater consistency with the properties of the REH relative to professionals. However, for the most recent sub-period associated with increased levels of macroeconomic uncertainty, larger deviations from rationality were observed for both agent classes. Nevertheless, in section 3.2 it was noted that both SPF and Michigan Survey forecasts invariably satisfy the error orthogonality condition; there thus appears to be some minimum level of forecast efficiency, or rationality, which both agent classes consistently attain. The observation that expectations comply with the error orthogonality condition supports the results presented by various studies including Rich (1989), Roberts (1997), Thomas (1999), Mehra (2002) and Thomas and Grant (2008).

The results presented in 3.1 and 3.2 thus indicate that survey forecasts are neither purely adaptive nor purely rational. An interesting test by Roberts (1997) examined whether survey forecasts were consistent with an average of adaptive and mathematical rational expectations. However, neither Livingston Survey nor Michigan Survey expectations were deemed consistent with the predictions of this model. Thus in addition to being neither purely rational, nor purely adaptive, survey forecasts cannot be represented as a weighted average of the two hypotheses.

Moreover, to examine whether expectations are formed in a forward- or backward-looking manner, (3.4.1) below, as presented by Curtin (2005) shall be tested upon survey forecasts:

$$\begin{aligned} E_{i,t}[\pi_{t+h}] = \alpha_0 + \alpha_1 \sum_{j=1}^{4} \pi_{t+j} + \alpha_2 \pi_t + \alpha_3 \sum_{j=1}^{4} \pi_{t-j} \\ + \alpha_4 \sum_{j=1}^{4} E_{t+j-h}[\pi_{t+j}] + \epsilon_{i,t} \end{aligned} \quad (3.4.1)$$

Specifically, if α_1 is significant whilst α_3 is insignificant expectations would appear to exhibit forward-looking characteristics; contrastingly, evidence in favour of backward-looking behaviour requires α_3 to be significant whilst α_1 is insignificant. In support of the results in 3.1 and 3.2, the results from testing (3.4.1), as presented in Appendix 3.9 do not offer conclusive evidence that agent expectations favour either forward- or backward-looking behaviour; the coefficients for inflation over both the four-leading and four-lagged quarters are repeatedly rejected, most notably for the volatile sub-period. Therefore, additional investigations, and alternative models which mitigate the limitations of traditional expectation approaches by relaxing various assumptions, are thus required.

In addition to examining whether these results are robust to alternative definitions of inflation, given the multi-horizon structure of the SPF, future studies may wish to reconsider examining whether professional forecasts are more consistent with the properties of traditional theories as the forecast horizon shortens. Moreover, it will prove interesting to determine whether professional forecasting behaviour switch from backward-looking behaviour at longer forecast horizons to greater rationality as the event period nears[71].

Following on from the discussion in 3.3, which introduced several contemporary approaches to the modelling of macroeconomic expectations, the subsequent chapters shall consider models which relax the assumptions of traditional theories. Although both incomplete information and adaptive learning provide interesting departures from conventional theory, the analysis shall primarily consider models of information rigidity, as introduced in 3.3.3, which consider the manner which agents acquire and process information in forming their expectations. Specific attention will be devoted to analysing models of rational inattention (Sims, 2003, 2006), noisy-information (Woodford, 2003, Maćkowiak and Wiederholt, 2009), sticky-information (Mankiw and Reis, 2002, Mankiw et al., 2003, Coibion and Gorodnichenko, 2010, 2012) and epidemiology (Carroll, 2003, 2006), and determining whether survey forecast are consistent with the predictions of these models.

[71] In subsequent chapters the multi-horizon structure of the SPF shall be exploited in relation to information rigidities.

CHAPTER 4: HOUSEHOLD DEMOGRAPHICS AND EXPECTATIONAL HETEROGENEITY

In Chapter 3 aggregate Michigan Survey inflation forecasts were empirically analysed to determine whether they were more consistent with the predictions of traditional expectation theory relative to those reported by professionals in the SPF. However, these tests solely considered consensus forecasts and ignored heterogeneity amongst the forecasts of individual survey participants. In recent years, economists have become increasingly interested in relaxing the assumptions of homogeneous agents and analysing the implications of expectational heterogeneity on macroeconomic outcomes.

Although the focus in this study has thus far been limited to aggregate expectations, there is a general appreciation amongst economists that agents are not equally informed about future macroeconomic outcomes; instead, Mankiw et al. (2003) acknowledge that there is a dispersion of beliefs amongst individuals. The economic literature identifies two distinct sources of expectational heterogeneity; first, akin to noisy information models presented by Woodford (2003), Sims (2003) and Mackowiak and Wiederholt (2009), agents are subject to idiosyncratic signals regarding the future values of economic variables, and secondly, as demonstrated by Patton and Timmermann (2010) agents possess asymmetric priors and utilise different models when forming their expectations. The presence of expectational heterogeneity has various important economic consequences as summarised by Gnan et al. (2011). Firstly, in in the presence of idiosyncratic signals, Sims (2009) argues that heterogeneity may require policymakers to construct 'multi-tiered' communication strategies to ensure expectations are formed with respect to a common anchor. Moreover, Bomberger (1996) and Lahiri and Sheng (2010) identify heterogeneity as an indicator of perceived levels of uncertainty which thus affects the economic behaviour of agents, including consumption, investment and saving decisions. Finally, Doepke and Schneider (2006) indicate that heterogeneity in expectations may be an indication of the asymmetric wealth effects of inflation and suggest a role for fiscal policy to adjust for the impact across households.

The Michigan Survey distinguishes between households with various demographic characteristics, grouping participants by age, education, gender, income and region of residence. However, due to the construction of the Michigan Survey cross-demographic results are expected to be similar as each individual household is classified within each disaggregation; the data is constructed from the same set of survey responses yet disaggregated by different characteristics. Furthermore, certain demographic characteristics are likely to be intrinsically related; for example, it is conceivable that more educated households have greater knowledge and skills and thus exhibit greater productivity resulting in higher income.

This chapter introduces the demographically disaggregated inflation forecasts available from the Michigan Survey, and empirically analyses the key differences between the various groups, in a manner akin to the analysis in Chapter 2. Nevertheless, the reported forecasts and associated forecast errors derived from measures of central tendency are not particularly informative regarding the differences within each individual group. To determine whether individual demographic groups exhibit greater intra-group disparity relative to others, the concept of disagreement shall be introduced and analysed. In section 4.1, the analysis of previous studies shall be considered, introducing various key results and establishing whether there is some general consensus regarding the impact of demographic characteristics on agent forecasts. The disaggregated data from the Michigan Survey shall be formally introduced in 4.2, which shall also evaluate the key statistical differences between the various demographic groups. Intra-group disagreement is analysed in 4.3 and determines whether the forecasts of more advantaged households exhibit greater agreement than those reported by lesser advantaged households. The final section provides a discussion on the role of demographics for expectation formation.

4.1. Demographics of Inflation Expectations: Literature Review

As highlighted in the introduction, for analytical simplicity many macroeconomic models treat expectations across agents as homogeneous. However, increasing attention is being devoted to heterogeneity and the impact of demographics upon economic decision making. Moreover, there is some general agreement amongst empirical studies including Jonung (1981), Bryan and Venkatu (2001a, 2001b), Lombardelli and Saleheen (2003), Souleles (2004), Pfajfar and Santoro (2008), Burke (2010) and Bruine de Bruin et al. (2010c, 2011b), that households do not anticipate inflation homogeneously.

One of the earliest studies to recognise that survey data is subject to the dispersion of agent beliefs was conducted by Cukierman and Wachtel (1979) who observed a positive relationship between both Livingston Survey and Michigan Survey inflation expectations and the variance in actual inflation. More recently, Carlson and Valev (2003) and Souleles (2004) report a positive relationship between the dispersion of beliefs and the inflation rate. More recently, Mankiw et al. (2003) show that whilst professional forecasts exhibit a reasonable degree of consensus with an interquartile range (IQR) of 1 ½ to 3 percent[72], the Michigan Survey has a much wider IQR of 0 to 5 percent with the distribution exhibiting much longer tails. Consequently, household inflation forecasts appear subject to much greater levels of heterogeneity relative to those formed by professionals; moreover, whilst average forecasts may indicate that differences in expectations between professionals and households are small, the typical professional is likely to report superior expectations compared to the typical household (Thomas, 1999).

Analysing Swedish survey data, Jonung (1981) reports that demographic characteristics, namely age and gender, are significantly related to differences in inflation expectations. Utilising approximately twenty years of data collated from the Michigan Survey, Souleles (2004) finds that forecast errors are correlated with household demographics, arguing that shocks do not affect all agents homogeneously. Similarly, using data from the Federal Reserve Bank of Cleveland/Ohio State University (FRBC/OSU) Inflation Psychology Survey, Bryan

[72] To analyse the distribution of professional forecasts, Mankiw et al. (2003) pool responses from the Livingston Survey and SPF.

and Venkatu (2001a, 2001b) find that men generally have lower inflation expectations than women, whilst households in the lowest education or income categories report greater levels of expected inflation than more advantaged counterparts.

A potential explanation for forecast heterogeneity, as identified by Michael (1979), Idson and Miller (1997), Hobijn and Lagakos (2005), McGranahan and Paulson (2006), Hobijn et al. (2009) and Menz and Poppitz (2013) concerns asymmetries between inflation experiences across demographic groups. Specifically, Idson and Miller (1997) find that those agents with lower levels of education experience higher levels of inflation[73]; moreover, McGranahan and Paulson (2006) find that less advantaged households experience more variable rates of inflation relative to their more advantaged counterparts. To analyse these differences, various studies have constructed and analysed price indices based upon group-specific expenditure. For the 1970's, Michael (1979) reports that the difference between the means of group-specific indices are small, whilst no group experiences consistently higher or lower inflation relative to others. On an aggregate level, Hobijn and Lagakos (2005) similarly report that individual categories are unlikely to experience above average inflation in consecutive years. Nevertheless, considering expectations of German households Menz and Poppitz (2013) report the RMSE associated with group-specific measures of inflation is smaller for all demographic groups compared to the respective RMSE associated with aggregate inflation. As previously highlighted by Michael (1979), whilst the analyses of group-specific indices is useful for examining the dispersion of forecasts within an individual group, they are uninformative regarding differences across demographics.

Furthermore, McGranahan and Paulson (2006) and Menz and Poppitz (2013) identify that older respondents report higher expectations of inflation relative to younger respondents, which the former attribute to relatively high health care expenditure which is documented by Amble and Stewart (1994) to be subject to larger price increases relative to alternative expenditure categories. Indeed, Curtin (2009:4) states that "It makes no economic sense to assume that people pay attention to an inflation rate higher or lower than the one they actually encounter."

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[73] Utilising European data Colavecchio et al. (2011) report similar evidence that less socio-advantaged households experience higher levels of inflation.

Nevertheless, there is a general consensus that demographics influence the rate of inflation experienced by households.

An experimental study conducted by Bruine de Bruin et al. (2011b) similarly suggests that expectational heterogeneity arises as a proportion of agents report forecasts influenced by specific prices whilst the remainder form expectations which consider the overall rate of inflation. Specifically, Bruine de Bruin et al. (2011b) find that those agents asked to recall specific prices reported higher expectations than those asked to recall prices in general; furthermore, agents were found to have a tendency to recall extreme increases or decreases. Moreover, gas and food prices were found to be particularly influential upon agent expectations which Bruine de Bruin et al. (2011b) attribute to not only large price increases amongst these goods, but also to repeat purchases. Similarly, Bates and Gabor (1986) assert that the weight an agent places on individual goods in forming their general price expectations is dependent upon its share of overall household expenditure, whereas Ranyard et al. (2008) and Georganas, Healy and Li (2014) argure that more frequently purchased items are more salient in decision making scenarios. These results thus suggest that expectational heterogeneity arises from both household experiences and the attentiveness of some households being diverted to goods with more volatile prices.

As the wording of the Michigan Survey contains the phrase "prices in general" as opposed to specifically referring to "inflation", all households face the task of interpreting the survey question; yet, those with greater financial or economic literacy are found by Bruine de Bruin et al. (2010c) and Burke and Manz (2010) to report more accurate expectations, suggesting that more advantaged groups are most likely to relate the 'prices in general' wording with the overall rate of inflation. Similarly, utilising UK data, Blanchflower and Kelly (2008) and Blanchflower and MacCoille (2009) observe higher non-response rates to survey questions regarding the inflation rate among the young, the less educated, those on low income, and women whilst Dräger and Fritshce (2013) report that low education groups and women have a higher non-response to quantitative inflation questions than other groups. There thus appears some general appreciation amongst previous studies that the groups who are found to report the largest forecast errors, have the greatest difficulty in interpretating survey questions relating to inflation.

Previous empirical studies which examine disaggregated survey forecasts have highlighted substantial differences between the inflation expectations of men and women. Considering survey data from Sweden for the late 1970's Jonung (1981) reports that women expect a higher rate of inflation than men[74]. Later studies by Palmqvist and Strömberg (2004), Lindén (2005) and del Giovane et al. (2009) present evidence in support of Jonung's (1981) observations utilising Swedish and European data respectively. Similarly, employing US survey data, both Bryan and Venkatu (2001b) and Meyer and Venkatu (2011) report that men have lower expectations of inflation than women[75]. Moreover, analysing gender disaggregated inflation forecasts against the inflation differentials between category inflation[76] and the overall CPI-U inflation rate, Anderson et al. (2012) report significant differences between the forecasts of men and women. Inflation differentials across all categories are found by Anderson et al. (2012) to be jointly significant. However, significant heterogeneity is only observed in response to inflation differentials across the apparel and transportation categories; therefore, unlike Jonung (1981), Anderson et al. (2012) do not observe differences in the food and beverages inflation differential between men and women. Nevertheless Anderson et al. (2012) indicate that the most significant difference concerns lagged inflation which women weight more heavily than men, indicating that women may be subject to greater adaptive behaviour when formulating inflation forecasts.

A common explanation for gender differences in expectations, as provided by Jonung (1981), is that women are more greatly influenced by food prices which tend to experience relatively high levels of inflation; indeed, during the late 1970's, food prices in Sweden are shown by Jonung (1981) to have been rising more rapidly relative to other commodities. However, in recent years Bryan and Venkatu (2001b) argue that US food price inflation has tended to be marginally lower than the

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[74] Women were also found by Jonung (1981) to report higher perceptions of past price increases.
[75] Whilst Meyer and Venkatu (2011) employ approximately ten years of Michigan Survey data starting in 2000, Bryan and Venkatu utilise data sourced from the Federal Reserve Bank of Cleveland/Ohio State University Inflation Psychology Survey.
[76] The inflation differential categories analysed by Anderson et al. (2012) concern medical, food and beverages, housing, apparel and transport commodities.

aggregate CPI, whilst Meyer and Venkatu (2011) observe that women tend to report higher inflation expectations than men even during periods where food inflation is relatively low. In recent years, gender differences in expectations thus appear to be dependent upon non-market basket factors. These conflicting arguments may be the result of cultural differences between Sweden and the US whilst social change over the intervening period over which these studies are conducted may also have affected the consumption behaviour, and consequently expectation formation, of both men and women.

In accordance with women reporting higher expectations, and the general trend that households overestimate the rate of inflation, various studies have established that women realise larger forecast errors. Examining Michigan Survey data Pfajfar and Santoro (2008) report that the sum of squared errors (SSE) of women is in excess of 25 percent larger relative to the SSE of men. Similarly, utilising data from the Bank of England's Inflation Attitudes Survey, Blanchflower and MacCoille (2009) establish that the probability of inflation expectations and perceptions of men lie within some 'correct' interval is larger relative to women. Furthermore, considering Irish data from the EU Consumer Survey, Duffy and Lunn (2009) report that perceived levels of inflation for women are higher, and more likely to over- and underestimate actual inflation, relative to men.

An alternative explanation for the higher expectations and inferior accuracy of women is proposed by Curtin (2009) who argues that men generally have greater interest in economics and thus have a superior understanding of the implication of various variables and statistics on the inflation rate. Similarly, Lusardi and Mitchell (2008), Bruine de Bruin et al. (2010c), Burke and Manz (2010) and Lusardi et al. (2008) find that in comparison to men, women have lower economic and financial literacy, shorter financial planning horizons and lower financial confidence[77]. Consequently, women may experience higher information acquisition and processing costs which result in larger forecasting errors. Indeed, in accordance with Jonung (1981), Bryan and Venkatu (2001b), and Meyer and Venkatu (2011), both Bruine de Bruin et al. (2010c) and Burke and Manz (2010) report that female respondents expect a higher level of inflation than their male counterparts. Furthermore, Bruine

[77] Older women are found by Lusardi and Mitchell (2008) to exhibit particularly low levels of financial literacy.

de Bruin et al. (2010c) find that a large percentage of women report inflation expectations in excess of 5 percent, whilst Burke and Manz (2010) find that women exhibit significantly larger absolute forecast errors. Nevertheless, accounting for economic and financial literacy, Burke and Manz (2010) report that gender differences in expectations and associated forecast errors are insignificant; indicating that gender is not a primary cause of expectational heterogeneity per se; instead, heterogeneity arises as a result of different cultural and educational influences between men and women.

There is also considerable interest amongst economists regarding the role of increased education and income upon expectations. Previous studies considering these socio-demographic factors have often found that educational attainment and household income exert a strong influence on reported forecasts. Specifically, Jonung (1981), Bryan and Venkatu (2001a), Palmqvist and Strömberg (2004), Lindén (2005), Pfajfar and Santoro (2008) and Bruine de Bruin et al. (2010c) observe that households with lower levels of education or income report higher expectations of inflation than their more advantaged counterparts. In accordance with households overestimating the future rate of inflation, Pfajfar and Santoro (2008) and Ehrmann et al. (2014) report that those with higher levels of income and education realise smaller forecast errors. A potential explanation for these findings, as shall be thoroughly explored in Chapter 5 in relation to sticky information and epidemiology theories, relates to the ability of more advantaged households to acquire and process greater levels of information. Moreover, assuming that information is a normal good, Fishe and Idson (1990) argue that households with increased levels of education or income will have greater demand for information, which resultantly reduces the size and dispersion of forecast errors.

A further cause of expectational heterogeneity amongst Michigan Survey forecasts relates to the age of the respondents; however, previous studies have failed to establish a consensus regarding the impact of age upon expectations. Whereas Jonung (1981) and Madeira and Zafar (2012) report that younger respondents expect higher levels of inflation than older respondents, Lombardelli and Saleheen (2003) and Blanchflower and MacCoille (2009) find that older respondents in the UK have higher expectations of inflation. In contrast, Bryan and Venkatu (2001a) and

Palmqvist and Strömberg (2004) find that household expectations have a U-shaped relationship with age, whilst Lindén (2005) reports that EU expectations are hump-shaped; despite the disagreement between the two studies, they both indicate that the expectations reported by middle-aged respondents differ to those of younger and older agents.

The observation of heterogeneity across age disaggregated inflation forecasts may however not result from an inherent forecasting bias per se; instead, Lombardelli and Saleheen (2003) and Malmendier and Nagel (2009) find a correlation between expectations and past inflation experiences. More specifically, employing adaptive learning processes, Malmendier and Nagel (2009) argue that whilst more recent inflation experiences receive the greatest weight in agent expectation formation, historic experiences continue to influence the expectations of older respondents. In accordance with this argument, Madeira and Zafar (2012) find that high levels of inflation during the 1970's have a larger impact upon the expectations of younger respondents throughout the 1980's, whilst the expectations of older respondents retain some bias arising from low inflation experiences throughout the 1950's and 1960's[78].

The remainder of this chapter seeks to re-evaluate demographic differences across disaggregated Michigan Survey inflation forecasts and determine whether inter-group heterogeneity and intra-group disagreement is time-variant and dependent upon macroeconomic conditions. The next section shall formally introduce disaggregated Michigan Survey forecasts and empirically assess key statistical differences across groups.

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[78] Within a sticky information framework, the expectations of younger households

4.2. Empirical Investigations Regarding Household Forecast Heterogeneity

In accordance with the general approach undertaken by previous research regarding heterogeneous expectations (e.g. Carroll (2003), Mankiw et al. (2003), Nunes (2009)), and the analysis in the previous chapters, median survey forecasts shall continue to be employed in the forthcoming empirical investigations. However, utilising measures of central tendency to analyse expectation heterogeneity is not without limitations; for example, a point estimate fails to acknowledge intra-group disagreement in expectations, an issue which shall be examined in greater detail in 4.3. Moreover, although two or more demographic groups may report average expectations which are approximately equal, the expectations of one group may be more widely dispersed relative to others.

A further issue with empirically analysing disaggregated survey forecasts, as previously identified in 4.1, concerns inflation inequality, namely households experiencing significantly higher or lower inflation than the official measure. This issue is particularly notable recalling that the Michigan Survey wording uses the term "prices in general" rather than inflation per se[79]; whilst some respondents provide an expectation of the general price level, others may base their forecast on own consumption experiences. Consequently, utilising aggregate inflation measures may be considered inappropriate for the analysis of disaggregate forecasts and result in an exaggeration of the forecast errors, or introduce some bias, of various groups. Whereas Michael (1979) and Hobijn and Lagakos (2005) construct group-specific inflation rates from the Consumer Expenditure Survey and CPI data, the analysis shall continue to focus on publicly available CPI as an aggregate inflation measure; this shall ensure that forecast errors can be consistently analysed across demographics. Moreover, the use of aggregate measures avoids the issue presented by Michael (1979) that the utilisation of specific price indices results in shifting the focus away from the differences across demographics to dispersion within individual groups.

[79] Bruine de Bruin et al. (2010a, 2010b) and Burke and Manz (2010) provide a more detailed analysis regarding survey wording and the resulting impact upon responses.

To provide an elementary understanding of the heterogeneity across disaggregate expectations, the relative forecasting performance of disaggregate household inflation forecasts shall be analysed. As for aggregate expectations, the analysis shall first consider some key elementary statistics as presented in Appendix 4.1 and Appendix 4.2, whilst Appendix 4.3 through to Appendix 4.7 consider the equality of mean forecasts across each disaggregation. However, as noted in Chapter 2 these are relatively uninformative; therefore, the mean forecast error (MFE) and mean squared forecast error (MSFE) statistics, which indicate the relative accuracy of each demographic, are presented in Appendix 4.8 with the associated tests of cross-sectional equality of MFE's and MSFE's presented in Appendix 4.9 and 0.

Unsurprisingly, the results presented in Appendix 4.1 and Appendix 4.2 are similar to those presented for aggregate Michigan Survey expectations in Chapter 2 with mean forecasts around three percent across the four sample periods. Nevertheless, several key differences are observed across demographics. Firstly, the mean forecasts reported by less advantaged households are generally higher than those from more advantaged groups; moreover, the mean forecast reported by women is invariably larger than that reported by men. These results are in accordance with those reported by various studies including Jonung (1981), Bryan and Venkatu (2001a, 2001b), Palmqvist and Strömberg (2004), Linden (2005), Pfajfar and Santoro (2008) and Meyer and Venkatu (2011). The reported point forecasts of demographic groups thus appear subject to different influences which may include heterogeneous information, group-specific price experiences, and differential interpretation of the survey question.

Nevertheless, unlike Bryan and Venkatu (2001a), Palmqvist and Strömberg (2004) and Lindén (2005), whom report U-shaped or hump-shaped relationships between inflation expectations and age, there is no discernible evidence from Appendix 4.1 and Appendix 4.2 that expectations are influenced by age; similarly, there is little evidence of regional disparity across point forecasts of inflation. Moreover, Appendix 4.3 through to Appendix 4.7 further analyse whether group mean inflation forecasts are equal to those reported by the SPF. In accordance with the results for aggregate Michigan Survey forecasts presented in Chapter 2, the evidence for the whole, Greenspan-Bernanke and stable periods indicate that the point forecasts of some groups, particularly the old, women, and those with lower levels of education and income, are significantly different to those of professionals. In contrast, the ANOVA F-tests presented in Appendix 4.3 are unable to reject the equal mean null hypothesis for each pairing of age groups for the Greenspan-Bernanke, stable and volatile periods; nevertheless, for the whole sample period, the mean forecasts of younger households are found to be statistically different to those reported by middle-aged and older households. Similarly, for regionally disaggregate expectations, the ANOVA F-tests presented in Appendix 4.7 are unable to reject the equal mean null hypothesis at any reasonable level of significance for any sample of the four sample periods. Furthermore, for the recent period of increased macroeconomic uncertainty, the ANOVA F-test rejects the equal mean null hypothesis for all demographic groups. Given the results presented in Appendix 4.2 which highlight that SPF forecasts exhibit a lower mean and standard deviation relative to all demographic groups, these results support the argument presented in Chapter 2 that household expectations are more sensitive to transitory macroeconomic shocks, whilst professional expectations appear 'well anchored'.

In accordance with aggregate Michigan Survey expectations, the MFE's reported by demographic groups across all four sample periods, as presented in Appendix 4.8, are generally negative indicating that all households have a tendency to over-predict the future inflation rate. Demographic differences are also observed with larger errors (in absolute terms) observed for the young, less educated, women and low income households; the MFE's associated with the expectations of these agents are also statistically different from zero. Moreover, considering the MSFE's, there is a general trend for older respondents to exhibit larger MSFE's relative to younger and middle aged respondents, whilst households with higher levels of income and education exhibit lower MSFE's than their more advantaged counterparts. Similarly, men consistently realise lower MSFE's relative to women; however, as observed for MFE's, there is no discernible difference between the MSFE's realised by households across the four regions. These results indicate that certain demographic characteristics, namely education, income and gender, appear to greatly influence the magnitude of forecast errors realised by households, whereas others, including the respondents region of residence, appear to have little, if any, effect.

Moreover, the size of MFE's and MSFE's appear to be time-variant, the size of MFE's are generally smaller for the Greenspan-Bernanke and stable periods relative to the whole sample period indicating greater accuracy amongst respondents for periods of reduced macroeconomic volatility. Moreover, for the Greenspan-Bernanke and stable sample periods only those households within the lowest income or education categories, and women, report MFE's which are statistically different from zero. Compared to the Greenspan-Bernanke and stable periods, Appendix 4.8 clearly indicates that for the recent period of macroeconomic volatility, all demographic groups exhibit a fall in forecast accuracy with larger (absolute) MFE's and MSFE's. Moreover, the majority of groups report MFE's significantly different from zero; nevertheless, substantial heterogeneity remains evident with the null hypothesis unable to be rejected at a 5 percent level for those aged 18-34, with college degree or graduate education, men, or in the top two income groups. These larger forecast errors, and expectational bias, potentially result from agents failing to anticipate the 2009 deflationary episode. Specifically, akin to the inflation experience arguments of Malmendier and Nagel (2009) and Ehrmann and Tzamourani (2012), due to agent expectations being "reasonably well-anchored" (Bernanke, 2010:17), attributable to relatively stable inflation throughout the 1990's and 2000's, and improvements in Federal Reserve credibility, agents are less convinced that high inflation and deflation are likely outcomes.

To analyse the degree of heterogeneity across demographic groups tests of equality of MFE's and MSFE's for each disaggregation shall be examined. The cross-sectional equality of MFE's and MSFE's are examined utilising the Welch F-test with the results presented in Appendix 4.9 and Appendix 4.10 respectively. In Appendix 4.9 it is evident that whilst age and region do not impact upon the average forecast error realised by households, significant differences are observed for the education, gender and income disaggregations. Nevertheless, for the volatile sub-period, for each cross-sectional disaggregation, there is no evidence that MFE's significantly differ across households. Moreover, across all four sample periods, there is no evidence for any disaggregation that MSFE's significantly differ indicating that the average magnitude of forecast errors is equal across groups. Although the Welch F-tests indicate the general trends across household demographics, they are unable to identify whether individual groups realise significantly larger or smaller errors relative to their counterparts. To provide a more detailed analysis of differences in forecast errors, ANOVA F-tests are performed on both MFE's and MSFE's across individual groups for each disaggregation with the results presented in Appendix 4.11 through to Appendix 4.20.

Beginning with age disaggregated expectations, in accordance with Appendix 4.8, the results presented in Appendix 4.11 provide some limited evidence that the forecast errors of younger age groups differ to those of older respondents; however, the significance of differences is limited to a 10 percent level and for the whole sample period. Similarly, from Appendix 4.19, no evidence of significantly different MFE's is evident for regionally disaggregated expectations, indicating that any difference in regional inflation rates is not reflected in expectations of the aggregate price level. Nevertheless, whereas the forecast errors of the two youngest age groups and all regions are not significantly different to those realised by the SPF for any sample period, for the whole sample period, the MFE's of the two oldest age groups are significantly larger than those reported by professionals. Given that the expectations of those aged 55-64 and 65-97 whole sample period are not significantly different from zero for the whole sample period, this appears to indicate greater forecast accuracy on the part of older respondents relative to both professionals and younger counterparts.

Contrastingly, the forecast errors reported by those of the lowest education and income groups are significantly different to those realised by households with higher levels of education or income. In accordance with Pfajfar and Santoro (2008), taking these results in conjunction with those presented in Appendix 4.8, it is thus apparent that the least advantaged households within the Michigan Survey realise the largest forecast errors. There is however little evidence across the other education and income groups that forecast errors are significantly different from each other and with those realised by professionals. Nevertheless, for the whole, Greenspan-Bernanke and stable sample periods, significant differences in forecast errors are realised across genders, indicating that for periods of increased stability, men exhibit significantly greater forecast accuracy relative to women. However, the forecast errors of both men and women are not significantly different to those reported by professionals. These results indicate that whilst various groups appear to have similar levels of forecast accuracy, the expectations of the young, less advantaged and women appear to realise larger deviations from actual inflation relative to their counterparts.

Given these results, it may be considered useful to examine whether the forecasts of various agents are consistent with traditional theories of expectation formation as previously examined in Chapter 3. Nevertheless, given that the results in Appendix 4.9 and 0, indicating that MFE's are not robustly equal to zero, it would appear that the expectations of many household groups are not fully consistent with the predictions of the REH. As previously demonstrated, failure of the elementary unbiasedness property would be a clear indicator of the inconsistency of expectations with the rational expectations paradigm; to establish an elementary understanding of whether certain demographics are more rational than others, (3.2.1) shall be tested on disaggregate Michigan Survey forecasts across the four sample periods with the results presented in Appendix 4.21 to Appendix 4.25.

In Chapter 3, aggregate Michigan Survey expectations for the whole sample period were observed to be consistent with the unbiasedness property; however, the results presented in Appendix 4.21 to Appendix 4.25 indicate that the unbiasedness of household inflation forecasts are instead dependent upon household demographics. At a five percent level of significance, the Wald χ^2 null hypothesis of unbiasedness cannot be rejected for the middle-aged, those with high school degree or some college education, both genders, the second income quartile, and the North-East and South regions[80]. Notably, for age, education and income disaggregations, the inability to reject the unbiasedness property is observed for demographic groups roughly in the centre of the distribution; this could indicate that the rate of inflation experienced by these groups consistently corresponds with the official measure of CPI. For other groups, the failure of the unbiasedness property may be a consequence of demographic price experiences which do not accurately reflect the official market basket; similarly inflation differentials across regions may result in regional bias across expectations.

[80] For the whole sample period, the error orthogonality condition, as represented by (3.2.9) cannot be rejected for any demographic group at a five percent level significance, and only for the least educated, the first income quartile and women at a 10 percent level. Therefore, other than the least advantaged demographic groups, household expectations appear to exhibit some degree of rationality.

For the Greenspan-Bernanke and stable sample periods, analogous to the results for aggregate Michigan Survey inflation forecasts presented in Chapter 3, the joint Wald χ^2 test of $\alpha_0 = 0, \alpha_1 = 1$ consistent with a null hypothesis of unbiasedness cannot be rejected at a five percent level of significance for any demographic group except for those with less than high school education. Therefore, for periods of reduced macroeconomic volatility, agents across demographics exhibit a degree of rationality in the formation of inflation forecasts. Nevertheless, for both of these sample periods, those households with less than high school education or in the first income quartile report expectations which fail the error orthogonality condition at conventional significance levels[81]. For periods of reduced macroeconomic volatility, the expectations of the least advantaged households can thus be deemed inconsistent with the properties of RE. This indicates that for periods of increased stability only households with sufficient cognitive ability or financial resources have the capability of forming economically efficient expectations; alternatively the dynamics of group-specific inflation for the least advantaged may substantially differ from those for aggregate CPI.

For the volatile sub-period, the results presented in Appendix 4.21 to Appendix 4.25 are again generally consistent with those for aggregate Michigan Survey expectations, with the unbiasedness property rejected across demographics. Compared to the stable period, household expectations thus appear less consistent with the properties of rationality for periods of increased volatility; moreover, these results are again consistent with those presented by Mehra (2002) and Croushore (2010) that the unbiasedness of expectations is time-variant and dependent upon macroeconomic conditions. Nevertheless, analogous with the stable sample period, only the least educated and the first income quartile fail the error orthogonality condition. Nevertheless, expectations reported by those with college degree or graduate school education, and those in the second income quartile (Y24), conform with the unbiasedness condition[82]. As highlighted by Cukierman and Meltzer (1982)

[81] Additionally, for the Greenspan-Bernanke sample period, the expectations reported by those with college degree or graduate school education, those in the fourth income quartile, and the North-East region fail the error orthogonality condition. As there is no evidence that these groups fail this property of the REH for either the stable or volatile periods, this feature of expectations is could be related to the stock market crash of 1987 which more advantaged households fail to recognise.

[82] The expectations of these agents also conform with the error orthogonality condition; moreover, tests of weak-form efficiency reveal that only the least educated and the first income quartile fail this

and Souleles (2004), and previously mentioned in Chapter 2, the short timespan associated with the volatile sub-period may however be insufficient for agents to distinguish between permanent and transitory innovations, contributing to short-run deviations from the predictions of the REH. Moreover, recalling from Chapter 3 that the REH makes various predictions concerning the properties of agent expectations, it would be premature to declare that demographic groups form expectations rationally, particularly as macroeconomic conditions across the most recent sub-period have been characterised by high levels of uncertainty.

As previously highlighted by Keane and Runkle (1990), and Chapter 3, the failure of survey forecasts to invariably comply with the unbiasedness condition is only an indication that the expectations reported by these groups are inconsistent with RE; the evidence is however insufficient for a comprehensive rejection of the conformity of survey forecasts with the hypothesis. Similarly, additional testing would be required to make more rigorous conclusions regarding the rationality of these groups who comply with this elementary property, and would further allow for more informed judgments regarding the relationship between rationality and household demographics. Nevertheless, from the results presented above it is clearly evident that across demographics, household inflation forecasts are more consistent with the unbiasedness property for periods of increased macroeconomic stability, whilst deviations from this elementary property of the REH are more evident for the recent period of macroeconomic volatility. Unsurprisingly, these results are consistent with those for aggregate Michigan Survey expectations presented in Chapter 3.

In accordance with the studies of Jonung (1981), Bryan and Venkatu (2001a, 2001b) and Pfajfar and Santoro (2008), the results presented in this section evidently demonstrate the presence of heterogeneity amongst expectations across household demographics. Differences are particularly notable across gender, income and education groups, with women and less advantaged households reporting higher point forecasts and realising larger forecast errors relative to men and more advantaged groups. Nevertheless, not all demographic characteristics impact upon the forecast behaviour of households with the differences between age groups and between regions of residence generally not significant. In contrast to McGranahan

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property of the REH further indicating that the expectations of the least advantaged exhibit greater deviations from rationality relative to other demographic groups.

and Paulson (2006), Malmendier and Nagel (2009), Madeira and Zafar (2012), and Menz and Poppitz (2013), current market basket differences of the various age groups and historical price experiences appear to have limited effect upon the expectations of households; similarly, regional inflation differentials do not appear to impact on household heterogeneity. Interestingly, these relationships were found to be robust across the four sample periods, indicating that the level of heterogeneity across demographic groups is independent of macroeconomic conditions.

Despite these findings demonstrating that forecasting behaviour is not homogeneous across agents, the use of group consensus forecasts is still unable to account to account for the full extent of heterogeneity and forecast dispersion across households. In an attempt to address this issue, the next section considers the degree of forecast dispersion, analyses whether disagreement is group-specific, and investigates the determinants of disagreement.

4.3. Forecast Dispersion and Disagreement

As previously highlighted, although the analysis of reported forecasts and forecast errors provide some insight regarding expectation differences between demographic groups, they are not particularly informative of intra-group differences amongst forecasters within a specific demographic category. The analysis of demographically disaggregated forecasts shall thus be extended by considering group-specific disagreement. Whereas analysis of forecasts and associated errors provide an indication of agent perceptions of future macroeconomic conditions, Bomberger (1996), Mankiw et al. (2003) and Lahiri and Sheng (2010) note that disagreement provides an indication of the perceived level of uncertainty amongst forecasters[83].

As highlighted by Lamla and Maag (2012), disagreement arises from agents utilising different information sets and employing different forecasting models. One can thus formally model disagreement by considering the expectations of individual agents $E_{i,t}[\pi_{t+h}]$ such that:

$$E_{i,t}[\pi_{t+h}] = f_{i,t}\{I_{i,t}\} \quad (4.3.1)$$

where $I_{i,t}$ is the information set and $f_{i,t}$ is the forecasting model of agent i in period t. Following Patton and Timmermann (2010), one may alternatively consider differences in $f_{i,t}$ to represent heterogeneity in agent priors whilst differences in $I_{i,t}$ represent heterogeneous signals. Disagreement across agents can thus be identified by the sample standard deviation in beliefs across all agents such that:

$$\sigma_t = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}\left(E_{i,t}[\pi_{t+h}] - \bar{E}_{i,t}[\pi_{t+h}]\right)^2} \quad (4.3.2)$$

The standard deviation σ_t represents disagreement across agents whilst $\bar{E}_{i,t}[\pi_{t+h}]$ represents the mean expectation. Some may question the use of the standard deviation acknowledging that this measure of dispersion is sensitive to the presence

[83] Disagreement and uncertainty are however identified by Zarnowitz and Lambros (1987) to be distinct concepts with the former indicating the degree of consensus regarding point forecasts, whilst the latter refers to the distributions of forecasts. Moreover, Zarnowitz and Lambros (1987) demonstrate that both high and low levels of disagreement can be associated with high or low levels of uncertainty.

of outliers. Nevertheless, considering the expectation formation process for an extended sample period the standard deviation is able to consider the dispersion of beliefs.

A frequently employed measure of disagreement, as utilised by Mankiw et al. (2003) and Dovern et al. (2012), relates to the interquartile range (IQR); however, this measure of dispersion only considers the middle 50% of respondents, excluding those at either tail of the forecast distribution and thus fails to fully capture the extent of disagreement amongst agents. An alternative approach is adopted by Kolb and Stekler (1996), who prefer analysing whether the dispersion of forecasts is consistent with the properties of a uniform or normal distribution; specifically, consensus amongst forecasters is argued to arise when the former is rejected in favour of the latter. However, questioning this approach, Döpke and Fritsche (2006) suggest that forecasts may be too close together to be consistent with the properties of a normal distribution, and instead propose that where the distribution is not skewed and have a significant kurtosis greater than 3, a consensus amongst forecasters is established.

As the analysis in this section focuses on the degree of forecast dispersion amongst agents, and the response of disagreement to macroeconomic conditions, the standard deviation shall be employed for empirical examination. In 4.3.1, the level of forecast dispersion for individual groups is identified and compared across demographics whilst the macroeconomic determinants of disagreement, and the response of disagreement to the perceived level of news, are analysed in 4.3.2 and 4.3.3 respectively.

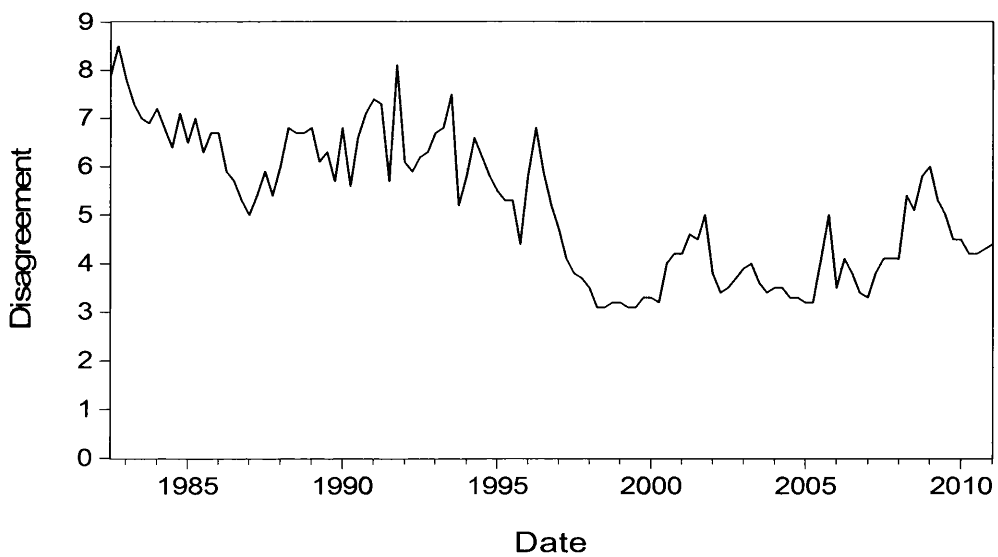
4.3.1. Disagreement and Household Demographics

As previously noted, in addition to publishing the reported forecasts of households, the Michigan Survey also reports the standard deviation for both aggregate and disaggregate forecasts. Continuing to focus upon inflation forecasts, these statistics shall be analysed by identify whether the level of disagreement amongst household forecasters is group-specific and time-variant. Elementary statistics regarding forecast dispersion amongst aggregate Michigan Survey inflation forecasts and the evolution of disagreement over the sample period, are presented in Table 4.3.1 and Figure 4.3.1 respectively.

Table 4.3.1: Aggregate Michigan Survey Disagreement – Elementary Statistics

	WHOLE	G-B	STABLE	VOLATILE
Mean	5.182	4.874	4.770	4.489
Maximum	8.500	8.100	8.100	6.000
Minimum	3.100	3.100	3.100	3.000
Std. Dev.	1.434	1.321	1.419	0.757

Figure 4.3.1: Aggregate Michigan Survey Disagreement



For aggregate Michigan Survey expectations, the mean level of disagreement presented in Table 4.3.1 does not appear to vary greatly over the four sample periods; moreover, the maximum, minimum and standard deviation values for the whole, Greenspan-Bernanke and stable sample periods are very similar. Nevertheless, there is an apparent fall in disagreement over time with mean and maximum levels of disagreement for the stable and volatile sub-periods lower compared to the longer whole and Greenspan-Bernanke sample periods; moreover, for the volatile sub-period, disagreement appears to be less variable relative to the earlier sample periods. For the recent period of increased macroeconomic volatility this is indicative of some trade-off between greater uncertainty regarding macroeconomic conditions and the opportunity costs arising from larger forecast errors associated with deviations from the consensus forecast. Additionally, Figure 4.3.1 reveals that during the 1980's and early to mid-1990's, disagreement amongst aggregate Michigan Survey respondents was relatively high, whereas from the mid- to late 1900's, disagreement is generally much lower; these results are consistent with those reported by Rich and Tracy (2010). Peaks in the level of disagreement are however observed following the early 2000's recession and the more recent economic downturn in the late 2000's. Nevertheless, disagreement over these periods remains lower relative to the general level observed for the early years of the sample period.

Also of interest is whether individual demographic groups exhibit greater forecast dispersion relative to others. In a similar manner to the analysis in 4.2 elementary statistics relating to disagreement across disaggregate Michigan Survey forecasts for the four sample periods are presented in Appendix 4.26 and Appendix 4.27, whilst Welch F-test statistics are presented in Appendix 4.28 to analyse whether the mean level of disagreement across groups is statistically equal. Turning attention to dispersion across disaggregate Michigan Survey forecasts, the general trends identified for aggregate forecasts are again observed with mean disagreement for individual groups approximately equal across the whole, Greenspan-Bernanke and stable sample periods, whilst disagreement for the volatile period is generally lower. Moreover, it is apparent that various demographic characteristics, namely, gender, education and income, impact upon the level of forecast disagreement.

In accordance with the analysis concerning inflation expectations in 4.2, a U-shaped relationship is observed between disagreement and age; again indicating that 'middle-aged' respondents form their expectations differently to the young and the old; this could again indicate differences historical price experiences between age groups, or greater intra-group heterogeneity in consumption behaviour and current price experiences amongst middle-aged respondents. Nevertheless, the Welch F-tests presented in Appendix 4.28, and the ANOVA F-Tests for individual pairs of age groups in Appendix 4.29 do not generally reveal any statistically significant differences between age groups for each of the four sample periods[84]. Similarly, although mean disagreement for the South region is invariably larger relative to the other three regions across the four sample periods, differences in disagreement across regionally disaggregated expectations are not statistically significant at the 5 percent level[85].

In contrast, for all four sample periods, highly significant differences in mean disagreement are observed in Appendix 4.28 for the education, gender and income disaggregations; the results presented in Appendix 4.26 and Appendix 4.27 clearly indicate that disagreement is lower amongst men and those households with higher levels of education or income. Moreover, asymmetric responses in disagreement to macroeconomic conditions are observed amongst these groups; for women and less advantaged households, disagreement for the stable period is higher relative to the volatile sample period, however, for men and more advantaged households, higher levels of disagreement are observed for the volatile sub-period. This is likely to indicate asymmetry amongst demographic groups regarding the utilisation of information across macroeconomic conditions. Furthermore, for the whole, Greenspan-Bernanke and stable periods, the ANOVA F-tests presented in Appendix 4.30 and Appendix 4.32 clearly indicate that the null hypothesis of equal levels of forecast dispersion can be rejected for all pairs of education or income groups. Similar results are also reported for the volatile sub-period, however there is some evidence of equal disagreement between individual pairs of adjacent education or income groups[86] suggesting that whilst the overall relationship of higher levels of disagreement for less advantaged groups remains, differences in forecast dispersion are smaller.

Whilst analysis of mean disagreement across demographics provides an elementary indication of differences in forecast dispersion across households, they are not particularly informative for economists. In accordance with Mankiw et al. (2003),

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[84] For the whole and Greenspan-Bernanke sub-periods, there is some evidence of significant differences in the forecast dispersion between the two oldest age groups.

[85] At a 10 percent level of significance, the Welch F-test rejects the equal means null hypothesis for region disagreement for the whole sample period.

[86] The forecast dispersion for those households with less than high school education and those in the first income quartile remains significantly larger in comparison to other education or income groups respectively.

this section highlights that measures of central tendency are unable to account for the full extent of expectational heterogeneity; instead, substantial levels of disagreement are observed across demographic groups. Nevertheless, those groups that report larger forecast errors, namely women and less advantaged households, also exhibit more dispersed expectations. To provide a better understanding of disagreement across demographics and time, the next section empirically examines the macroeconomic determinants of Michigan Survey disagreement, with particular attention to whether perceived news regarding both business conditions and prices have symmetric effects on forecast dispersion across demographic groups and macroeconomic conditions.

4.3.2. Macroeconomic Determinants of Forecast Disagreement

The analysis in 4.3.1 above identified that forecast disagreement amongst households is dependent on both agent demographics and macroeconomic conditions with higher levels of disagreement observed amongst those households whom on average realise larger forecast errors including those with lower levels of education or income, and women. Whereas the examination of the descriptive statistics of forecast dispersion provides an overview of expectational disagreement, and further establishes substantial forecast heterogeneity amongst individual demographic groups, it is not particularly informative to economists. Therefore, to establish a more thorough understanding of the properties of group-specific disagreement, this section shall empirically analyse the macroeconomic determinants of forecast dispersion amongst households akin to Mankiw et al. (2003), Lamla and Maag (2012) and Doven et al. (2012).

In accordance with the analysis presented by Mankiw et al. (2003) the empirical analysis of the macroeconomic determinants of forecast dispersion shall begin by considering the relationship between group-specific levels of disagreement $\sigma_{i,t}$ and macroeconomic variables, namely the inflation rate, π_t, the four-period absolute change in inflation, $|\pi_t - \pi_{t-4}|$, and the output gap, Gap_t:

$$\sigma_{i,t} = \alpha_0 + \alpha_1 \sigma_{i,t-1} + \alpha_2 \pi_t + \alpha_3 |\pi_t - \pi_{t-4}| + \alpha_4 Gap_t + \epsilon_t \qquad (4.3.3)$$

The inclusion of lagged disagreement controls for dispersion in prior beliefs as advocated by Patton and Timmermann (2010), whilst the absolute four period ahead change in inflation controls for inflation variability. The results for aggregate Michigan Survey expectations across all four sample periods are presented in Appendix 4.34.

Across all four sample periods, in accordance with the results presented by Lamla and Maag (2012), the one period lagged disagreement amongst aggregate households is highly significant indicating that forecast disagreement is highly persistent. Moreover, across all four sample periods, whereas α_2 is positive and highly significant, α_3 is insignificant. Therefore, in accordance with Mankiw et al. (2003), D'Amico and Orphanides (2008) and Dovern et al. (2012), higher rates of inflation are associated with higher levels of disagreement whereas the observation that inflation volatility has no impact upon household disagreement[87] supports the findings of Lamla and Maag (2012) for both household and professional forecasters. For the stable period, disagreement appears to exhibit a larger response to inflation relative to the whole and Greenspan-Bernanke sample periods. In contrast, for the volatile sub-period, the value of α_1 is much smaller, thus whilst the rate of inflation remained a significant influence on household disagreement, uncertainty relating to the wider economy is likely to have had an increased contribution to forecast dispersion relative to periods of greater stability. In accordance with Dovern et al. (2012), a general negative relationship is observed between disagreement and the output gap suggesting that forecast dispersion rises during recessions; this corresponds with the observations from Figure 4.3.1 which showed higher levels of disagreement for the early 2000's and late 2000's recessions.

Equation (4.3.3) is further tested upon disaggregate Michigan Survey expectations with the results presented in Appendix 4.35 to Appendix 4.39. Across demographic groups and sample periods, disagreement is found to be generally positive and significant. For the whole, Greenspan-Bernanke and stable sample periods, disagreement is more persistent for younger households, those with lower levels of education or income, women and the South region. For these three sample periods, α_2 is again positive and significant for all demographic groups further supporting the idea that disagreement increases as the inflation rate rises; moreover, larger values of α_2 are observed for households aged 45 or over, men, lower income groups and the North-East region whilst a U-shaped relationship is observed across education groups. In contrast, α_3 associated with inflation volatility, is generally insignificant across demographics; nevertheless, for the whole and Greenspan-Bernanke sample periods a significant positive relationship is observed for the two highest education groups, men, and the fourth income quartile. Therefore, disagreement amongst more advantaged demographics appears more sensitive to the volatility of inflation relative to lower advantaged groups which may indicate that consensus amongst these groups is more sensitive to macroeconomic conditions. Finally in accordance with the results for aggregate expectations, a negative relationship is again observed between disagreement and the output gap; thus, in accordance with Dovern et al. (2012)

[87] Replacing this measure of inflation volatility with the squared inflation rate yields the same conclusions.

disagreement increases during recessions, further supporting the argument that as inflationary pressures decrease, disagreement increases supporting the argument of Mankiw and Reis (2002) and Pfajfar and Santoro (2010) that agents devote greater attention to expectation formation when inflation matters.

Recalling from Appendix 4.8, Appendix 4.26 and Appendix 4.27 that both forecast errors and forecast disagreement are generally larger for less advantaged groups and women, one may further hypothesise that larger forecast errors amongst a certain demographic are likely to result in greater levels of group-specific disagreement amongst subsequently formed expectations. Intra-group disagreement may thus arise as some agents within any given group adjust their forecasts in response to the realisation of forecast errors, whereas others continue to report expectations consistent with prior beliefs. This asymmetric behaviour may result from differences in interpretation of forecast errors as information regarding permanent or transitory shocks respectively. Moreover, in relation to professional expectations, Giordani and Söderlind (2003) report that SPF disagreement is positively correlated with the absolute value of the most recent forecast error. Similarly, in their analysis of information rigidities, Andrade and Le Bihan (2010) utilise the squared forecast error to proxy for economic shocks, and again observe a positive and significant relationship between agent disagreement and forecast errors.

To establish whether any relationship between disagreement and forecast accuracy is exhibited by Michigan Survey expectations, the following model shall be examined:

$$\sigma_{i,t} = \gamma_0 + \gamma_1\sigma_{i,t-1} + \gamma_2(\pi_t - E_{t-h}[\pi_t])^2 + \gamma_3\pi_t + \gamma_4|\pi_t - \pi_{t-4}| + \gamma_5 Gap_t + \epsilon_t \quad (4.3.4)$$

The inclusion of lagged disagreement again controls for dispersion in prior beliefs as advocated by Patton and Timmermann (2010), whilst the absolute four period ahead change in inflation controls for inflation variability. The results for aggregate Michigan Survey expectations for the four sample periods are presented in Appendix 4.40. Corresponding with the results presented by Andrade and Le Bihan (2010), for the whole, Greenspan-Bernanke and stable periods there is some evidence of a significant positive relationship between forecast errors and household disagreement. Utilising forecast errors as a proxy for economic shocks and the predictions of information rigidity as presented by Coibion and Gorodnichenko (2012), the positive relationship between forecast errors and disagreement can be considered consistent with sticky information theory[88]. In contrast, for the volatile sub-period, γ_2 is insignificant; this is consistent with the predictions of noisy information models, with Andrade and Le Bihan (2010) and Coibion and Gorodnichenko (2012) highlighting that disagreement is invariant to shocks, arising instead from idiosyncratic noise which is constant across individuals and time[89].

Tests of (4.3.4) are also examined for disaggregate Michigan Survey expectations with the results presented in Appendix 4.41 to Appendix 4.45. For all four sample periods, disagreement remains highly persistent and positively related to the inflation rate, however, the value of γ_2 is generally insignificant across demographic groups. Nevertheless, where significant, the value of γ_2 is invariably positive indicating that larger forecast errors increase disagreement, again supporting the notion that agent inflation forecasts are subject to sticky information. Nevertheless, in accordance with the results for aggregate expectations presented in Appendix 4.40, γ_2 is almost invariably insignificant for the volatile sub-period[90]; this would support the argument that information rigidities embodied within household expectations for the recent period of macroeconomic uncertainty are more consistent with the predictions of noisy information theory.

An alternative approach to analyse heterogeneity in forecast dispersion across demographics is to examine the relationship between group-specific levels of disagreement and measures of aggregate uncertainty. As previously highlighted by Coibion and Gorodnichenko (2012) where uncertainty regarding macroeconomic conditions reduces the signal-to-noise ratio, disagreement amongst agents is likely to increase. Similarly, Dovern et al. (2012) report a positive relationship between agent disagreement and the volatility of the forecast variable.

Whilst economic uncertainty is an important concept for decision makers, it is difficult to quantify. A potential proxy for aggregate uncertainty concerns disagreement amongst professionals regarding the forecast variable under the assumption that greater disagreement amongst well informed agents relates to greater uncertainty regarding macroeconomic conditions. Alternatively, following recent

[88] Models of sticky information shall be examined in greater detail in Chapter 5.
[89] The predictions of information rigidity models shall be extensively examined in Chapter 6.
[90] At a five percent level γ_2 is only significant for the first income quartile.

studies, including Leduc and Liu (2014), Istrefi and Piloiu (2013) and Bachmann et al. (2013), the economic policy uncertainty index of Baker, Bloom and Davis (2013) shall be employed[91]. Specifically, in accordance with Istrefi and Piloiu (2013), to avoid correlation with professional disagreement, only the news-coverage component of uncertainty shall be employed.

In a similar manner to (4.3.3) and (4.3.4), to establish the relationship between household disagreement and aggregate measures of uncertainty, the following model shall be analysed for both aggregate and group-specific Michigan Survey disagreement:

$$\sigma_{i,t} = \gamma_0 + \gamma_1 \sigma_{i,t-1} + \gamma_2 \sigma_{P,t} + \gamma_3 Bloom_t + \gamma_4 \pi_t + \epsilon_t \qquad (4.3.5)$$

Professional disagreement is denoted $\sigma_{P,t}$ whilst $Bloom_t$ denotes the news-coverage component of the Bloom uncertainty index; lagged household disagreement and the current inflation rate again control for the prior dispersion beliefs and current macroeconomic conditions. The results for aggregate expectations across the four sample periods are presented in Table 4.3.2 below:

Table 4.3.2: Aggregate Household Disagreement and Macroeconomic Uncertainty

Testing Equation: $\sigma_{i,t} = \gamma_0 + \gamma_1 \sigma_{i,t-1} + \gamma_2 \sigma_{P,t} + \gamma_3 Bloom_t + \gamma_4 \pi_t + \epsilon_t$

	γ_0	γ_1	γ_2	γ_3	γ_4	R^2	$\bar{R}^2$	D.W. Stat
Period: Whole 1982Q3 – 2011Q1								
MS	0.008 (0.231)	0.809*** (0.042)	-0.050 (0.197)	0.443** (0.185)	0.172*** (0.045)	0.797	0.787	2.663
Period: Greenspan-Bernanke 1987Q2 – 2011Q1								
MS	0.023 (0.249)	0.805*** (0.048)	-0.047 (0.226)	0.446** (0.187)	0.169*** (0.050)	0.784	0.774	2.638
Period: Stable 1990Q1 – 2006Q2								
MS	0.099 (0.298)	0.754*** (0.062)	-0.980** (0.435)	0.490* (0.248)	0.386*** (0.068)	0.791	0.776	2.554
Period: Volatile 2006Q3 – 2011Q1								
MS	0.611** (0.257)	0.812*** (0.077)	-0.459 (0.286)	0.475*** (0.108)	0.049*** (0.012)	0.737	0.662	2.463

In accordance with tests of (4.3.3) and (4.3.4), the γ_1 and γ_4 coefficients are positive and significant across all four sample periods providing further evidence that the positive relationship between disagreement and both the prior dispersion of beliefs and the current inflation rate, are robust. From Table 4.3.2, it is evident that for all

[91] The economics policy uncertainty index comprises of newspaper coverage of policy uncertainty and the disagreement among professional forecasters.

four sample periods uncertainty measured by the Bloom uncertainty index has a significant and positive relationship with household disagreement. Greater uncertainty coverage by newspapers thus results in an increase in dispersion amongst aggregate Michigan Survey inflation forecasts. However, whilst the value of γ_3 is approximately equal across the four sample periods, a reduction in significance is observed for the stable sub-period which may be indicative of reduced news coverage of uncertainty during periods of reduced macroeconomic volatility. In accordance with this argument, the value of γ_3 is significant at the 1 percent level for the latest sample period associated with higher levels of uncertainty and volatility.

Contrastingly, for the whole, Greenspan-Bernanke and stable sample periods, professional disagreement is insignificant suggesting that the views of professionals have little impact upon the dispersion of household expectations, and may further indicate that professional disagreement is a poor proxy for wider economic uncertainty. Nevertheless, for the stable sub-period, γ_2 is negative and significant suggesting that an increase in professional disagreement results in a reduction in household disagreement. During periods of greater macroeconomic stability, households may thus seek to report expectations more consistent with the consensus where uncertainty rises, and thus further supports the argument that some trade-off exists between greater uncertainty regarding macroeconomic conditions and the opportunity costs arising from larger forecast errors associated with deviations from the consensus forecast.

Tests of (4.3.5) are also performed on demographically disaggregated Michigan Survey expectations with the results presented in Appendix 4.46 to Appendix 4.50. In accordance with the results presented in Table 4.3.2 for aggregate Michigan Survey expectations, uncertainty represented by SPF disagreement for the whole and Greenspan-Bernanke sample periods, is insignificant for all demographic groups at the conventional 5 percent level of significance. In contrast, the coefficient attached to the Bloom uncertainty index is generally larger, and is observed to be significant for various demographic groups; specifically, a positive and significant relationship between the Bloom index and disagreement is observed for higher education and income groups, the North East and South regions, both genders and all age groups, except those aged 65-97.

For the stable period, disagreement amongst young respondents, men, all four regions and those with higher levels of education or income again exhibit a positive and significant response to the Bloom uncertainty index; as uncertainty rises, the inflation forecasts reported by these agents exhibit greater dispersion. In contrast, α_3 for older respondents, women, those with lower levels of education or income is insignificant; instead for most of the groups α_2 is significant and negative indicating that disagreement amongst those demographics falls as professional disagreement rises.

For the volatile sample period, whereas the coefficient associated with professional disagreement is again generally insignificant across demographic groups, an asymmetric response is observed regarding the Bloom index. Specifically, whilst α_3 is significant for the middle aged, those with some college or college degree education, the third and fourth income quartiles, and the North-Central, North-East and South regions, disagreement amongst other demographic groups is insensitive to this measure of uncertainty.

These results indicate that the dispersion of expectaions amongst less advantaged households are insensitive to the Bloom newspaper index; these agents may lack the cognitive abaility and resources to process information regarding less predictable outcomes and thus exhibit greater inattention to uncertainty regarding macroeconomic conditions. Disagreement amongst those groups with lower sensitivity to the Bloom index instead appears to exhibit a larger response to the inflation rate; this indicates that at higher rates of inflation, the expectations of certain agents, including the less advantaged, are subject to greater dispersion relative to other groups. A potential explanation, as proposed by Bruine de Bruin et al. (2011b) is that the expectations of a proportion of these agents are subject to extreme observations in specific prices resulting in greater deviations from the consensus median forecast.

The results presented in this section indicate that the macroeconomic determinants of disagreement are dependent upon the sample period and household demographics. Across the various specifications, the coefficients associated with lagged agent disagreement are relatively large and are generally highly significant for all disaggregations; in accordance with Lamla and Maag (2012) agent disagreement is highly persistent and dependent upon the prior dispersion of beliefs as indicated by Patton and Timmermann (2010). However, asymmetric responses are observed regarding various macroeconomic variables, for example, disagreement amongst less advantaged households exhibits a larger response to inflation relative to more advantaged counterparts. These asymmetric responses may be resulting from differences in information. To analyse the effect of the available information, the next section utilises Michigan Survey responses regarding the perceived level of news, to consider the manner which news volume and news tone impact upon household disagreement.

4.3.3. Forecast Disagreement and Perceived News

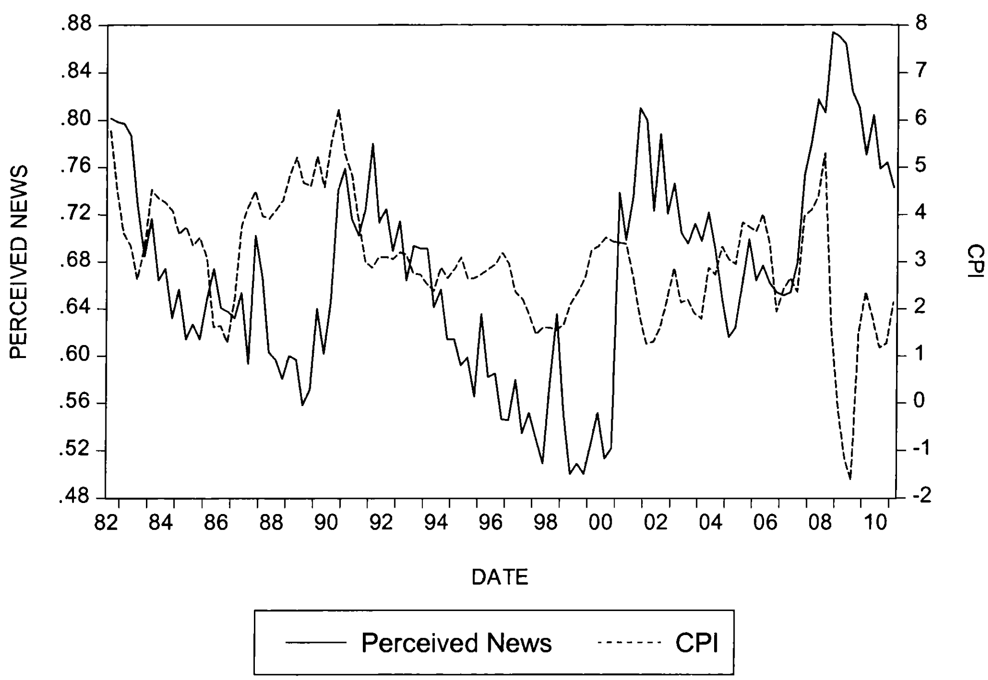
In 4.3.1 and 4.3.2, in a manner akin to Mankiw et al. (2003), it has been established that forecasts reported by Michigan Survey respondents are subject to persistent levels of dispersion whilst disagreement is dependent upon demographic characteristics and macroeconomic conditions. In a similar manner to Lamla and Lein (2008) and Lamla and Maag (2012), the relationship between household disagreement and news shall be analysed; moreover, it shall further be examined whether any relationship is evident between household and professional disagreement, akin to the survey-updating hypothesis of Carroll (2003).

In accordance with Carroll (2003), Lamla and Lein (2008) and Lamla and Maag (2012), it is assumed that in forming their inflation forecasts, rather than individually observing data regarding all macroeconomic variables, agents obtain their views from media reports. Various commentators, including Mankiw et al. (2003), Carroll (2003), Lamla and Lein (2008), Pfajfar and Santoro (2010, 2013) and Lamla and Maag (2012), hypothesise that a greater volume of news will result in greater expectational consensus amongst economic agents; it is thus appropriate to examine whether the quantity of news impacts upon the level of disagreement across household expectations. Additionally, Lamla and Lein (2008), Easaw and Ghoshray (2010), Lamla and Maag (2012), and Pfajfar and Santoro (2013) highlight that expectations may respond asymmetrically in response to favourable and unfavourable news. The response of forecast disagreement to variable news reports shall also be examined to determine the impact of news tone on forecast consensus.

Assessing the rate of information diffusion, Carroll (2003) utilises an index of news intensity based upon newspaper reports regarding inflation, as obtained from the LexisNexis database; however, this is argued by Pfajfar and Santoro (2013) to not be particularly informative with regards to agent behaviour whilst Blinder and Krueger (2004) argue that television is a more popular information source than newspapers. Instead, the analysis in this section follows the approach employed by Pfajfar and Santoro (2013), utilising the perceived level of news reported by Michigan Survey respondents as a proxy for the availability of news available to households in any given period. Specifically, the Michigan Survey asks respondents whether *"During the last few months, have you heard of any favourable or unfavourable changes in* *business conditions?"* Upon a positive repose to the *"any change"* question, the Michigan Survey subsequently asks respondents *"What did you hear?"* From these questions, the Michigan Survey reports data concerning the proportion of agents having heard any news, the proportions hearing any form of favourable or unfavourable news, and further disaggregates the favourable and unfavourable responses into various categories including news concerning prices, employment and the stock market.

Figure 4.3.2 reports the fraction of Michigan Survey respondents that have heard any news regarding business conditions together with the rate of inflation as measured by the CPI:

Figure 4.3.2: Michigan Survey Perceived News



From Figure 4.3.2, there appears some correlation between the percentage of agents reporting that they have heard some news regarding business conditions and the rate of inflation. Namely throughout the early to mid-1980's, the perceived level of news falls with the rate of inflation; similarly, for the early 1990's where inflation peaks at over 6 percent, there is an increase in the perceived level of news. Furthermore, for the mid- to late-1990's for increased levels of macroeconomic stability, agents have a lower probability of having heard any news regarding business conditions; moreover, high levels of perceived news are additionally observed for the recent period of increased macroeconomic uncertainty where inflation has been previously identified to be particularly volatile. This could indicate a greater volume of news for the recent period of macroeconomic uncertainty, or alternatively, that agents are more attentive to the available information set.

To examine whether the perceived level of news impacts upon the level of disagreement amongst Michigan Survey inflation forecasts, (4.3.6) akin to Andrade and Le Bihan (2010), Bruine de Bruin et al. (2011a) and Lamla and Maag (2012) shall be evaluated:

$$\sigma_{i,t} = \alpha_0 + \alpha_1\sigma_{i,t-1} + \alpha_2 News_{i,t} + \alpha_3\pi_t + \alpha_4|\pi_t - \pi_{t-4}| + \alpha_5 GAP_t + \epsilon_t \tag{4.3.6}$$

Again, $\sigma_{i,t}$ defines the level of disagreement at time t for demographic group i, whilst $News_{i,t}$ represents the group-specific proportion of agents having heard any form of news[92] and GAP_t is again the output gap; in accordance with Lamla and Maag (2012), the inclusion of the lagged dependent variable is motivated by the dispersion of prior beliefs as further demonstrated by Patton and Timmermann (2010), whilst the inclusion of π_t, and $|\pi_t - \pi_{t-4}|$ account for inflation and inflation variability. The results from testing (4.3.6) for aggregate Michigan Survey forecasts for the four sample periods are presented in Appendix 4.51.

Firstly, setting $\alpha_4 = 0$ and $\alpha_5 = 0$, a significant negative relationship is observed between news intensity and disagreement for the whole, Greenspan-Bernanke and volatile sample periods; this indicates that as the volume of news regarding general business conditions rises, a greater consensus in aggregate Michigan Survey inflation forecasts is observed. This result corresponds with those presented by Lamla and Maag (2012) and Menz and Poppitz (2013) for EU and German survey data respectively. However, for the stable period, α_2 is insignificant at the five percent level indicating that disagreement is less sensitive to news coverage during periods of reduced macroeconomic uncertainty. This suggests that agents are less attentive to the media, and given the larger value of α_3 for the stable period, supports the argument that disagreement is more dependent upon the level of inflation and may be the result of asymmetric inflation experiences across demographic groups. Whilst α_3 is insignificant for the volatile period, the value of α_2 is more negative relative to

[92] To calculate the proportion of agents having heard any news we utilise the relative news index of recent changes in business conditions available from the Michigan Survey.

the whole and volatile periods indicative of greater uncertainty amongst agents regarding general business conditions during the recent period of macroeconomic volatility. Removing the restrictions on α_4 and α_5, the news intensity variable is only significant for the Greenspan-Bernanke and volatile sub-periods. News reports thus appear to have a particularly large impact on disagreement amongst forecasters for the most recent period of macroeconomic volatility.

Tests of (4.3.6) are also evaluated for disaggregate expectations with the results presented in Appendix 4.52 to Appendix 4.56. Across sample periods and demographics, disagreement is again found to be persistent and positively related to the inflation rate; whilst a general negative relationship is again observed with the output gap For the whole, Greenspan-Bernanke and stable periods, α_2 is generally insignificant; however, for the Greenspan-Bernanke sub-period, and to a lesser extent the stable sub-period, significant negative relationships between news and disagreement are observed, particularly for more advantaged households. This could indicate that only a proportion of households are attentive to news during periods of relative macroeconomic stability, and upon observing news, report expectations which exhibit greater consensus. For the volatile periods, a larger significant negative relationship is observed across demographic groups, indicating that for the recent period of macroeconomic uncertainty, an increased volume of news reduces the dispersion of agent forecasts.

Whilst (4.3.6) represents the baseline specification utilising the overall perceived level of news, Lamla and Lein (2008), Easaw and Ghoshray (2010), Lamla and Maag (2012), and Pfajfar and Santoro (2013) further investigate whether the content, or tone, of perceived news impacts on the expectation formation process and resulting disagreement[93]. Specifically, Lamla and Lein (2012) highlight that the tone of media reports can induce some form of media bias, shifting forecasts away from the rational expectation, and may thus result in greater forecast heterogeneity and disagreement. Alternatively, one may argue that an increase in unfavourably toned news may raise the awareness of agents to macroeconomic issues, who thus incorporate the latest news in information sets and a reduction in forecast dispersion.

[93] Similarly, Dräger (2011) reports that the tone of media reports results in asymmetric effects upon both inflation expectations and perceptions in Sweden.

In a similar manner to the aforementioned studies, the impact of both favourable and unfavourable perceived news, as reported by Michigan Survey respondents, upon household disagreement shall be examined utilising (4.3.7):

$$\sigma_{i,t} = \alpha_0 + \alpha_1\sigma_{i,t-1} + \alpha_2 NewsF_{i,t} + \alpha_3 NewsU_{i,t} + \alpha_4\pi_t + \alpha_5\pi_t^2 + \alpha_6|\pi_t - \pi_{t-4}| + \epsilon_t \quad (4.3.7)$$

The group-specific proportion of agents having heard favourable and unfavourable news is represented by $NewsF_{i,t}$ and $NewsU_{i,t}$ respectively. The results for aggregate expectations are presented in Appendix 4.57.

Firstly, akin to the preliminary analysis of (4.3.6) the restrictions $\alpha_5 = 0$ and $\alpha_6 = 0$ are imposed. From these tests, there is clear evidence that there is an asymmetric response in disagreement amongst aggregate Michigan Survey expectations to favourable and unfavourable news. Specifically, for a five percent level of significance, the coefficient associated with favourable news is insignificant whereas a highly significant positive relationship is observed between disagreement and unfavourable news. Therefore, whilst favourable news has limited impact, as the volume of news articles concerning unfavourable news increases, households report more widely dispersed inflation forecasts. This could indicate that in response to unfavourable news, a proportion of agents underreact, perhaps resulting from inattentiveness, whilst an additional proportion overreact indicative of some inherent pessimism. Utilising the expectation gap rather than disagreement per se, similar findings are reported by Lamla and Lein (2008), Dräger (2011) and Pfajfar and Santoro (2013).

In contrast, for the unrestricted specification presented in Appendix 4.57, across all four sample periods, both α_2 and α_3 are insignificant thus indicating that both favourable and unfavourable news concerning business conditions have no impact upon the level of disagreement amongst aggregate Michigan Survey inflation expectations. Instead, for the whole, Greenspan-Bernanke and stable periods, α_4 is positive and significant further supporting the argument that disagreement is highly dependent upon the rate of inflation[94].

[94] At a five percent level of significance, inflation volatility and the output gap are also found to have no impact upon disagreement for any of the four sample periods.

Tests of (4.3.7) are also evaluated for disaggregate Michigan Survey expectations with the results presented in Appendix 4.58 to Appendix 4.62. In accordance with the results for aggregate expectations, across all disaggregations and sample periods both α_2 and α_3 are generally insignificant; instead, for the whole, Greenspan-Bernanke and stable sample periods, α_4 is positive and significant in nearly all cases. This again indicates that news tone has limited impact upon forecast disagreement, but further supports the existence of a robust relationship between disagreement and the rate of inflation. Nevertheless, in several cases, positive and significant responses in disagreement are observed, most notably for higher education and income groups. This suggests that disagreement amongst these groups exhibiting greater levels of forecast consensus is more sensitive to unfavourable news relative to less advantaged counterparts; this could be the result of greater attentiveness to news by these agents.

Whereas (4.3.6) and (4.3.7) refer to news regarding overall business conditions, this may be uninformative or irrelevant for the evolution of the price level and inflation. Therefore, the two previous specifications shall be re-examined replacing perceived news with the more specific measure regarding the perceived news on prices reported by Michigan Survey respondents. Specifically, (4.3.6) and (4.3.7) shall be respecified as follows:

$$\sigma_{i,t} = \alpha_0 + \alpha_1\sigma_{i,t-1} + \alpha_2 NewsP_{i,t} + \alpha_3\pi_t + \alpha_4|\pi_t - \pi_{t-4}| + \alpha_5 GAP_t + \epsilon_t \quad (4.3.8)$$

$$\sigma_{i,t} = \alpha_0 + \alpha_1\sigma_{i,t-1} + \alpha_2 NewsPF_{i,t} + \alpha_3 NewsPU_{i,t} + \alpha_4\pi_t + \alpha_5|\pi_t - \pi_{t-4}| + \alpha_6 GAP_t + \epsilon_t \quad (4.3.9)$$

The group-specific proportion of agents having heard any news regarding prices is defined as $NewsP_{i,t}$ whilst $NewsPF_{i,t}$ and $NewsPU_{i,t}$ represent the group-specific perceived levels of favourable and unfavourable news regarding prices.

Tests of (4.3.8) for aggregate Michigan Survey expectations are presented in row (1) of each panel of Appendix 4.63. For all four sample periods, the relationship between aggregate disagreement and the perceived news intensity on prices is insignificant; instead, significant relationships between forecast disagreement and the inflation rate, inflation volatility and the output gap are observed. Akin to the results for news regarding general business conditions, the news intensity concerning prices appears to have little impact on forecast dispersion which instead depends more heavily upon general macroeconomic conditions. These results may however arise from some correlation between the perceived level of price news and the actual rate of inflation. Restricting (4.3.8) such that $\alpha_3 = 0$ the results presented in row (2) of Appendix 4.63 indicate that a positive relationship exists between aggregate Michigan Survey forecast disagreement and the perceived news on prices for all four sample periods. The positive relationship between disagreement and both forecast dispersion and the actual rate of inflation supports the argument that the proportion of agents hearing news on prices is related to the inflation rate.

The unrestricted specification of (4.3.8) is also tested on disaggregate Michigan Survey expectations with the results presented in Appendix 4.64 to Appendix 4.68. For various demographic groups, tests of (4.3.8) reveal similar results to those for aggregate Michigan Survey expectations; namely, for the whole, Greenspan-Bernanke and stable sample periods, α_2 is insignificant for the young and those households with higher levels of education or income. In contrast, α_2 for older age groups, the less educated, lower income quartiles and all four regions is generally negative and significant; disagreement amongst these agents thus falls as the proportion of agents hearing news on prices increases.

Across demographics, the effect of perceived news on prices on forecast disagreement for the stable sample period remains negative but is generally insignificant across demographic groups; nevertheless, α_2 is large and significant for both the lowest education and income groups suggesting that dispersion amongst the forecasts of the less advantaged agents is robustly dependent upon the volume of price news. Moreover, the forecasts of these agents may be more sensitive to news on prices relative to those of more advantaged households as inflation impacts upon their income or welfare more compared to other agent groups. Nevertheless, for all demographic groups, the proportion of agents hearing any news for any given period of the stable sub-period is much lower on average compared to either the 1980's or the recent volatile sub-period. Insignificant values of α_2 across disaggregations may therefore result from agents being less able to recall hearing news on prices; consequently, the reported forecasts and resulting disagreement is likely to depend upon alternative economic variables.

In contrast to the three alternative sample periods, the value of α_2 for the volatile sub-period across demographic groups is invariably positive and generally significant. Larger values of α_2 are again observed for less advantaged households indicating that news has a larger impact on disagreement amongst these agents relative to their more advantaged counterparts. Contrary to periods of greater macroeconomic stability, as the proportion of agents hearing news on prices increases, forecast dispersion amongst agents rises. This indicates that in the presence of macroeconomic volatility, a greater volume of news generates uncertainty amongst agents regarding the future value of inflation, generating more widely dispersed expectations; this may result from heterogeneity in the interpretation of news amongst agents, or alternatively, from news reports portraying conflicting perceptions of inflation or wider macroeconomic conditions.

Tests of (4.3.9) for aggregate Michigan Survey expectations are presented in Appendix 4.69. Firstly, imposing $\alpha_5 = 0$ and $\alpha_6 = 0$ a significant negative relationship between disagreement and favourable news is observed for both the whole and Greenspan-Bernanke sub-periods; however, α_3 associated with unfavourable news is insignificant. For the stable sub-period, the relationship between disagreement and both favourable and unfavourable news are insignificant yet for the volatile sub-period, whilst the coefficients associated with the two news tones are significant, disagreement falls in response to positive news, but increases in response to unfavourable price news.

Tests of (4.3.9) are also examined for disaggregate Michigan Survey expectations with the results presented in Appendix 4.70 to Appendix 4.74. For the whole, Greenspan-Bernanke and stable sample periods the coefficient on positively toned news is generally insignificant[95] whereas, for various demographic groups, a negative relationship between disagreement and negatively toned news is observed. Specifically, significant values of α_3 are observed for those in the two older age groups, the less educated and those in the first, second and third income quartiles. In accordance with Menz and Poppitz (2013), disagreement amongst households who generally realise larger forecast errors, appears to react more to unfavourable news regarding prices relative to other demographic groups. For regionally disaggregated

[95] A significant negative relationship is however observed between perceived price news and forecast disagreement amongst men.

expectations, the values of α_3 are fairly homogenous yet the coefficient is significant for the North-Central, South and West regions for the whole sample period, whereas significance is observed in the stable period for the North-East region. These results suggest there is some asymmetry in the sensitivity of disagreement to news, perhaps reflecting regional inflation differentials, however, disagreement for all regions appears to fall in response to unfavourable news.

In accordance with Lamla and Maag (2012) and Menz and Poppitz (2013) forecast disagreement amongst agents is dependent upon various factors including the volume and tone of the available news. These effects appear dependent upon both household demographics and the sample period with disagreement amongst less advantaged households more dependent upon price news, whilst news regarding general macroeconomic conditions has a larger impact upon the forecast dispersion amongst more advantaged households. This could indicate differences in information processing capacities akin to Sims (2003) or different distributions of attentiveness in welfare maximisation. Nevertheless, disagreement remains highly persistent further indicating that the prior dispersion of beliefs, remains a key determinant of the degree of consensus amongst agent expectations as previously highlighted by Lamla and Maag (2012) and Patton and Timmermann (2010).

4.4. Discussion

Recognising that the use of consensus measures of aggregate expectations fails to fully acknowledge the distribution of expectations amongst agents, this chapter has sought to establish the extent of disagreement and heterogeneity amongst the reported inflation forecasts across the various socioeconomic groups within the Michigan Survey. In accordance with the results presented by Pfajfar and Santoro (2008) and those in Chapter 2 for aggregate Michigan Survey expectations, all demographic groups tend to overestimate the future rate of inflation whilst forecast errors are larger for the recent period of macroeconomic volatility. Nevertheless, the reported expectations of women and those households with lower levels of education or income were found to realise larger forecast errors and exhibit higher levels of intra-group disagreement compared to men and more advantaged counterparts.

A potential issue with the analysis of disaggregated inflation expectations concerns agents experiencing different rates of inflation dependent upon their demographic characteristics. As previously noted by Bruine de Bruin et al. (2010b) and Armantier et al. (2012), differential interpretations regarding the wording of the Michigan Survey makes this issue particularly noteworthy; whereas some agents may respond with an expectation concerning the general price level, others may respond with personal price experiences. Given that more advantaged households are likely to have greater levels of economic and financial literacy in the manner described by Bruine de Bruin et al. (2010c) and Burke and Manz (2010), it is likely that those households with higher levels of education or income would be able to employ the necessary cognitive or financial resources required to report expectations more in line with official measures; however, it is not possible to distinguish from the reported forecasts in the Michigan Survey which measure of inflation households are targeting.

Despite disaggregating the Michigan Survey by demographic characteristics, the methodology employed in this chapter has been unable to fully exploit the full nature of heterogeneity across household expectations. Specifically, the median average employed for each demographic group can be considered an aggregate measure. Employing a percentile time-series in the manner demonstrated by Pfajfar and Santoro (2008, 2010) or the use of probability density functions akin to D'Amico and Orphanides (2008) and Boero et al. (2014) are viable alternatives to mitigate the aggregation issue.

As discussed throughout this chapter, and by previous studies including Michael (1979), Idson and Miller (1997), Hobijn and Lagakos (2005), McGranahan and Paulson (2006), Hobijn et al. (2009) and Menz and Poppitz (2013), household demographics impact upon consumption expenditure patterns; consequently, asymmetries arise in the inflation rates experienced by households. Despite recognising this asymmetry, the analysis presented in this chapter focuses on the aggregate measure of CPI inflation. This methodology is arguably most consistent with the 'prices in general' approach adopted by the Michigan Survey question; additionally, utilising the aggregate measure ensures comparability across households and with professional expectations. Consequently, the calculated forecast errors, associated with groups who form expectations based upon own circumstances and experiences, as opposed to the general price level, are likely to be considerably biased; this was evaluated in section 4.2 which demonstrated that across all demographic disaggregations, household forecasts fail the unbiasedness property required by the REH. An alternative approach would thus have been to construct group-specific price indices and analyse disaggregated expectations relative to both aggregate and group-specific measures in a manner akin to Menz and Poppitz (2013); this approach is however beyond the scope of this study.

This chapter has further established pervasive levels of disagreement amongst households, with the extent of forecast dispersion dependent upon household demographics and macroeconomic conditions. Namely, women and households with lower levels of income and education exhibit significantly higher levels of forecast dispersion compared to men and more advantaged counterparts; nevertheless, over the whole sample period, there appears some general trend of a fall in disagreement. However, utilising the standard deviation to measure the extent of forecast dispersion fails to acknowledge any change in the sample size, with the impact of outliers falling as the sample size increases. The empirical analysis of disagreement established the extent of forecast dispersion amongst households is highly persistent, whilst in accordance with Mankiw et al. (2003) a robust positive relationship across demographic groups was observed between the level of forecast dispersion and the inflation rate, indicating that higher rates of inflation are associated with higher levels of forecast disagreement amongst households. Moreover, in accordance with Dovern et al. (2012), a negative relationship between disagreement and the output gap is commonly observed indicating that forecast disagreement amongst households is higher during recessions.

Utilising the proportion of Michigan Survey respondents hearing news regarding both general business conditions and prices respectively, the empirical analysis also considers the impact of the volume and tone of news on forecast dispersion amongst households. Whilst the effect of news regarding general business conditions on aggregate disagreement is generally insignificant, stronger relationships are observed for individual demographic groups. These results indicate that whereas the volume of news does not impact upon the level of inter-demographic forecast disagreement, a greater dispersion of agents hearing news for any demographic reduces the level of intra-demographic disagreement.

Specifically, an increase in the volume of news concerning business conditions reduces forecast disagreement amongst households, most notably for men and those households with higher levels of income and education. In contrast, price news appears to have a larger effect on households with lower levels of education and income. Disagreement amongst more advantaged households is thus associated with general macroeconomic conditions; yet, forecast dispersion amongst less advantaged households is more influenced by price news suggesting that prices have a larger impact on the welfare of these agents. Alternatively, rather than assuming that all agents have access to a homogenous information set, a plethora of news sources, which attach different weights to specific news such as prices and general macroeconomic conditions, are likely to be available to agents; the effects identified in 4.3.3 may thus arise from demographic groups devoting asymmetric degrees of attention to individual news sources. For the volatile sub-period whereas the relationship between disagreement and general business conditions is negative for all demographic groups, the coefficient associated with price news is positive. This could indicate that whereas a greater volume of news concerning general macroeconomic conditions serves to inform agents regarding the future path of the economy, news concerning prices generates uncertainty regarding the effect of inflation on individual welfare.

In accordance with Menz and Poppitz (2013), asymmetric effects of news tone were also observed; specifically, whereas unfavourable news concerning both general business conditions and prices reduces the degree of forecast dispersion amongst households, positively toned news is generally insignificant. This supports the arguments of Mankiw and Reis (2002) and Pfajfar and Santoro (2010) that agent expectations are more sensitive to information when the opportunity costs associated with inflation, and the resulting impact on decision making and agent welfare, are sufficiently high. Nevertheless, the impact of unfavourable news was observed to be asymmetric with disagreement amongst more advantaged households more sensitive to unfavourable news regarding general business conditions, whilst the dispersion of forecasts amongst less advantaged groups exhibits a stronger relationship with unfavourable price news. This further highlights that the decision profiles, and consequently economic welfare, of the various demographic groups are subject to asymmetric economic influences.

Rather than utilising data regarding actual news reports for a given period, the analysis has instead focused on the perceived volume and tone of news heard by Michigan Survey respondents; this measure of news may however not be a reliable indicator of forecast dispersion and agent disagreement. Firstly, the responses of Michigan Survey participants may be subject to some self-reporting bias or misinterpretation of the volume or content of available news; consequently, the news measure employed in 4.3 may not be a reliable indicator of news items in circulation for any given period. Secondly, the content of the news heard by Michigan Survey respondents may not relate to the associated forecast horizon, and is instead associated with current or past values of economic variables or macroeconomic conditions. Alternatives to the Michigan Survey perceived news indices employed in 4.3.3 include the LexisNexis database, as utilised by Carroll (2003); however, as highlighted in 4.3.3, any index constructed from this data may not encompass the full extent of news sources encountered by agents.

The observed levels of disagreement amongst households over time could be a consequence of information rigidities with forecast dispersion a key component in both the noisy information and sticky information hypotheses. As highlighted by Andrade and Le Bihan (2010) and Coibion and Gorodnichenko (2012) disagreement in these models arises from imperfect and differences in information sets amongst agents. The consistency of agent forecasts with the predictions of these models shall be extensively analysed in Chapter 5 and Chapter 6.

CHAPTER 5: HOUSEHOLD FORECASTS, STICKY INFORMATION AND EPIDEMIOLOGICAL UPDATING HYPOTHESES

It is generally appreciated by economists that inflation reacts to macroeconomic disturbances with some lag. In recent years however, a key debate amongst macroeconomists has arisen concerning whether the predictions of sticky price or information rigidity models are best able to replicate observed inflation dynamics. Sticky price theory was introduced by New Keynesians including Taylor (1980) and Calvo (1983) and suggests that nominal prices are infrequently adjusted by firms. This contrasts with the notion of perfectly flexible prices and continuous adjustment advocated by Classical economists. Sticky price models are however often criticised for being unable to replicate the observed dynamic effects of macroeconomic variables. Indeed, within a staggered pricing framework, Ball (1994) observes that credible disinflations result in a 'boom', contrasting with post-war experiences; moreover, Fuhrer and Moore (1995) argue that the overlapping wage contracting model of Taylor (1980) produces excessive inflation persistence. These issues are argued by Mankiw and Reis (2002) to arise due to inflation being more responsive to disturbances than predicted by sticky price models. These issues have thus prompted increasing interest in models of information rigidity.

In Chapter 3 models of information rigidity were briefly introduced, including the prominent sticky information hypothesis as advocated by Mankiw and Reis (2002) and Reis (2006a, 2006b). These models provide interesting departures from traditional theories and attempt to mitigate the issues and limitations concerning adaptive expectations and the rational expectations hypothesis (REH). This chapter seeks to appraise these models and assess whether survey forecasts are empirically consistent with the predictions of information rigidity theory. Sub-section 5.1 reviews the development of information rigidity theory by previous studies. Next, the discussion focuses on a particular theory, epidemiological expectations as proposed by Carroll (2003, 2006), considers whether previous studies consider the model as a reasonable explanation of agent expectations, and examines several notable extensions. Empirical tests of the epidemiological hypothesis shall then be established with the results examined in sub-sections 5.3.1 and 5.3.2 across the previously identified sample periods for aggregate and disaggregate Michigan

Survey inflation forecasts respectively. The final sub-section provides a discussion of the preceding analysis and provides a judgement regarding whether expectations are consistent with information rigidity theory and whether the degree of attentiveness amongst agent expectations is dependent upon household demographics and macroeconomic conditions.

5.1. The Development of Information Rigidity Models: A Literature Review

In 3.3 a number of approaches were identified which relax the information requirements associated with standard theories of expectation formation, including incomplete information and bounded rationality, adaptive learning, and information rigidities. Whilst incomplete information and adaptive learning have provided useful departures from standard expectation models, applying more realistic assumptions regarding information acquisition and agent foresight, models of information rigidity have provided interesting insights regarding the formation of agent expectations. Specifically, information rigidity is primarily concerned with two classes of models, namely noisy information and sticky information. Prior to analysing whether agent expectations are empirically consistent with information rigidity theory, the predictions of the various models shall first be identified and assessed.

Firstly, noisy information models, as proposed by Woodford (2003), Sims (2003) and Maćkowiak and Wiederholt (2009) assert that whilst information sets are continuously updated by agents, information is imperfect, with signals contaminated by noise. The Lucas (1972) assumption that aggregate disturbances are observable following a one-period lag is relaxed by Woodford (2003) and Sims (2003) who instead assume that such information is public, available to agents who are sufficiently attentive. Nevertheless, as noisy information models assume that agent forecasts are only able to partly absorb new information into expectations, forecast errors will contain a predictable component, thus violating the requirements of RE.

In response to nominal disturbances, Woodford (2003) demonstrates within a noisy information model that agent actions and aggregate outcomes react with inertia. Specifically, in the presence of strategic complementarity, Woodford (2003:30) proposes that agents receive news through some "noisy channel". Following a monetary disturbance, Woodford (2003) highlights that in addition to individual forecast errors, agent actions are subject to uncertainty arising from higher-order beliefs. Consequently, whilst the real effects of the shock are demonstrated to die out quickly, noisy information results in agent actions responding slowly. Moreover, the degree of persistence is shown to increase the larger is the variance in individual errors relative to the innovation variance. However, despite imposing a substantial degree of noise within the model, Woodford demonstrates that individual actions respond fairly rapidly to innovations; however, higher-order beliefs are shown to respond with greater inertia. Moreover, Woodford (2003) shows that as the degree of strategic complementarity and the uncertainty regarding the actions of others increases, the greater is the inertia of the average response.

Similarly, Sims (2003) identifies that the behaviour of macroeconomic variables is inconsistent with the predictions of either Classical or Keynesian theory, specifically recognising that prices are excessively sticky to be compatible with these models. To resolve this, Sims (2003) develops a model of rational inattention where agents possess limited information processing capacity and face an optimisation problem given a fixed probability distribution of information. The imposition of information capacity constraints is subsequently demonstrated by Sims (2003) to account for the smooth response of both real and nominal variances to idiosyncratic disturbances without the necessity of imposing some arbitrary mechanism such as the islands metaphor employed by Phelps (1970) and Lucas (1972).

Assuming that agents face varying information acquisition and processing costs, inducing heterogeneous rational inattention, the full information set will be aggregately observed; however, as demonstrated by Woodford (2003) and Maćkowiak and Wiederholt (2009), agents are required to divide their attention to both aggregate and idiosyncratic conditions. Despite idiosyncratic information processing constraints, Sims (2003) however notes that agents are likely to respond to information in a similar manner; consequently, there is likely to be a common component to individual actions and forecast errors. Moreover, where information is noisy, Sims (2003) demonstrates that agents will be unable to make fully accurate inferences regarding the macroeconomic state, therefore, following some exogenous shock, sub-optimal responses arise.

As previously discussed, the Phelps-Lucas 'islands' model was one of the first attempts to accommodate imperfect information and expectation heterogeneity under a RE framework; however, as Clements (2012) demonstrates, the level of disagreement in the model is exogenously determined. To resolve this issue, Mankiw and Reis (2002) present a 'sticky information' model where the level of disagreement is endogenously determined. Specifically, rather than agents continuously updating their information set, Mankiw and Reis (2002) propose that a proportion of agents make optimal plans utilising the most recent information whilst the remainder formulate actions on outdated information acquired one or more periods previously. Importantly, whereas noisy information models assume that agents possess information capacity constraints and cannot incorporate the full spectrum of signals into decision profiles, Mankiw and Reis's (2002) sticky information hypothesis assumes that although agents are infrequently attentive, when updating occurs full information is obtained. Over the past decade, the implications of sticky information and inattentive expectations have prompted extensive theoretical and empirical research and debate amongst economists; notable contributions have been provided by Mankiw et al. (2003), Sims, (2003, 2006), Reis (2006a, 2006b), Pfajfar and Santoro (2008, 2010, 2013) and Coibion and Gorodnichenko (2010, 2012) amongst others.

The sticky information hypothesis presented by Mankiw and Reis (2002) relies upon agents possessing the ability to form RE; as previously mentioned in Chapter 3, their model attempts to combine imperfect information akin to Lucas (1972) with elements of Calvo's (1983) sticky price model. Specifically, in any given period, Mankiw and Reis (2002) conjecture that all firms undertake price adjustment; however, a proportion do not utilise the latest information in forming their decision. This behaviour is considered by Khan and Zhu (2006) to be rational providing their exists some positive cost in the acquisition and processing of information. More formally, for any given period, Mankiw and Reis (2002) propose that a proportion λ of firms are exogenously attentive, observing and noiselessly incorporating all new information into decision profiles; the remaining proportion of the population $1-\lambda$ are inattentive and continue to set prices subject to information acquired in previous periods.

In response to the empirical failings of sticky price models, Mankiw and Reis (2002) derive a sticky information Phillips Curve (SIPC) which serves to replace the conventional new Keynesian (NKPC) specification. Specifically, expressing all variables as logs, Mankiw and Reis (2002) propose that a firm's optimal price p_t^* is dependent upon the overall price level p_t and the output gap y_t:

$$p_t^* = p_t + \alpha y_t \quad (5.1.1)$$

Real rigidities are represented by α which represent a firm's sensitivity to the output gap. Where $\alpha < 1$, Trabandt (2007) argues that pricing decisions amongst firms convey strategic complementarity, as previously documented by Woodford (2003), which consequently induces inflation inertia. As firms are frequently inattentive, sporadically absorbing information into decision profiles, Mankiw and Reis (2002) thus derive individual and aggregate prices as (5.1.2) and (5.1.3) respectively:

$$x_{i,t,j} = E_{i,t-j} p_{i,t}^* \quad (5.1.2)$$

$$p_t = \lambda \sum_{i=0}^{\infty} (1-\lambda)^j x_{i,t,j} \quad (5.1.3)$$

Where j represents the period in which a firm last updated their information. Combining (5.1.1) and (5.1.3), Mankiw and Reis (2002) identify the following equation for the SIPC:

$$\pi_t = \frac{\alpha\lambda}{1-\lambda} y_t + \lambda \sum_{j=0}^{\infty} (1-\lambda)^j E_{i,t-1-j}(\pi_t + \alpha \Delta y_t) \quad (5.1.4)$$

The SIPC thus expresses inflation as a function of lagged expectations of macroeconomic conditions; as Mankiw and Reis (2002) and Trabandt (2007) highlight, this contrasts with sticky-price models which express inflation as a function of current expectations of future conditions.

For empirical analysis Mankiw and Reis (2002) impose coefficient values $\alpha = 0.1$ and $\lambda = 0.25$ which respectively imply that a firm's relative price is fairly insensitive to macroeconomic conditions[96] whilst the average rate of updating is approximately once a year. Utilising these parameter values, Mankiw and Reis (2002) evaluate whether the sticky information and sticky price models are able to generate the positive correlation between US inflation and output, commonly termed

[96] Given that Mankiw and Reis (2002) model sticky information under the premise of RE, agents are aware that a proportion of the population reset prices according to outdated information, thus exacerbating the degree of real rigidity.

the *acceleration phenomenon*[97]. Comparing the results for both sticky prices and sticky information, Mankiw and Reis (2002) observe that the former predicts a correlation coefficient of -0.13 whilst the latter supports the empirical observation of a positive relationship with a correlation coefficient of 0.43. These results thus appear to favour the sticky information model over pre-existing sticky price theories.

Utilising bivariate VARs to construct out of sample forecast for inflation and the output gap, Khan and Zhu (2006) re-evaluate estimates of the sticky information Phillips Curve (SIPC) as previously updated by Mankiw and Reis (2002). For various forecasting horizons and inflation definitions, Khan and Zhu (2006) reject the null hypothesis of 'no information stickiness'. Nevertheless, Khan and Zhu's (2006) estimates indicate that as the forecast horizon increases, λ falls. Specifically, for short horizon forecasts, agents are found to update information approximately every three months whilst for longer horizon forecasts, the rate of updating increases to every seven months[98]. Moreover, the degree of informational stickiness is found to be larger for CPI than for the GDP deflator.

As previously noted in Chapter 2, Mankiw et al. (2003) observe disagreement amongst the inflation forecasts of both households and professionals; specifically, Mankiw et al. (2003) identify the interquartile range (IQR) with disagreement. Whilst there has been some interest in expectational disagreement amongst economists, with the Lucas-Phelps islands model being an important contribution, there is a general failure amongst macroeconomic theory in acknowledging any dispersion of opinion[99]. Attempting to resolve this failure, disagreement is endogenously generated within the sticky information model. To evaluate whether the sticky information model can replicate the observed levels of disagreement amongst survey forecast, Mankiw et al. (2003) estimate a VAR on quarterly US data for both Livingston and Michigan Survey forecasts. Utilising $\lambda = 0.1$, Mankiw et al. (2003) note that the correlation between the disagreement predicted by the sticky information model and Livingston Survey and Michigan Survey are 0.66 and 0.80

[97] Mankiw and Reis consider US quarterly data between 1960 and 1999.
[98] These estimates are considered by Khan and Zhu (2006) to be in line with those presented by Mankiw and Reis (2002), Mankiw et al. (2003) and Carroll (2003).
[99] As discussed in Chapter 4, in recent years there has been increased interest in forecast disagreement, particularly in relation to models of information rigidity with notable contributions by Lahiri and Sheng (2008), Andrade and Le Bihan (2010), Lamla and Maag (2012) Dovern et al. (2012) and Pfajfar and Santoro (2013).

respectively. However, the level of disagreement exhibited by Michigan Survey expectations is observed to be approximately 4 percentage points higher than predicted, which Mankiw et al. (2003) attribute to idiosyncratic heterogeneity which the sticky information model fails to capture. Moreover, analysing the relationship between the dispersion generated by the sticky information model and macroeconomic conditions, Mankiw et al. (2003) find that the relationship between disagreement and the inflation rate is positive, whilst the output gap is found to be insignificant. These predictions are noted by Mankiw et al. (2003) to be consistent with those reported for both Michigan Survey and SPF inflation forecasts, indicating that the sticky information model is able to generate the nature of disagreement amongst agent forecasts.

Extending the analysis of information rigidity, Mankiw and Reis (2007) develop a general equilibrium model, examining the degree of informational stickiness across three distinct agent classes: consumers, firms and workers. Specifically, Mankiw and Reis (2007) assume that in each period, a fraction δ of consumers, a fraction ω of workers, and a fraction λ of firms obtain new information which is subsequently incorporated into decision profiles. Using maximum-likelihood and Bayesian methodologies, Mankiw and Reis (2007) estimate their model on US quarterly data between 1954Q3 and 2006Q1. Whilst firms are found to be relatively attentive, consumers and workers are found to exhibit greater inattention; specifically, the estimates presented by Mankiw and Reis (2007) indicate that firms update approximately every four months whilst both consumers and workers update their information every 16 months[100].

Similarly, Döpke et al. (2008) evaluate the degree of information stickiness amongst firms across four different European countries, namely France, Germany, Italy, and the UK. Utilising Consensus Economics data between 1991Q4 and 2004Q4, Döpke et al. estimate (5.1.4), as presented by Mankiw and Reis (2002), employing both non-linear least squares and seemingly unrelated regression (SUR) techniques for each of the four countries, imposing $\alpha = 0.10, 0.15, 0.20$ and truncating j at 4 and 6 lags respectively. For all α and j Döpke et al. (2008) report that all estimates of λ are highly significant under both estimation techniques. For France, Germany and

[100] The null hypothesis that both workers and consumers update their information at the same rate cannot be rejected by Mankiw and Reis (2007).

the UK, λ is estimated by Döpke et al. (2008) to lie between 0.144 and 0.296[101]; meanwhile, for Italy, the rate of information updating is estimated to be approximately double which Döpke et al. (2008) attribute to greater inflation uncertainty. Nevertheless, the results presented by Döpke et al. (2008) indicate a much lower frequency of information updating by firms than previously estimated by Mankiw and Reis (2007). These results thus indicate that the rate at which agents update their information is not homogeneous as assumed by Mankiw and Reis (2002), but are instead dependent upon idiosyncratic macroeconomic conditions.

A potential explanation for the variable degrees of information stickiness amongst agents, as demonstrated by Mankiw and Reis (2007) and Döpke et al. (2008), concerns the opportunity costs of inattentiveness. Moreover, in some periods, the use of outdated information may be less costly in comparison to others, resulting in time-variant degrees of information stickiness. This concept is explicitly modelled by Brock and Hommes (1997), proposing that agents can switch between employing a sophisticated predictor available at some cost $C > 0$, and a simple predictor which is freely available $C = 0$. Where the alternative predictor yields a greater net benefit to the one currently employed by an agent, they will switch their predictor of choice.

In a similar manner to the framework proposed by Brock and Hommes (1997), Branch (2007) attempts to relax the static assumptions of sticky information imposed by Mankiw and Reis (2002), and instead allow the degree of information rigidity to vary with time under the premise that agent attentiveness varies according to macroeconomic conditions. Specifically, Branch (2007) utilises maximum-likelihood estimation to evaluate whether information stickiness across Michigan Survey forecasts exhibits dynamic properties, and analyse the distribution of agents and the relative cost of updating information at various frequencies. The predictor found by Branch (2007) to be the least costly, and thus utilised by the largest proportion of agents, concerns updating information every six months. The predictor updated every month, consistent with full information, is found by Branch (2007) to be more costly than updating every three months, but less costly than updating every nine months, suggesting that an agents optimal decision involves a limited degree of inattentiveness. However, at times of increased macroeconomic volatility, agents are

[101] These estimates are indicated by Döpke et al. (2008) to represent firms in these countries updating their information every 3.4 to 6.9 quarters.

shown by Branch (2007) to employ a predictor which has a higher expected mean square forecast error. Additionally, during periods of macroeconomic uncertainty, the performance of all predictors is generally more volatile, therefore naïve predictors may be considered less costly relative to more sophisticated alternatives.

Assuming that agents respond to the most recently available measure of predictor accuracy, Branch (2007) indicates that during periods of increased volatility, a greater propensity to switch to less sophisticated predictors will prevail[102]. This suggests that during periods of increased uncertainty, household expectations are likely to exhibit an increased degree of information stickiness. Moreover, Branch's analysis dismisses the notion that the rate of information diffusion is constant over time as implicitly assumed by Mankiw and Reis (2002) and Carroll (2003, 2006). However, Branch's (2007) results arise due to the limited reduced-form classes of models under consideration, therefore one must be careful in making general statements regarding the performance of dynamic sticky information models. Despite this, Branch's (2007) approach would appear to correspond with near-rational behaviour of households who update more frequently where the costs associated with macroeconomic conditions are sufficiently large[103].

As noted by Khan and Zhu (2006), unlike sticky-price models (e.g. Calvo (1983)), prices under sticky information are fully flexible, yet the decisions of a proportion of firms is based on past or outdated information. Moreover, utilising Sims's (2003) methodology, Trabandt (2007) argues that the sticky information hypothesis implies that agents have either infinite or zero information processing capacity. Moreover, Mankiw and Reis (2002) do not formally model information processing costs, instead utilising a Poisson process to describe the arrival of new information such that firms randomly receive information updates. Should the arrival of new information deviate from the artificially imposed Poisson process, Carroll (2003) argues that the rate which agents update is likely to be significantly different.

The sticky information model presented by Mankiw and Reis (2002) assumes that despite exhibiting infrequent attention to news, when agents update they acquire and

[102] The intensity of choice parameter, as proposed by Brock and Hommes (1997), would be high.
[103] The concept of near-rationality is introduced by Akerlof et al. (2000) who present a model where firms only incorporate inflation into the decision making process where the costs of exclusion are sufficient.

process information costlessly to form optimal decisions. Maintaining the assumption that agents are rational, Reis (2006a) derives a model of inattention which formally introduces costs in the acquisition of information. Under full information, Reis (2006a) argues that all agents are fully attentive thus when new information is published, consumption decisions are adjusted fully and immediately. In contrast, where consumers are inattentive, Reis (2006a) proposes that consumption reacts according to the following equation:

$$C_t - C_{t-1} = c + \phi_0 N_t + \phi_1 N_{t-1} + \cdots + \phi_j N_{t-j} \qquad (5.1.5)$$

Consumption growth is represented by $C_t - C_{t-1}$ whilst N_{t-i} represents news in period $t - i$ and are assumed by Reis to be mutually uncorrelated and unpredictable. Meanwhile, the ϕ_i coefficients correspond with the proportion of agents that last updated their information between $t - i$ and $t - i - 1$, Reis (2006a) demonstrates that ϕ_i is non-increasing in i.

Where $\phi_0 = 1, \phi_i = 0$ for $i \geq 1$, consumption immediately responds to news, synonymous with full information. However, where agents are inattentive, $\phi_0 < 1$, consumption is shown by Reis (2006a) to act inattentively to news and instead identifies that the response is concave with $\phi_0 > \phi_1 > \cdots > \phi_j$ with more recent news weighted more heavily relative to past news. Furthermore, Reis (2006a) identifies that where $\phi_i \neq 0$ for some $i > 0$, then inattentiveness generates excess smoothness in consumption. To evaluate whether these propositions are supported empirically, Reis estimates a structural VAR on quarterly US data between 1953Q1 and 2002Q4. In accordance with Reis's (2006a) predictions, aggregate consumption adjusts in response to a shock following some delay; however, the adjustment is shown to be mostly completed within a year of the shock supporting Reis's (2006a) prediction of a concave adjustment path. Moreover, the inattentiveness model is shown by Reis (2006a) to replicate the excess smoothness of consumption observed in US data. The results presented by Reis (2006a) thus demonstrate that sticky information and inattention theory is empirically applicable to various macroeconomic decisions faced by agents.

In a separate paper, Reis (2006b) introduces a model of inattentive producers who encounter a standard profit maximisation problem but are additional faced with nonnegative costs K of acquiring, absorbing and processing information in order to formulate optimal plans. Where information costs are zero, Reis (2006b) recognises that firms will be fully attentive. Nevertheless, Reis (2006b) further identifies that inattentiveness is longer the larger are planning costs; however, inattentiveness is demonstrated to be reduced the larger are the losses from failing to update. Consequently, in the presence of increased shock volatility, Reis (2006b) illustrates that firms update more frequently as the costs of inattentiveness are higher; moreover, where the price elasticity of demand is small, Reis (2006b) further demonstrates that firms exhibit greater inattentiveness due to the losses resulting from deviations from full information optimal prices being small.

Utilising Zbaracki et al.'s (2004) planning costs estimate of 2.8 percent of total costs Reis estimates that the optimal inattentiveness of firms is approximately 8 quarters. Moreover, reducing planning costs to 0.1 percent of total costs, Reis (2006b) observes that the optimal length of firm inattentiveness remains substantial at 6 months. Despite providing micro-foundations for the sticky information model proposed by Mankiw and Reis (2002), Reis (2006b) assumes that firms uniformly update and acquire asymmetric information; this behaviour is argued by Jinnai (2007) to be inconsistent with the fundamental staggered updating premise inherent to sticky information theories. Rather than utilising planning costs as a percentage of total costs, Jinnai (2007) utilises a cost of planning of 4.6 percent of net margin, as also presented by Zbaracki et al. (2004), predicting an optimal length of inattentiveness of between 2.1 and 6.3 quarters. These estimates are more consistent with those reported by Mankiw et al. (2003) and Carroll (2003) for information stickiness amongst inflation expectations, without having to follow Reis (2006b) and impose a sufficiently small cost of planning. Nevertheless, these estimates appear inconsistent with the predictions of Mankiw and Reis (2007) that firms update up to four times as frequently as consumers.

Whilst the majority of studies, including Mankiw and Reis (2007, 2002), Mankiw et al. (2003) and Sims (2003) examine whether survey forecasts are consistent with a single model of economic friction, Coibion and Gorodnichenko (2012) undertake an analysis of SPF, Livingston, Michigan Survey and FOMC forecasts to determine whether agent forecast are most consistent with the predictions of RE, sticky information or various noisy information alternatives[104]. Although the econometric specification of these models shall be explicitly considered in Chapter 6, the results reported by Coibion and Gorodnichenko (2012) are particularly noteworthy. As SPF and Michigan Survey forecast errors exhibit a non-zero response to various economic shocks, Coibion and Gorodnichenko (2012) argue that information rigidities are embodied within the inflation forecasts of both households and professionals. Moreover, evaluating the response of forecast errors to lagged inflation, and the sensitivity of disagreement to shocks, Coibion and Gorodnichenko (2012) consider the behaviour of inflation forecasts from all agent classes to be most consistent with the predictions of (baseline) noisy information assumptions in preference to those of sticky information theory or models of heterogeneous priors. These conclusions shall be re-evaluated in Chapter 6.

[104] The noisy information models considered by Coibion and Gorodnichenko (2012) are namely a baseline model akin to Woodford (2001) and Sims (2003), strategic interaction (Morris and Shin, 2002), and heterogeneous priors (Patton and Timmermann, 2010) and heterogeneous signals (Capistrán and Timmermann, 2009).

5.1.1. Sticky Information vs. Sticky Prices – A Review of Comparative Studies

Recalling that the sticky information hypothesis was initially proposed in response to the empirical failings of sticky price models, Mankiw and Reis (2002) evaluate whether sticky information is able to replicate inflation dynamics in response to various macroeconomic disturbances. Specifying $\alpha = 0.1, \lambda = 0.25$ Mankiw and Reis (2002) utilise (5.1.4) to analyse the response of both output and inflation to various macroeconomic disturbances. In response to a fall in aggregate demand, Mankiw and Reis (2002) document that these values cause a monotonic output recovery, moreover, as $0 < \alpha < 1$, firms gradually adjust prices in response to the shock, consequently, the response of inflation is shown to be delayed and gradual. Furthermore, in response to an unanticipated disinflation, the sticky information model is again demonstrated by Mankiw and Reis (2002) to induce a gradual and delayed response in both output and inflation as agents sporadically update their information to incorporate the shock.

The effects of an anticipated disinflationary shock are also considered by Mankiw and Reis (2002). Under sticky price assumptions, Mankiw and Reis (2002) indicate that as firms immediately adjust prices in response to the announcement, inflation falls prior to the shock causing a temporary period of output growth. In contrast, under sticky information Mankiw and Reis (2002) demonstrate that firms gradually observe the announcement yet do not adjust prices until the realisation of the shock. However, as some firms continue to utilise outdated information, a proportion of firms fail to anticipate the shock; this is shown by Mankiw and Reis (2002) to result in a small recessionary effect, approximately a fifth of that under the surprise disinflation scenario. This result arises from the exogenously determined and probabilistic nature of inattentiveness amongst firms. Amending the assumptions regarding the diffusion of information, such that a proportion of firms are inherently inattentive, is likely to result in the loss lying between the two disinflation scenarios considered by Mankiw and Reis (2002).

Moreover, in response to monetary policy shocks Mankiw and Reis (2002) document that whilst sticky information can replicate the delayed and gradual response of both output and inflation, sticky price theory can only replicate the former, with inflation instead responding to monetary disturbances immediately.

Similarly, analysing sticky information in a DSGE framework, Trabandt (2007) demonstrated that inflation reacts with inertia to monetary policy shocks whilst Klenow and Willis (2007) further demonstrate that as the degree of informational stickiness increases, the larger the delayed response in both output and inflation becomes. These studies thus deem that sticky information is better able to replicate the delayed response of inflation to monetary policy shocks, as is generally accepted by many economists including Friedman (1972) and Christiano, Eichenbaum and Evans (1999, 2005).

In addition to documenting whether sticky information is able to replicate inflation dynamics in response to macroeconomic disturbances, subsequent research, including studies by Kiley (2007), Korenok (2008), Coibion (2010) and Dupor et al. (2010) have attempted to compare the performance of both classes of rigidity. The Mankiw and Reis (2002) sticky information model is demonstrated by Dupor et al. (2010) to replicate inflation inertia extremely well, however, all four studies refute the suggestion of replacing sticky prices with sticky information.

Estimating both a baseline and a hybrid specification of the sticky price and sticky information models, Kiley (2007) examines which of the competing models are most consistent with US price data. The baseline sticky price model is shown by Kiley (2007) to exhibit a larger Q-statistic and smaller R^2 relative to the baseline sticky information model. These results thus support the sticky information approximation of inflation dynamics; however, both classes of rigidity perform relatively poorly relative to reduced form models, encouraging Kiley (2007) to examine the hybrid specifications. Whereas Kiley's (2007) baseline model relates current inflation with expectations and real marginal costs, the hybrid sticky information model also includes a distributed lag specification of inflation which Kiley (2007) attributes to rule-of-thumb behaviour and dynamic indexation as demonstrated by Galí and Gertler (1999) and Christiano, Eichenbaum and Evans (2005) Providing that the lag length is sufficiently long, the sticky price hybrid model is shown by Kiley (2007) to outperform the reduced form models, and both the baseline and hybrid sticky information models[105]. Consequently, Kiley (2007) concludes that the hybrid sticky price model outperforms sticky information alternatives.

Similarly, Korenok (2008) examines the predictions of the sticky price and sticky information models utilising Bayesian full information techniques. The estimates of both the sticky price and sticky information parameters reported by Korenok (2008) indicate that both the perfectly flexible prices and perfectly flexible information null hypotheses are rejected. Instead, Korenok's (2008) results indicate that both prices and information are infrequently updated with firms resetting prices, and acquiring new information, every 9 to 12 months on average. Nevertheless, in accordance with Kiley (2007), the sticky price model is found by Korenok (2008) to dominate the sticky information model, exhibiting higher R^2 and log-likelihood statistics. However Kiley (2007) recognises that neither sticky price nor sticky information models are able to adequately account for the importance of lagged inflation without introducing some ad hoc adjustment rule. The results of both Kiley (2007) and Korenok (2008) thus suggest that inflation dynamics may instead accommodate features of both real and informational rigidities.

To solve for both sticky price and sticky information, Korenok (2008) and Coibion (2010) present encompassing models, as illustrated by (5.1.6) below, where the two competing models, sticky prices and sticky information, are jointly examined:

$$\pi_t = \omega\pi_t^{SP}(\gamma,\kappa) + (1-\omega)\pi_t^{SI}(\lambda,\alpha) + v_t \qquad (5.1.6)$$

The new Keynesian Phillips curve (NKPC) is represented by $\pi_t^{SP}(\gamma,\kappa)$ where γ is the sticky price parameter and κ is a function of real rigidity and price stickiness, whilst the sticky information Phillips curve (SIPC) is represented by $\pi_t^{SI}(\lambda,\alpha)$ where λ represents the information stickiness parameter and α measures the degree of real rigidity, and ω is a weighting parameter. The null hypothesis $\omega = 1$ is shown by Coibion (2010) to favour the NKPC whilst $\omega = 0$ favours the SIPC; however Coibion (2010) further identifies that (5.1.6) can reject both or neither of the competing models. Utilising the GDP deflator and SPF forecasts, the encompassing model (5.1.6) is shown by Coibion (2010) to reject the SIPC yet not the NKPC.

[105] The four-lag hybrid sticky information model is similarly found to be superior to the baseline specification, however, the improvements in the Q-statistic and R^2 are more modest

Similar results are reported by Korenok (2008), estimating that sticky price firms constitute 70 percent of the population. Moreover, forecasts from the NKPC are shown by Coibion (2010) to account for approximately 80 percent of the variation in inflation whereas the SIPC can only account for 55 percent of the variation. Nevertheless, accounting for over 50 percent of inflation variance suggests that the SIPC may explain some elements of inflation dynamics. Nevertheless, Coibion (2010) suggests that although the SIPC is able to accommodate the inertial response of inflation, the weight on past information is too high, thus leading to excessive persistence and insufficient inflation volatility. Consequently, in accordance with Kiley (2007), Coibion (2010) favours sticky prices over sticky information.

Similar to the approach adopted by Korenok (2008) and Coibion (2010), Dupor et al. (2010) present a dual-stickiness model which incorporates both real and informational rigidities. Specifically, Dupor et al. (2010) consider a monopolistic firm which independently updates prices with probability $1 - \gamma$, and updates information with probability $1 - \phi$[106]. Employing a two-step VAR estimation on quarterly US inflation data, Dupor et al. (2010) find that both γ and ϕ are significant. Namely, Dupor et al.(2010) estimate that between 9 and 19 percent of firms rest prices in each quarter, whilst 19 to 60 percent update information; point estimates of 14 and 42 percent respectively are further demonstrated by Dupor et al. (2010) to indicate that in any given quarter, 5.9 percent of firms reset prices given the most up to date information. Moreover the $\bar{R}^2$ term for the dual stickiness model is larger relative to either the sticky information or sticky price model. Additionally, the dual-stickiness model is shown by Dupor et al. (2010) to outperform a hybrid New Keynesian model akin to Galí and Gertler (1999) where a fraction ω of firms employ a simple backward-looking predictor. By extending the dual-stickiness model to allow for a fraction ω of backward-looking firms, Dupor at al. (2010) analyse whether there is support for the hybrid model; the estimates presented by Dupor et al. (2010) indicate that ω is insignificant suggesting the hybrid model fails to accurately accommodate US inflation dynamics. Therefore, in accordance with Korenok (2008) and Coibion (2010), Dupor et al (2010) conclude that both classes of rigidity are present.

[106] The probability that a firm updates either its price or its information are emphasised by Dupor et al. (2010) to be uncorrelated with each other and with time.

Although the sticky information approach advocated by Mankiw and Reis (2002) is demonstrated by Dupor et al. (2010) to replicate inflation inertia, whilst Korenok (2008) finds that the imposition of information rigidities improve upon perfectly flexible information assumptions, studies which take a comparative approach appear to favour pre-existing sticky-price theory. Although these studies thus cast doubt on the relevancy of sticky information theory as an appropriate hypothesis of inflation dynamics, Coibion (2010) acknowledges that neither real nor informational rigidities are able to adequately reconcile the response of inflation to a range of macroeconomic disturbances. Instead, Kiley (2007), Korenok (2008) and Coibion (2010) argue that agents are likely to be subject to multiple frictions or imperfections which simultaneously impact upon inflation dynamics thus advocating a dual-stickiness approach as proposed by Dupor et al. (2010).

5.1.2. Evaluation of Previous Studies

The current evidence regarding sticky information seems balanced. Survey evidence appears to support the notion that agents update their information infrequently, whilst Mankiw et al. (2003) find that the sticky information model is able to generate central tendency and a level of disagreement consistent with those observed across survey forecasts. Nevertheless, the evidence presented by Branch (2007) and Pfajfar and Santoro (2010) suggests that sticky information assumptions appear to have increased relevance in the presence of expectational heterogeneity. Indeed, to assume that agents infrequently update their information but possess a homogeneous probability of updating, as proposed by Mankiw and Reis (2002), provides good tractability but fails to acknowledge capture the additional uncertainty and costs imposed upon agents across various stages of the business cycle.

Despite Mankiw et al. (2003), Reis (2006a, 2006b) and Khan and Zhu (2006) presenting empirical evidence consistent with the sticky information hypothesis, several studies report evidence to the contrary. A notable example is Coibion and Gorodnichenko (2012) who compare the predictions of various information rigidity models with the behaviour of inflation forecasts from various agent classes. For both professionals and households, Coibion and Gorodnichenko (2012) argue that inflation forecasts reported by these agents are more consistent with the predictions of noisy information theory rather than sticky information.

Similarly, various studies have evaluated whether sticky price theory is better able to accommodate inflation dynamics relative to sticky information. Despite Dupor et al. (2010) reporting that sticky information theory is able to replicate inflation inertia well, various studies including Kiley (2007), Korenok (2008) and Coibion (2008) favour sticky prices. Nevertheless, there is some consensus amongst these studies that inflation dynamics cannot be perfectly accounted for solely by real rigidities, and are likely to depend upon a multiple sources of stickiness.

Despite the evidence regarding the relevancy of the sticky information hypothesis appearing balanced, there has been extensive research in recent years developing the understanding of information rigidities amongst agents. Of particular empirical interest has been the rate of information diffusion across agents. The next sub-section considers a particular theory of sticky information, namely epidemiological expectations, as proposed by Carroll (2003, 2006) and further developed by Lanne, Luoma and Luoto (2009), Nunes (2009), Easaw and Ghoshray (2010) and Easaw and Golinelli (2010). These studies empirically analyse the rate of information diffusion across proportions of the population.

5.2. Epidemiological Expectations

As identified in the literature review above, one of the first attempts to empirically test for the presence of information rigidities and the relevance of the sticky information hypothesis was undertaken by Carroll (2003). In an attempt to provide microfoundations for sticky information, Carroll (2003) employs an epidemiological model to analyse the formation of household expectations where information disseminates across agents in a manner analogous to that in which a disease spreads.

In the spirit of Brock and Hommes (1997), it is assumed that when forming inflation expectations, households face the decision of employing either a sophisticated predictor, obtainable at some cost, or a freely available simple predictor. The sophisticated predictor is assumed by Carroll (2003) to be derived from newspaper reports which reflect professional expectations. Households rationally choose which predictor to employ.

To examine the diffusion properties of information across agents, an epidemiological model as identified by (5.2.1) below, is presented by Carroll (2003, 2006)[107]:

$$E_t^H[\pi_{t+h}] = \lambda E_t^P[\pi_{t+h}] + (1-\lambda)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t \qquad (5.2.1)$$

Current h-period ahead household expectations are represented by $E_t^H[\pi_{t+h}]$ whilst the corresponding professional forecast is represented by $E_t^P[\pi_{t+h}]$. Adopting the interpretations of Mankiw and Reis (2002) and Carroll (2003), λ represents the proportion of households who are attentive in any given period, absorbing the latest information into expectations; moreover, $(1-\lambda)$ represents the remaining proportion who are inattentive and utilise own lagged forecasts to generate current expectations. Alternatively, the λ coefficient can be interpreted as the rate at which households update their information and expectations; therefore, the larger is λ the shorter is the average time-period between information updates.

[107] The procedure employed by Carroll (2003) is similar to that of Roberts (1998) who analyses whether expectations adjust towards a rational forecast. However, as the rational forecast is unobservable, Roberts employs actual inflation and utilises GMM estimation which requires the use of instrumental variables. The epidemiological model avoids the requirement of instrumental variables.

To ensure that all households exhibit expectations consistent with forward-looking behaviour, Carroll (2003) imposes the restriction that the inflation process is equal to the fundamental rate π_t^f plus some white noise transitory shock ϵ_t; moreover the fundamental rate is subject to permanent innovations η_t. The inflation process can thus be defined as:

$$\pi_t = \pi_t^f + \epsilon_t$$
$$\pi_{t+1}^f = \pi_t^f + \eta_{t+1} \tag{5.2.2}$$

Consequently, Carroll (2003) argues that future changes in the fundamental rate of inflation are unforecastable beyond the next period and is consistent with the near-unit root process of inflation documented by Barsky (1987) and Ball (2000).

The model presented by (5.2.1) can be considered an extension of adaptive expectations theory; similar to these models, one may thus argue that the fixed-horizon specification is inappropriate. Instead, one may wish to respecify the epidemiological hypothesis considering forecast revisions and the manner which news diffuses across fixed-event expectations, namely:

$$E_t^H[\pi_{t+h}] = \gamma E_t^P[\pi_{t+h}] + (1-\gamma)E_{t-j}^H[\pi_{t+h}] + \epsilon_t \tag{5.2.3}$$

The fixed-event specification (5.2.3) thus analyses the manner which households adapt their expectations for period $t+h$ given the arrival of new information between periods $t-j$ and t. However, due to the manner which inflation is defined, as illustrated by (5.2.2), Carroll (2003) obtains $E_{t-j}^H[\pi_{t+h}] = E_{t-j}^H[\pi_{t-j+h}]$ and thus prefers the fixed-horizon specification (5.2.1)[108].

Besides, in the event that households are pre-informed of some structural change that influences the future path of inflation from period $t+h$ onwards, specification (5.2.3) is able to effectively incorporate this information into lagged expectations. Consequently, the coefficient on professional expectations in (5.2.3) is able to evaluate household attentiveness to new information more effectively in comparison to (5.2.1). However, as previously documented in Chapter 2, the preferred

[108] The four-period ahead structure of Michigan Survey inflation forecasts further dictates the use of the fixed-horizon specification (5.2.1) for empirical analysis.

specification (5.2.3) is unable to be employed for empirical evaluation as the Michigan Survey does not report multi-horizon inflation forecasts.

To empirically examine the baseline epidemiological model Carroll restates (5.2.1), as follows:

$$E_t^H[\pi_{t+h}] = \alpha_0 + \alpha_1 E_t^P[\pi_{t+h}] + \alpha_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t \qquad (5.2.4)$$

Specifically, Carroll (2003) estimates (5.2.4) utilising aggregate Michigan Survey and SPF inflation forecasts for 1981Q3 – 2000Q2. Firstly, setting $\alpha_0 = 0$, Carroll (2003) reports $\alpha_1 = 0.36, \alpha_2 = 0.66$ and cannot reject $\alpha_1 + \alpha_2 = 1$ implying that household forecasts represent a weighted average of current professional and own lagged forecasts. For a similar test utilising $\alpha_2 = 1 - \alpha_1$ Carroll (2003) reports $\alpha_1 = 0.27, \alpha_2 = 0.73$[109] and is unable to reject the null hypothesis $\alpha_1 = 0.25$, the estimate of the sticky information parameter reported by Mankiw and Reis (2002). This estimate is shown by Carroll (2003) to imply that approximately 25 percent of households update their information in any given quarter, whilst $(1 - 0.25)^4 = 31.6$ percent of households report expectations formulated on information acquired more than one year ago.

The baseline specification (5.2.1) is also examined by Carroll (2003) without imposing a restriction on the constant term with empirical tests finding α_0 to be positive and highly significant. However, Carroll (2003) rejects the inclusion of the constant due to only modest improvements in R^2; furthermore, Carroll (2003) acknowledges that where professional expectations and actual inflation are zero, a positive constant implies that households will continue to expect a positive rate of inflation. Instead, Carroll (2003) argues that the significance of the constant term implies that the epidemiological model is misspecified and could indicate the presence of social interaction in the diffusion of information as proposed by Carroll (2006).

The baseline epidemiological model assumes that all information regarding macroeconomic conditions absorbed by households is embodied within the forecast

[109] Re-evaluating the epidemiological hypothesis for an updated sample period comprising 1981Q3 – 2007Q2, Nunes (2009) reports a similar value for α_1.

of professionals. This is however an over-simplification; instead households are likely to update their information from a variety of sources which may include professional or newspaper forecasts, but also includes social interaction and observations of realised macroeconomic variables. Recognising this notion, Carroll (2003) further modifies the epidemiological model to include the possibility of households updating their information in relation to past inflation[110], empirically examining the following model[111]:

$$E_t^H[\pi_{t+h}] = \alpha_0 + \alpha_1 E_t^P[\pi_{t+h}] + \alpha_2 E_{t-j}^H[\pi_{t+h-j}] + \alpha_3 \pi_{t-k} + \epsilon_t \qquad (5.2.5)$$

Utilising $h = 4, j = 1, k = 1$ and again imposing $\alpha_0 = 0$, Carroll (2003) reports a negative value for α_3; however, including the constant term, the value of α_3 is found to be positive yet insignificant[112]. The lagged inflation rate is thus deemed by Carroll (2003) to lack explanatory power for Michigan Survey inflation forecasts. Nevertheless, utilising $k = 0$ and annualised monthly inflation data rather than annual data, Luoma and Luoto (2009) report a significant value for α_3. The appropriateness of using lagged or current inflation is however debatable. Whereas Carroll (2003) recognises that the one-period lagged inflation rate is the most recently published rate of inflation available to agents in period t, there appears to be an inconsistency in methodology that households are able to absorb the current professional forecast but not current inflation. Whilst the professional forecast could be argued to proxy for all current news relating to macroeconomic conditions, it is perhaps unreasonable to assume that households are unable to accommodate current inflation into information sets given that they encounter the current changes in prices, although not necessarily aggregate inflation, through day-to-day purchasing behaviour.

Appraising the epidemiological model, Pfajfar and Santoro (2008) highlight that the properties of household attentiveness assumed by Carroll (2006, 2003) fail to fully accommodate key components of information diffusion. Firstly, Pfajfar and Santoro (2008) argue that the slow diffusion of information is likely to be heterogeneous and

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[110] This is akin to Lanne et al.'s (2009) naïve sticky information model.

[111] Carroll (2003) again employs $h = 4, j = 1$.

[112] Setting both $\alpha_0 = 0$ and $\alpha_1 = 0$, Carroll (2003) further reports that the coefficient on lagged inflation remains insignificant.

dependent upon the socio-demographic characteristics of households. Employing a percentile time-series approach Pfajfar and Santoro (2008) examine the degree of information stickiness and, utilising demographically disaggregated Michigan Survey data determine whether the rate of information diffusion is heterogeneous. Whilst less advantaged households are found to formulate expectations utilising individual consumption as a reference point, Pfajfar and Santoro (2008) observe greater attentiveness to inflation dynamics by more advantaged counterparts. Similarly, when Pfajfar and Santoro (2010) employ the percentile time-series approach to aggregate Michigan Survey inflation forecasts, varying rates of information updating is again observed. Specifically, Pfajfar and Santoro (2010) report a U-shaped pattern; for the 50th percentile an updating period of 7 months is observed, yet outside of the 40th-90th percentile range, the updating frequency exhibited by households is greater than 24 months.

Another failure of Carroll's (2003) epidemiological approach, as acknowledged by Pfajfar and Santoro (2010), concerns the time-varying properties of information updating. Specifically, the respondents between the 59th and 79th percentile[113] are identified by Pfajfar and Santoro (2010) to exhibit varying rates of inattentiveness dependent upon the rate of inflation as indicated above; when inflation is high, these agents update more frequently, attributable to greater opportunity costs associated with inattentiveness relative to periods of lower inflation. Moreover, utilising maximum-likelihood methodology, Branch (2007) demonstrates that a dynamic specification of sticky information that allows the rate of information updating to vary, provides a better fit to Michigan Survey inflation forecasts relative to the static approach advocated by Mankiw and Reis (2002) and Carroll (2003).

The structure of the epidemiological model presented by Carroll (2003) asserts that information flows are unidirectional from professionals to households. Consequently, professional forecasts must Granger-cause household forecasts but not in the opposite direction. For 1981Q3 – 2000Q2, the results presented by Carroll (2003) indeed suggest that whilst SPF mean inflation forecasts Granger-cause mean Michigan Survey forecasts, there is no evidence of bidirectional causality.

[113] Pfajfar and Santoro (2010) identify agents between the 59th and 79th percentile to be those most consistent with inattentive behaviour.

The assumption that households update their expectations upon media reports, as proposed by Carroll (2003, 2006), suggests that the rate of information diffusion is positively correlated with the intensity of news coverage. Constructing a news intensity index utilising inflation reports from the *New York Times* and *Washington Post*, Carroll (2003) establishes that greater news coverage is observed the higher the rate of inflation. Moreover, Carroll (2003) defends the epidemiological hypothesis observing that the difference between the mean Michigan Survey and SPF inflation forecasts is lowest during periods of high inflation, and is negatively correlated with the news intensity index. Similarly, for German inflation expectations, Lamla and Lein (2008) report a negative relationship between the absolute difference between consumer and professional expectations and news intensity. The volume of news regarding inflation thus appears to increase the rate which households update their information resulting in greater alignment with the 'benchmark' forecast reported by professionals.

Furthermore, dividing the sample period by mean news coverage, Carroll (2003) observes that the absorption rate, denoted α_1 in (5.2.1), is significantly larger when the news intensity index is higher than average. These results are supported by Lamla and Sarferaz (2012) who report that the propensity with which agents update information is greater in the presence of a larger quantity of news. Similarly, Pfajfar and Santoro (2010, 2013) observe that during periods of higher inflation, a greater proportion of Michigan Survey participants report expectations consistent with RE and a greater degree of information attentiveness. This could however be a result of greater media coverage of rising inflation relative to falling inflation, as identified by Lamla and Lein (2008). Alternatively, one may consider the opportunity costs of inattentiveness to be larger during highly inflationary periods relative to those where inflation is more stable.

In contrast, comparing the frequency of news reports with actual inflation in Germany, Lamla and Lein (2008:11) highlight that "the amount of reporting does not necessarily match the magnitude of price changes". Specifically, Lamla and Lein (2008) identify that whilst the growth rate of the harmonized index of consumer prices (HICP) exceeded 2 percent in both 2002 and 2004, the media reporting in 2002 was approximately double the 2004 figure. However, Lamla and Lein (2008) highlight that certain macroeconomic events may have influenced the intensity of news coverage, crediting the high frequency of inflation reporting between 2001 and 2002 with the 'euro cash changeover' and 'Teuro effect'[114]. Consequently, whilst the degree of attentiveness may be related to current inflation circumstances, wider macroeconomic conditions are also likely to impact upon the rate which agents update their information.

The news intensity index employed by Carroll (2003) is however limited in scope; despite utilising two national newspapers with wide circulation, it fails to acknowledge the extent of media sources available to agents, which include alternative newspapers, television network news and, for more recent years, the internet and online sources. Moreover, Carroll (2003) fails to acknowledge falling newspaper readership across over the sample period as documented by Ahlers (2006) and George (2008)[115]. Rather than just relying on the quantity of news, several studies including Lamla and Lein (2008), Easaw and Ghoshray (2010), Lamla and Maag (2012), and Lamla and Sarferaz (2012) consider a second channel of media influence on agent forecasts and information diffusion concerning the tone or quality of news coverage.

Analysing whether the tone of information has an impact upon the alignment of consumer forecast with those reported by professionals Lamla and Lein (2008) find that news regarding rising inflation increases the expectations gap between consumers and professionals, whereas news regarding falling inflation decreases the expectation gap. Consequently, Lamla and Lein (2008) deem that news regarding rising inflation has a more pronounced impact, with the media inducing a bias amongst consumer forecasts, exaggerating the expectational gap. Nevertheless, utilising a Bayesian learning model, Lamla and Maag (2012) find that the tone of media reports regarding inflation does not have any impact upon the disagreement of EU consumer forecasts. Similarly, utilising Michigan Survey data on consumer perception of news, Pfajfar and Santoro (2013) analyse whether households respond asymmetrically to favourable and unfavourable news concerning inflation. Considering the updating behaviour of households, Pfajfar and Santoro (2013) find

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[114] Teuro is identified by Lamla and Lein (2008) as a term derived from the German equivalent of expensive, *teuer* and euro.
[115] US daily newspaper circulation is shown by George (2008) to have fallen from 1.2 newspapers per household in 1950 to less than 0.5 by 2005.

no evidence of asymmetry in the response of favourable and unfavourable news. Nevertheless, Pfajfar and Santoro (2013) further report that whilst favourable news has an insignificant effect on the expectation gap, unfavourable news exerts a positive and significant effect; therefore, in the presence of rising inflation, where households are generally appreciated to exhibit greater levels of attention (Carroll, 2003, Pfajfar and Santoro, 2008), the difference between household and professional forecasts increases.

Similarly, Lamla and Sarferaz (2012) argue that the rate at which agents update their information increases as the quality of the available signals improves. This argument is akin to the predictions of noisy information models, as presented by Sims (2003), Woodford (2003) and Maćkowiak and Wiederholt (2009), where the behaviour of agent forecasts is dependent upon the signal-to-noise ratio. As the epidemiological model imposes a single signal upon the formation of household expectations, namely professional forecasts, Lamla and Sarferaz's (2009) argument implies that where the forecast errors realised by professionals are small, the frequency which households update increases. Recalling the forecast error statistic reported in Chapter 2, Lamla and Sarferaz (2009) would thus predict that households update more frequently for the stable and Greenspan-Bernanke sub-periods. If instead household attentiveness is related to the relative quality of professional forecasts relative to own forecasts, the frequency of information updates would be expected to be greater for the volatile sub-period.

As previously recognised, despite Carroll's (2003) epidemiological hypothesis proposing that agents are infrequently attentive, the model does not distinguish between different sources or varying content of information. An agent's response to news may however vary depending upon the perceive tone of the absorbed information. Utilising Michigan Survey responses to perceived and expected business conditions, Easaw and Ghoshray (2010) reconsider the epidemiology of information, decomposing the rate of absorption to attentiveness towards good news and to bad news. Specifically, agents are assumed to form their expectations upon news $N_t = N_t^G - N_t^B$ where N_t^G and N_t^B represent 'good' (or favourable) and 'bad' (or unfavourable) news respectively:

$$E_{i,t}[\pi_{t+h}] = \alpha[N_t^G - N_t^B] \quad (5.2.6)$$

Specifically, Easaw and Ghoshray (2010) utilise Michigan Survey data regarding the perceived level of favourable and unfavourable news regarding business conditions in a similar manner to the empirical analysis in 4.3. Noting that $\alpha > 0$, Easaw and Ghoshray (2010) recognise that the α coefficient implies that agents devote equal importance to 'good' and 'bad' news, analogous to Carroll's (2003) assumptions. Replacing this with the assumption that agents attach a weight $\delta \geq 0$ to 'good' news, and a weight $\gamma \geq 0$ to 'bad' news, Easaw and Ghoshray respecify (5.2.6) as:

$$E_{i,t}[\pi_{t+h}] = [\delta N_t^G - \gamma N_t^B] \quad (5.2.7)$$

Where $\delta < \gamma$, bad news is deemed to assert a greater influence on agent expectations relative to 'good' news. Applying some information capacity constraint, akin to Sims (2003), resulting in positive information acquisition and processing costs, Easaw and Ghoshray examine the inertial response of expectations to news shocks by incorporating (5.2.7) into the Mankiw and Reis (2002) sticky information and Carroll (2003) epidemiological frameworks:

$$E_{i,t}[\pi_{t+h}] = \lambda\{[\delta N_t^G - \gamma N_t^B]\} + (1-\lambda)E_{i,t-j}[\pi_{t-j+h}] \quad (5.2.8)$$

In the short-run, Easaw and Ghoshray (2010) report that both good news and bad news have a similar effect upon household expectations with $\hat{\delta} = 0.66$ and $\hat{\gamma} = 0.60$ respectively; nevertheless, the impact of bad news is demonstrated to decay much quicker than good news. These results are in accordance with those reported by Pfajfar and Santoro (2013) who find no evidence of asymmetry in updating behaviour amongst households in response to favourable and unfavourable news regarding inflation. Nevertheless, in the long-run Easaw and Ghoshray (2010) demonstrate that bad news has an insignificant impact on expectations whilst good news is considered more important. These observations could indicate that in the short-run households have a tendency to overreact to bad news.

Despite Carroll (2003) preferring the baseline epidemiological model, assuming that households update their expectations with respect to those reported by professionals, recalling Atkeson and Ohanian's (2001) findings that professional forecasts are no better than a simple naïve forecast, Lanne et al. (2009) question whether households would devote the resources required to acquire and process the sophisticated forecast. Instead, Lanne et al. (2009) propose replacing the professional forecast in (5.2.1) with the one-period lagged inflation rate π_{t-1}, presenting a naïve sticky information model:

$$E_t^H[\pi_{t+h}] = \lambda\pi_{t-1} + (1-\lambda)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t \qquad (5.2.9)$$

This competing model is thus akin to adaptive expectations with household forecasts a weighted average of past inflation and lagged expectations. This naïve specification is however nested by Lanne et al. (2009) within Carroll's (2003) epidemiological framework, estimating the following regression:

$$\begin{aligned} E_t^H[\pi_{t+h}] = \lambda(\omega\pi_{t-1} + (1-\omega)E_t^P[\pi_{t+h}]) \\ + (1-\lambda)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t \end{aligned} \qquad (5.2.10)$$

The extreme vales $\omega = 0$ and $\omega = 1$ thus relate to the baseline epidemiological model (5.2.1) and the naïve sticky information model (5.2.9) respectively. For the unrestricted specification, and for the two extreme scenarios, Lanne et al. (2009) estimate (5.2.10) utilising quarterly Michigan Survey and SPF inflation expectations for the sample period ranging from 1981Q3 to 2001Q4. For the epidemiological specification, Lanne et al. (2009) estimate $\lambda = 0.35$, whilst for the naïve sticky information specification they estimate $\lambda = 0.18$. These estimates are consistent with those reported by Mankiw and Reis (2002) and Carroll (2003). For the unrestricted specification, Lanne et al. (2009) estimate $\lambda = 0.24, \omega = 0.65$; these estimates indicate that over half of the agents who update their information during any given period exhibit backward-looking behaviour, rather than absorbing the information content of the sophisticated forecast. Specifically, Lanne et al.'s (2009) estimates imply that approximately 15.6 percent of Michigan Survey respondents update their information with respect to past inflation whilst only 8.4 percent absorb current professional forecasts. Nevertheless, the posterior model estimates of the naïve sticky information and nested models are approximately equal, Lanne et al. (2009) argue that the inclusion of professional forecasts fails to sufficiently increase the fit; they thus conclude that the naïve sticky information model is consistent with the expectations of a significant proportion of Michigan Survey respondents.

Despite Carroll's (2003, 2006) epidemiological model providing an interesting application of the sticky information hypothesis and a simple application to determine the degree of attentiveness exhibited by agent expectations, several studies have identified issues with the methodology and suggest modifications to the approach undertaken. Whereas Carroll (2003) proposes that professional forecasts published by media sources can reasonably proxy for RE, Lein and Maag (2011) acknowledge that there is not a single professional forecast, with a degree of disagreement instead prevalent. Moreover, in accordance with Ehrbeck and Waldmann (1996) and Laster et al. (1999)[116], the presence of strategic incentives may result in professionals reporting forecasts which deviate from the consensus or conditional expected value. Consequently, Lein and Maag (2011) argue that the forecast absorbed into household information sets, as reported by the media, may not correspond with professional consensus and may further induce greater uncertainty upon household expectations.

The initial sticky information model presented by Mankiw and Reis (2002) assumed that agents update their expectations according to RE; therefore departures from RE by the SPF are argued by Nunes (2009) to invalidate the microfoundations developed by Carroll (2003). Recalling the results from Chapter 3, SPF forecasts were not found to be unambiguously consistent with the predictions of RE. These results are in accordance with Nunes (2009) who indicates that the SPF mean forecast fails the elementary unbiasedness property required under RE. Consequently, Nunes (2009) questions the appropriateness of Carroll's (2003) assumptions of updating towards the professional forecast, arguing that the model reflects sticky information under imperfect information and learning rather than RE as proposed by Mankiw and Reis (2002).-

In response to criticisms of Carroll's (2003) assumptions, Nunes (2009) adapts the survey-updating model (5.2.1) with a rational-updating specification. Whereas Carroll's (2003) model assumes that household expectations are updated to incorporate the latest SPF forecast, Nunes (2009) proposes that updating occurs towards the current 'rational' expectation $E_{t,RE}[\pi_{t+h}]$, as expressed by (5.2.11) below:

[116] Laster et al. (1999) present a model where professionals are remunerated on media attention in addition to accuracy.

$$E_{t,H}[\pi_{t+h}] = \gamma_0 + \gamma_1 E_{t,RE}[\pi_{t+h}] + \gamma_2 E_{t-1,H}[\pi_{t-1+h}] + v_t \quad (5.2.11)$$

Estimating both the survey- and rational- updating specifications (5.2.1) and (5.2.11), Nunes (2009) estimates $\gamma_1 = 0.224$ and $\gamma_1 = 0.157$ respectively[117] suggesting that the probability that an individual household updates in any given period is lower for the rational-updating model relative to the survey-updating specification. Specifically, whilst Nunes notes that the survey-updating model predicts that households update their information every 13 months, the rational-updating model predicts that information is updated every 19 months. Moreover, whilst the survey-updating model implies that approximately 36 percent of households form expectations on information which is a year or more out of date, the γ_1 estimate reported by Nunes (2009) implies that over 50 percent of households fail to update in any given year[118].

Analysing whether the survey- or rational-updating model is most suitable for Michigan Survey expectations, Nunes (2009) nests the two specifications within an alternative model where households update their expectations to either the SPF or RE, namely:

$$E_{t,H}[\pi_{t+h}] = \gamma_0 + \gamma_1 E_{t,RE}[\pi_{t+h}] + \gamma_2 E_{t-1,H}[\pi_{t-1+h}] + \gamma_3 E_{t,P}[\pi_{t+h}] + v_t \quad (5.2.12)$$

Estimating (5.2.12) Nunes (2009) finds that the null hypothesis $\gamma_3 = 0$ cannot be rejected at conventional significance levels and thus concludes that the empirical evidence supports the rational-updating model whilst the survey-updating model produces "excessive stickiness" (2009:644).

In response to the studies by Nunes (2009) and Coibion (2010) which question the relevance of the sticky information and epidemiological hypotheses, Easaw and Golinelli (2010) attempt to extend the microfoundations of expectation formation proposing a model where agents have varying information absorption rates.

[117] Nunes (2009) notes that whilst (5.2.1)can be estimated using OLS, identifying the 'rational' expectation with the actual realisation of inflation, (5.2.11) is estimated by GMM with an instrument set composed of four lags of inflation, two lags of the Michigan Survey forecast, the SPF mean, marginal cost, output gap and wage inflation.

[118] Following Carroll (2003), the percentage of those failing to update in any given year is calculated by $(1 - 0.224)^4 = 36.3$ percent and $(1 - 0.157)^4 = 50.5$ percent respectively.

Specifically, utilising UK survey data from Barclays Basix, Easaw and Golinelli (2010) classify agents as either 'active' (A) or 'passive' (P), both of which form their expectations using the professional forecast as an 'anchor' or reference point. Expectations of both agent classes $i = A, P$ are thus assumed to be formed as a ratio of the professional forecast, namely:

$$\frac{E_{t,H,i}[\pi_{t+h}]}{E_{t,P}[\pi_{t+h}]} = \beta_i$$
$$E_{t,H,i}[\pi_{t+h}] = \beta_i E_{t,P}[\pi_{t+h}] \tag{5.2.13}$$

where $\beta_i > 0$. The ratio is subsequently employed by Easaw and Golinelli (2010) as a weight on the professional forecast within an epidemiological framework akin to Carroll (2003, 2006) as demonstrated by below:

$$E_{t,H,i}[\pi_{t+h}] = \lambda_i(\beta_i E_{t,P}[\pi_{t+h}]) + (1 - \lambda_i)E_{t-1,H,i}[\pi_{t+h}] \tag{5.2.14}$$

Analysing disaggregated professional forecasts from the Barclays Basix survey, Easaw and Golinelli (2010) identify that the inflation forecasts of business economists evolve independently to those of other disaggregations and do not depend upon past inflation. In contrast, other professionals, namely academic economists, financial directors and trade unionists, absorb the forecasts of other professionals in forming their own expectations; moreover those of the general public are found by Easaw and Golinelli (2010) to respond to the forecasts of all classes of professionals. Furthermore, Easaw and Golinelli (2010) highlight that the rate at which agents update their expectations is heterogeneous, distinguishing financial directors and trade unionists as 'active' agents with an absorption rate of approximately 0.650, whilst academic economists and the general public are deemed 'passive' with a lower absorption rate of approximately 0.420. The results presented by Easaw and Golinelli (2010) further demonstrate that the rate at which agents update their information for expectation formation is heterogeneous and dependent on individual circumstances and experiences.

Models of information rigidity have received considerable attention in the macroeconomic literature in recent years. Whilst 5.1 considered various theories of information frictions, including noisy information and sticky information, this sub-section has considered the existing theory and empirical evidence concerning epidemiological expectations. Initially proposed by Carroll (2003, 2006), and further developed by Pfajfar and Santoro (2008, 2010, 2013), Lanne et al (2009). and Nunes (2009), epidemiological expectations assume that agents infrequently absorb information embedded in rational forecasts transmitted by the news media and professional forecasters, and provide microfoundations for the sticky information hypothesis presented by Mankiw and Reis (2002).

Empirically examining Michigan Survey inflation forecasts, Carroll (2003) predicts that approximately a quarter of households update their information in any given period[119]; these estimates were noted to be consistent with those of the sticky information parameter reported by Mankiw and Reis (2002) and Khan and Zhu (2006). Nevertheless, the baseline epidemiological approach fails to acknowledge that the rate of information diffusion may not be homogeneous; instead the rate at which households update their information may be dependent upon demographic characteristics and macroeconomic conditions. Furthermore, Lamla and Lein (2008) and Pfajfar and Santoro (2013) highlight that attentive behaviour exhibited by household forecast may be sensitive to the tone as well as the volume of news, reporting that the expectation gap increases in the presence of rising inflation, indicating increased inattentiveness. In contrast, favourable news regarding inflation is generally considered to be insignificant.

In the next section, models of epidemiological expectations shall be reassessed on the previously employed survey forecasts to determine whether the rate of information diffusion and attentiveness of households. Moreover, the investigations shall consider whether households update more frequently during periods of increased macroeconomic stability or uncertainty, whilst disaggregate Michigan Survey data shall be employed to determine whether demographic characteristics influence attentiveness.

[119] Nunes (2009) reported a similar rate of information diffusion for an extended sample period.

5.3. Empirical Investigations on Sticky Information

Compared to the static approach to sticky information implicitly proposed by Mankiw and Reis (2002) and Carroll (2003), Branch (2007) highlights that where the distribution of information flows are allowed to vary models of sticky information fit survey data better. Moreover, Coibion and Gorodnichenko (2010) acknowledge that the properties of information diffusion are time-dependent, proposing that information will be less 'sticky' following large and visible shocks to the macroeconomic system. Rather than employing a dynamic model of information diffusion, the empirical strategy employed in this section instead proposes to re-evaluate Carroll's (2003, 2006) epidemiological hypothesis, and various extensions, across the four previously identified sample periods to determine whether household attentiveness is time-variant and distinguish whether models of sticky information are more appropriate under certain macroeconomic conditions.

Recalling that the Michigan Survey solely reports four-quarter ahead inflation forecasts, the fixed-horizon specification (5.2.1), as employed by Carroll (2003), shall be examined, employing $h = 4$, and is appropriately restated by (5.3.1) below:

$$E_t^H[\pi_{t+4}] = \alpha_0 + \alpha_1 E_t^P[\pi_{t+4}] + \alpha_2 E_{t-1}^H[\pi_{t+3}] + \epsilon_t \qquad (5.3.1)$$

Equation (5.3.1) shall be estimated utilising OLS procedures over the four previously identified sample periods with Newey-West heteroskedasticity and autocorrelation corrected standard errors.

Furthermore, to examine whether the baseline epidemiological model can be considered as a plausible account of the manner which households form their inflation forecasts, modifications to the baseline model (5.3.1) shall also be considered. Specifically, in accordance with Carroll (2003) and Luoma and Luoto (2009), the baseline model shall be modified to include the possibility of households updating their information in response to realised values of inflation as previously demonstrated by (5.2.5). Additionally, tests of the naïve sticky information and rational updating models, as proposed by Lanne et al. (2009) and Nunes (2009) shall be empirically examined to determine whether the information updating behaviour of households is more backward or forward looking than assumed by Carroll's survey-updating hypothesis. Furthermore, a nested specification, simultaneously featuring elements of the survey-updating, naïve sticky information and rational-updating models shall be evaluated to establish the relative updating behaviour across agents.

To determine whether the frequency which households update their information is time variant and dependent upon macroeconomic conditions, the next sub-section conducts various tests of the epidemiological hypothesis upon aggregate Michigan Survey forecasts across the four sample periods. In 5.3.2, the survey-updating, naïve sticky information, rational-updating and heterogeneous updating specifications shall then be re-examined utilising disaggregate Michigan Survey forecasts to assess the degree of heterogeneity in information diffusion across demographic groups, and establish the heterogeneity in updating behaviour across groups.

5.3.1. Epidemiology of Aggregate Michigan Survey Inflation Forecasts

In accordance with Carroll (2003), the examination of the sticky information and epidemiological hypotheses commences with analysing aggregate Michigan Survey inflation forecasts. Specifically, empirical testing shall be conducted across the four previously identified sample periods to determine whether the rate of information diffusion is time-specific and dependent upon macroeconomic conditions.

5.3.1.1. Aggregate Michigan Survey Inflation Forecasts and the Survey Updating Hypothesis

As noted in 5.1, the presence of unidirectional Granger-causality is integral to Carroll's (2003, 2006) epidemiological approach, indicating that information flows from professionals to households. To determine whether Carroll's (2003) results regarding mean expectations hold for median SPF and aggregate Michigan Survey forecasts, Granger-causality between the two surveys shall be examined for the updated sample periods with the results presented in Table 5.3.1 below:

Table 5.3.1: Granger-Causality

	PANEL A SPF → MS			PANEL B MS → SPF		
LAGS	**2**	**4**	**8**	**2**	**4**	**8**
Period: Whole 1982Q3 – 2011Q1						
	4.246**	2.040*	1.665	5.321***	3.260**	3.182***
Period: Greenspan-Bernanke 1987Q2 – 2011Q1						
	3.896**	2.447*	1.871*	5.126***	3.780***	2.917***
Period: Stable 1990Q1 – 2006Q2						
	3.802**	1.777	0.890	1.302	1.560	1.206
Period: Volatile 2006Q3 – 2011Q1						
	0.273	0.406	0.713	2.389	2.878*	0.768

Whereas Carroll (2003) observes that Granger-causality is unidirectional, Table 5.3.1 indicates that for the whole and Greenspan-Bernanke sample periods Granger-causality is bidirectional[120]. Moreover, for the more recent stable and volatile sub-periods, there is little evidence to indicate that either survey Granger-causes the other.

These results thus appear to question the relevancy of the Carroll's (2003, 2006) epidemiological hypothesis. However, it is highlighted by Luoma and Luoto (2009)

[120] Table 5.3.1 further illustrates a greater significance of household forecasts Granger-causing professional forecasts in comparison to the opposite direction.

that professional information sets are likely to incorporate previous expectations of households and consumers. Furthermore, the lack of Granger-causality for the stable and volatile sub-periods may alternatively be an indication that households exhibit a high degree of inattentiveness to news. Therefore, the epidemiological model remains a useful strategy to examine the diffusion properties of information.

For the whole sample period, tests of Carroll's (2003) baseline survey-updating model (5.3.1), where $\alpha_0 = 0$, are presented in Table 5.3.2 below[121]:

Table 5.3.2: Baseline Survey-Updating Model – Whole Sample Period 1982Q3 – 2011Q1

Testing Equation:

$$E_{H,t}[\pi_{t+h}] = \alpha_0 + \alpha_1 E_{P,t}[\pi_{t+h}] + \alpha_2 E_{H,t-1}[\pi_{t+h-1}] + \epsilon_t$$

	α_0	α_1	α_2	Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
			Period: Whole 1982Q3 – 2011Q1				
(1)		0.128*** (0.049)	0.852*** (0.058)	$\alpha_1 + \alpha_2 = 1$ 2.053	0.328	0.322	2.109
(2)		0.119** (0.052)	0.881*** (0.052)	$\alpha_1 = 0.25$ 6.260**	0.317	0.317	2.138

Whereas, for a sample period consisting of 1981Q3 to 2000Q2, Carroll (2003) reports estimates of $\alpha_1 = 0.36$ and $\alpha_2 = 0.66$, the α_1 estimate reported in row (1) above is substantially lower, representative of a lower degree of attentiveness amongst households than previously reported. Nevertheless, the Wald χ^2 test is unable to reject the null hypothesis $\alpha_1 + \alpha_2 = 1$, supporting the proposition that household forecasts are a weighted average of own lagged and professional forecasts, whilst the Durbin-Watson statistic provides little evidence of serially correlated residuals. These statistics suggest that Carroll's (2003) model is able to accommodate the behaviour of household forecasts well. However, the $\bar{R}^2$ from the unrestricted model is less than half the value reported by Carroll (2003) and may indicate that conclusions regarding the epidemiological hypothesis are sensitive to either the series or the sample period employed.

Similarly, imposing the restriction $\alpha_1 + \alpha_2 = 1$ on the estimation of the baseline model, as reported by row (2), yields a much lower estimate of α_1 relative to the value reported by Carroll (2003). Whereas Carroll's (2003) estimates indicate that in

[121] For all empirical tests of the epidemiological hypothesis, Newey-West corrected standard errors shall be employed to account for heteroskedasticity and autocorrelation.

any given quarter approximately one-quarter of households have up-to-date information, the estimates for the whole sample period in Table 5.3.2 indicate that approximately 12 percent of agents are attentive each period[122]. As the Wald χ^2 test in row (2) rejects the null hypothesis that $\alpha_1 = 0.25$, the proportion of agents that update their information can be considered to be significantly lower relative to Carroll's estimate. Moreover, for the whole sample period, the estimate of $\alpha_1 = 0.119$ in row (2) indicates that approximately 60 percent (=$(1 - 0.119)^4$) of households report inflation forecasts formed on information acquired more than one year previously.

The results presented in Table 5.3.2 are evidently substantially different from those presented by Carroll (2003) and suggest that the level of inattentiveness amongst household inflation forecasts has been substantially underestimated by previous studies. Some may claim that information stickiness has risen in recent years, attributable to greater costs regarding the acquisition and processing of information during recent years of increased macroeconomic uncertainty; others may attribute the difference to the use of median survey forecasts instead of the mean average as preferred by Carroll (2003)[123]. To establish the cause of the apparent increased level of inattentiveness amongst households, the baseline model shall again be re-evaluated utilising mean Michigan Survey forecasts for the whole sample period, and median Michigan Survey forecasts for the sample period employed by Carroll, namely 1981Q3-2000Q2, with the results reported in Table 5.3.3 Panel A and Panel B respectively:

[122] The null hypothesis $\alpha_1 = 0.25$ is rejected by the Wald chi-square test at a 5 percent level of significance.

[123] The motivation for employing the mean was discussed in Chapter 2 in relation to elementary forecast and forecast error statistics.

Table 5.3.3: Baseline Survey Updating Model – Alternative Sampling

Testing Equation:

$$E_{H,t}[\pi_{t+h}] = \alpha_0 + \alpha_1 E_{P,t}[\pi_{t+h}] + \alpha_2 E_{H,t-1}[\pi_{t+h-1}] + \epsilon_t$$

	α_0	α_1	α_2	**Wald χ^2 Test**	R^2	$\bar{R}^2$	**D.W. Stat**
PANEL A:	**Period: Whole 1982Q3 – 2011Q1 Mean Michigan Survey Forecasts**						
(1)		0.205*** (0.065)	0.819*** (0.059)	$\alpha_1 + \alpha_2 = 1$ 3.760*	0.521	0.516	2.049
(2)		0.144** (0.055)	0.856*** (0.055)	$\alpha_1 = 0.25$ 3.671*	0.513	0.513	2.095
PANEL B:	**Period: Carroll 1981Q3 – 2000Q2 Median Michigan Survey Forecasts**						
(1)		0.307*** (0.091)	0.603*** (0.120)	$\alpha_1 + \alpha_2 = 1$ 7.759***	0.697	0.693	1.968
(2)		0.077*** (0.029)	0.923*** (0.029)	$\alpha_1 = 0.25$ 36.531***	0.608	0.608	2.275

Estimating the baseline model (5.3.1), utilising Michigan Survey mean forecasts, across the whole sample period, yields a higher value of α_1 relative to the results reported in Table 5.3.2; compared to the median, inattentiveness appears less pronounced amongst mean household forecasts. This could indicate that the distribution of household forecasts is skewed towards the proportion of agents who exhibit inattentive behaviour. Nevertheless, the value of α_1 is again much lower than the value reported by Carroll (2003), supporting the notion that inattentiveness amongst household inflation forecasts has increased in recent years. The results in Panel A row (2) support this claim indicating that approximately 14 percent of households update their information in any given period; moreover, the Wald χ^2 null hypothesis $\alpha_1 = 0.25$ is only marginally not rejected at the 5 percent level of significance[124]. The evidence again appears to suggest that Mankiw and Reis (2002) and Carroll (2003) overestimate the rate of information stickiness.

The estimates presented in Panel B row (1), for median household forecasts estimated for the sample period considered by Carroll (2003), appear to confirm this hypothesis, with α_1 larger in comparison with the whole sample period. Despite the estimates in row (1) being much closer to those reported by Carroll (2003), the value of α_1 in row (2), suggesting an average frequency of updating of every three years, appears particularly low[125]. These results thus suggest that Carroll's (2003) results are sensitive to both the composition of household forecasts and the sample period

[124] The p-value relating to the Wald chi-square test of $\alpha_1 = 0.25$ is $p = 0.0554$
[125] The Wald chi-square test unsurprisingly rejects that $\alpha_1 = 0.25$

employed. Moreover, the results further indicate that the degree of information stickiness is not homogeneous, as previously assumed by both Mankiw and Reis (2002) and Carroll (2003); instead, the rate of information diffusion may be heterogeneous across households and dependent upon underlying macroeconomic conditions.

To examine the extent which the rate of information diffusion is dependent upon macroeconomic conditions, the baseline and restricted baseline specifications of (5.3.1) shall be re-estimated for the three sub-sample periods previously identified, with the results presented in Table 5.3.4 below:

Table 5.3.4: Baseline Survey Updating Model – Sub-Sample Periods

Testing Equation:

$$E_{H,t}[\pi_{t+h}] = \alpha_0 + \alpha_1 E_{P,t}[\pi_{t+h}] + \alpha_2 E_{H,t-1}[\pi_{t+h-1}] + \epsilon_t$$

	α_0	α_1	α_2	**Wald χ^2 Test**	R^2	$\bar{R}^2$	**D.W. Stat**
PANEL A: Period: Greenspan-Bernanke 1987Q2 – 2011Q1							
(1)		0.167** (0.066)	0.832*** (0.072)	$\alpha_1 + \alpha_2 = 1$ 0.008	0.390	0.383	1.945
(2)		0.168** (0.070)	0.832*** (0.070)	$\alpha_1 = 0.25$ 1.364	0.390	0.390	1.945
PANEL B: Period: Stable 1990Q1 – 2006Q2							
(1)		0.269* (0.152)	0.727*** (0.159)	$\alpha_1 + \alpha_2 = 1$ 0.083	0.404	0.395	2.042
(2)		0.272* (0.151)	0.728*** (0.151)	$\alpha_1 = 0.25$ 0.020	0.403	0.403	2.043
PANEL C: Period: Volatile 2006Q3 – 2011Q1							
(1)		0.876*** (0.154)	0.412*** (0.119)	$\alpha_1 + \alpha_2 = 1$ 23.163***	0.380	0.344	1.315
(2)		0.131 (0.170)	0.869*** (0.170)	$\alpha_1 = 0.25$ 0.492	0.173	0.173	1.442

From Table 5.3.4, estimates of the baseline epidemiological model presented in Panel A and Panel B for the Greenspan-Bernanke and stable sub-periods show an increase in α_1 relative to the whole sample period. Therefore, excluding periods of excessive macroeconomic uncertainty associated with the Volcker disinflation and the recent financial crisis thus appear to have resulted in increases in household attentiveness. Specifically, the result from the restricted specification, presented in row (2) of Panel A and B indicate that approximately 17 percent of households update in each period for the Greenspan-Bernanke sub-period, increasing to 27 percent for the stable sub-period. Moreover, for both the Greenspan-Bernanke and stable sample periods it is not possible to reject the null hypothesis that a quarter of households are attentive to news; the estimates of $\alpha_1 = 0.25$ reported by Mankiw and Reis (2002) and Carroll (2003) may thus be appropriate for periods of reduced macroeconomic uncertainty. Nevertheless, for the stable sub-period, both the restricted and unrestricted specifications, presented in Table 5.3.4 Panel B, α_1 is only significant at the 10 percent level; this could indicate that despite households updating their information more frequently, their forecasts do not necessarily tend towards those reported by professionals.

For the Greenspan-Bernanke sub-period the increase in attentiveness could also be attributable to greater credibility amongst professionals following Federal Reserve policy of lowering inflationary pressures (Pfajfar and Santoro, 2008). Alternatively, recalling the reduction in SPF MFE and MSFE between the whole and Greenspan-Bernanke sub-periods presented in Chapter 2, paying greater attention to professional forecasts is thus consistent with the analysis presented by Brock and Hommes (1997) where agents switch to a sophisticated predictor should the net gain exceed the gain from employing a naïve predictor. Estimating the baseline model for the stable sub-sample period, the value of α_1 is higher relative to both the whole and Greenspan-Bernanke sample periods; moreover, these values are much closer to those reported by Carroll (2003) and Khan and Zhu (2006). The larger value of α_1 indicates that households update more frequently during periods characterised by reduced levels of macroeconomic volatility and uncertainty.

For the volatile sub-period, the value of α_1 from the baseline specification remains significant yet is much larger relative to either the Greenspan-Bernanke or stable sample periods. Nevertheless, the rejection of the Wald χ^2 test that $\alpha_1 + \alpha_2 = 1$ suggests that household expectations for the recent period of macroeconomic uncertainty are not formed as a weighted average of current professional and own lagged expectations; this thus questions the relevance of Carroll's (2003, 2006) epidemiological hypothesis. In row (2), where the weighted average restriction is imposed on expectations, the value of α_1 is observed to be smaller in comparison to the Greenspan-Bernanke and stable periods, and insignificant, thus implying that households exhibit greater levels of inattention during the volatile sub-period.

The results presented in Table 5.3.4 thus appear consistent with the argument that the frequency which households update their information is time-variant and dependent upon macroeconomic conditions; more specifically, households are more attentive to the professional forecast during periods of reduced macroeconomic uncertainty where the information acquisition and processing costs are reduced. Furthermore, recalling from Chapter 2 that the MFE and MSFE associated with aggregate Michigan Survey forecasts are much larger for the whole and volatile periods relative to periods of increased macroeconomic stability, the results presented in Table 5.3.4 thus appear to reject the hypothesis that agents update more frequently where the opportunity costs of remaining attentive are higher.

The baseline epidemiological model provides an approximation of information diffusion across household forecasts; however, the R^2 values observed in Table 5.3.2 and Table 5.3.4 are much lower than those reported by Carroll (2003). A simple modification which may improve the fit is to include a constant α_0 with the results from respective empirical tests on aggregate Michigan Survey forecasts presented below:

Table 5.3.5: Survey Updating Model (including Constant) – Aggregate Michigan Survey Forecasts

Testing Equation:

$$E_{H,t}[\pi_{t+h}] = \alpha_0 + \alpha_1 E_{P,t}[\pi_{t+h}] + \alpha_2 E_{H,t-1}[\pi_{t+h-1}] + \epsilon_t$$

α_0	α_1	α_2	Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
PANEL A: Period: Whole 1982Q3 – 2011Q1						
1.091***	0.113**	0.529***		0.451	0.442	1.863
(0.176)	(0.048)	(0.090)				
PANEL B: Period: Greenspan-Bernanke 1987Q2 – 2011Q1						
0.913***	0.128**	0.580***		0.472	0.460	1.761
(0.114)	(0.058)	(0.083)				
PANEL C: Period: Stable 1990Q1 – 2006Q2						
0.873***	0.217	0.488***		0.488	0.471	1.852
(0.254)	(0.161)	(0.140)				
PANEL D: Period: Volatile 2006Q3 – 2011Q1						
-0.140	0.939	0.413*		0.381	0.303	1.313
(1.317)	(0.813)	(0.227)				

The inclusion of the constant term within the epidemiological framework is however rejected by Carroll (2003) due to modest improvements in fit; similarly, the results presented in Table 5.3.5 provide fairly small improvements in R^2. Moreover, Carroll (2003:285) argues that should inflation be zero for extended time periods, the inclusion of the constant would imply that households would continue to expect a positive rate of inflation, and thus be perpetually biased. The significance of the constant may instead indicate that households employ some form of level anchoring to the Federal Reserve implicit inflation target or some arbitrary value based upon either recent or historical inflation experiences. Alternatively, the constant may be representative of agents forming expectations from previous inflation experiences; as the CPI has been invariably positive since 1955Q4, agent inflation forecasts may be positively biased. Consequently, should households form expectations in accordance with theories of adaptive learning, the presence of significant constant terms is deemed by Luoma and Luoto (2009) to be inconsequential for the epidemiological hypothesis.

As previously discussed, a further modification of the epidemiological model as proposed by Carroll (2003), and reassessed by Luoma and Luoto (2009) concerns including realised inflation values as detailed by (5.2.5). The analysis in 5.1 also recognised the debate regarding whether current or lagged inflation was most appropriate, identifying that both could be considered to be economically reasonable. The results from testing (5.2.5), imposing $\alpha_0 = 0$ for both $k = 1$ and $k = 0$ are presented in rows (1) and (2) of Appendix 5.1 respectively, rows (2) and (4) present the associated models where the weighted average restriction $\alpha_1 + \alpha_2 + \alpha_3 = 1$ is imposed.

Consistent with Carroll's (2003) results, the results in rows (1) and (2) indicate that α_3 is generally insignificant and suggests that the inclusion of past inflation is spurious[126]. The value of α_3 is also negative and suggests that households expect a lower inflation rate when lagged inflation is higher. Nevertheless, for the whole, Greenspan-Bernanke and stable sample periods α_3 in rows (3) and (4) is significant at the 5 percent level; consistent with the results for Luoma and Luoto (2009), a significant proportion of households are attentive to current inflation and suggests that agents do not employ excessively backward-looking behaviour in expectation formation. Moreover, the R^2 and $\bar{R}^2$ statistics are invariably larger for $k = 0$, whilst Durbin-Watson statistics between the two specifications are similar and close to 2. The data thus appears to favour the current inflation specification presented by

[126] The insignificance of α_3 may further arise from high correlation between the Michigan Survey and inflation, estimated to be 0.712 for the whole sample period, as previously indicated by Luoma and Luoto (2009).

Luoma and Luoto (2009), in preference to lagged inflation as examined by Carroll (2003).

For the whole sample period, it is however observed in row (4) that α_3 is larger than α_1 suggesting that a greater proportion update their information in response to current inflation than to the professional forecast. Moreover, α_1 is insignificant for all four sample periods thus it is not possible to reject the null hypothesis that the proportion of households that update their information relative to the professional forecast is zero[127]. These results suggest that households display some degree of attention to current conditions but are generally inattentive to forward-looking information. Moreover, the rate of information diffusion again appears to increase in the Greenspan-Bernanke and stable periods with α_2 falling relative to the whole sample period consistent with agents exhibiting greater attentive behaviour where the costs associated with information acquisition and processing are lower. Recalling that Carroll (2003) estimates that approximately a quarter of households update in any given period, the restricted specification is examined to determine whether the proportion of households utilising updated information significantly differs from 25 percent. The Wald χ^2 statistics presented in rows (2) and (4) of Appendix 5.1 generally indicate that the null hypothesis $\alpha_1 + \alpha_3 = 0.25$ cannot be rejected; nevertheless, for the whole sample period, the restriction is rejected where the one-period lagged inflation rate is employed, and further suggests that agents are more forward-looking than the Carroll (2003) specification assumes.

Consistent with the results for the baseline model, the results for the restricted specifications presented in Appendix 5.1 Panel D for the volatile sub-period again indicate that households exhibit greater inattention to news than for periods of reduced macroeconomic uncertainty, and instead resort to naïve backward-looking rules. The estimates of α_2 indicate that 80-90 percent of households are inattentive in any given period; this is considerably higher than the estimate reported by Mankiw and Reis (2002) and Carroll (2003), and further supports the notion that the degree of information stickiness is dependent upon macroeconomic conditions. Nevertheless, under the unrestricted specification, the restriction $\alpha_1 + \alpha_2 + \alpha_3 = 1$

[127] As α_1 is significant at the 10 percent level for the whole and stable sample periods. This may proxy for agents updating their information in response to observations on other macroeconomic variables which the professional forecast accommodates.

is again rejected, whilst Durbin-Watson statistics are low, further highlighting that the epidemiological model does not appear to be an appropriate hypothesis for evaluating household expectations for periods of increased macroeconomic uncertainty.

Despite tests of Carroll's (2006, 2003) epidemiology hypothesis indicating that households are inattentive, section 5.1 introduced a number of issues with Carroll's assumptions and identified several models which attempt to mitigate these concerns. These included the naïve sticky information model as presented by Lanne et al. (2009), and the rational updating model presented by Nunes (2009). The remainder of this sub-section shall thus empirically consider these models and determine whether they improve upon the results presented for the various specifications of the epidemiological hypothesis.

Recalling from Chapter 2 that the expectations and inflation data does not invariably satisfy the properties of stationarity, it is appropriate to consider tests of partial adjustment models which account for the observed persistence amongst the series. Guidance in this respect is provided by Lein and Maag (2011) who respecify a naïve sticky information model akin to Lanne et al. (2009) in first differences. Applying this approach to Carroll's survey-updating model yields the following specification:

$$\begin{aligned}\Delta E_{H,t}[\pi_{t+h}] = \gamma_0 + \gamma_1 \Delta E_{P,t}[\pi_{t+h}] \\ + \gamma_2 \Delta E_{H,t-j}[\pi_{t+h-j}] + \gamma_3 \Delta\pi_t + \epsilon_t\end{aligned} \tag{5.3.2}$$

The first difference regarding the expectations of agent class i in period t is defined as $\Delta E_{i,t}[\pi_{t+h}] = E_{i,t}[\pi_{t+h}] - E_{i,t-1}[\pi_{t+h-1}]$[128] whilst the first difference of inflation is defined as $\Delta\pi_t = \pi_t - \pi_{t-1}$. Appendix 5.2 reports the estimation results of various specifications of (5.3.2) over the four sample periods.

In accordance with Lamla and Maag (2012), the coefficients on the lagged change in expectations are negative for the whole, Greenspan-Bernanke and stable periods; however, for the volatile period γ_2 is positive and significant. Nevertheless, the coefficients on both the current change in professional expectations and the current

[128] The j-period lagged first difference in the expectations of agent class i is defined as $\Delta E_{H,t-j}[\pi_{t+h-j}]$.

change in inflation are invariably positive and significant indicating that a large proportion of households absorb changes in current macroeconomic conditions. Moreover, the R^2 and Durbin-Watson statistics suggest that the model including lagged inflation, but without a constant outperforms the three alternative specifications. Furthermore, the Wald χ^2 test is unable to reject the null hypothesis that the γ_1, γ_2 and γ_3 coefficients sum to one indicating that the change in household forecasts across all four sample periods is consistent with a weighted average model of the three variables.

5.3.1.2. Aggregate Michigan Survey Inflation Forecasts and the Naïve Sticky Information Hypothesis

In 5.1, both a naïve version of the sticky information and epidemiological hypotheses, and nested specification, as presented by Lanne et al. (2009), were identified by (5.2.9) and (5.2.10) where, rather than absorbing the information content of professional forecasts, agents adapt their forecasts in response to lagged inflation. To re-examine Lanne et al.'s (2009) results, and to determine whether the naïve sticky information model is superior to Carroll's (2003) epidemiological model the following models shall be empirically examined, utilising Michigan Survey and SPF inflation expectations, across the four previously identified sample periods:

$$E_t^H[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-1} + \beta_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t \qquad (5.3.3)$$

$$E_t^H[\pi_{t+h}] = \beta_0 + \beta_1(\beta_2\pi_{t-1} + (1-\beta_2)E_t^P[\pi_{t+h}]) + (1-\beta_1)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t \qquad (5.3.4)$$

The results for the whole sample period relating to tests of (5.3.3) and (5.3.4), for $h = 4, j = 1$, are presented in Table 5.3.6 for both current and the one period lagged inflation rate.

Table 5.3.6: Naïve Sticky Information and Nested Epidemiological Model – Whole Sample Period

Testing Equation:

$$(1).\ E_t^H[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + \beta_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

$$(2).\ E_{t,H}[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + (1-\beta_1)E_{t-j,H}[\pi_{t+h-j}] + \epsilon_t$$

$$(3).\ E_t^H[\pi_{t+h}] = \beta_0 + \beta_1(\beta_2\pi_{t-1} + (1-\beta_2)E_t^P[\pi_{t+h}]) + (1-\beta_1)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

		β_0	β_1	$(1-\beta_1)$	β_2	$(1-\beta_2)$	Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
					Period: Whole 1982Q3 – 2011Q1					
MS	**(1)**		-0.004		0.990***		$\beta_1+\beta_2=1$	0.287	0.281	2.302
	$k=1$		(0.032)		(0.034)		1.374			
	(1)		0.153**		0.836***		$\beta_1+\beta_2=1$	0.357	0.352	2.090
	$k=0$		(0.059)		(0.063)		1.071			
	(2)		-0.004	1.004***			$\beta_1=0.35$	0.281	0.281	2.314
	$k=1$		(0.027)	(0.027)			170.411***			
	(2)		0.155***	0.845***			$\beta_1=0.35$	0.353	0.353	2.098
	$k=0$		(0.042)	(0.042)			21.204***			
	(3)		0.087*	0.913***	-0.581	1.581***		0.323	0.317	2.174
	$k=1$		(0.050)	(0.050)	(0.539)	(0.539)				
	(3)		0.197***	0.803***	0.671***	0.329*	$\beta_1=0.25$ 2.134	0.363	0.357	2.027
	$k=0$		(0.036)	(0.036)	(0.183)	(0.182)	$\beta_1*(1-\beta_2)$=0.25 23.406***			

In accordance with the extension to the survey-updating model, for all three specifications of the naïve sticky information model, β_1 is larger where current inflation ($k=0$) is employed rather than lagged inflation ($k=1$); moreover, the R^2 values is larger for $k=0$ relative to $k=1$, whilst the Durbin-Watson statistic for the current inflation specification is closer to the optimum of 2.000. In accordance with Lanne et al. (2009), the value of β_1 is smaller than Carroll's estimates for updating associated with the survey-updating model. Nevertheless, for $k=0$, β_1 is larger than the value of α_1 estimated for both the unrestricted and restricted specifications of the epidemiological model presented in Table 5.3.2; however, the Wald χ^2 test rejects the null hypothesis that $\beta_1=0.35$, indicating that the rate of updating in the naïve sticky information model is lower compared to the estimate presented by Lanne et al. (2009).

Furthermore, for both the unrestricted and restricted specifications of the naïve sticky information model where $k=0$, the R^2 values are higher relative to tests the survey-updating, whilst the Durbin-Watson statistics are closer to the optimum of two indicating that the hypothesis presented by Lanne et al. (2009) is better suited to

Michigan Survey data. These results indicate that a significant proportion of aggregate Michigan Survey respondents report expectations consistent with the naïve sticky information model. Moreover, the restricted specifications of the survey updating and naïve sticky information models indicate that a larger proportion of households are attentive to the current rate of inflation relative to the professional expectations; namely the proportion of attentive agents is estimated at 15.5 percent by the naïve sticky information model whereas the epidemiological model estimates that only 12 percent of agents are attentive.

The nested specification (5.3.4) is presented in the last two rows of Table 5.3.6 for $k = 1$ and $k = 0$ respectively; again, the R^2 and Durbin-Watson statistics favour the current inflation specification. For $k = 0$, the nested specification indicates that approximately 20% of households update each period, with only $\frac{1}{3}$ of those who are attentive absorbing the current professional forecast whilst the remaining $\frac{2}{3}$ update in response to current inflation. These estimates are roughly consistent with those reported by Lanne et al. (2009) and indicate that a larger proportion of agents employ backward-looking updating rules as opposed to forward-looking behaviour as proposed by Carroll (2006, 2003).

To determine whether the backward-looking updating behaviour employed by households is time-variant, the unrestricted and restricted specifications of (5.3.3), and the nested specification (5.3.4), shall be examined for aggregate Michigan Survey forecasts over the three shorter sub-sample periods. As the naïve sticky information model was demonstrated to perform better for $k = 0$ only the results relating to current inflation shall be reported[129]. From Appendix 5.3, tests of both the unrestricted and restricted specifications (5.3.3) provide some evidence that the degree of agent attentiveness is time-variant, however differences are relatively small. For the Greenspan-Bernanke sub-period β_1 is marginally smaller relative to the whole sample period, whilst for the stable sub-period β_1 is fractionally larger; specifically, the proportion of attentive households for the Greenspan-Bernanke sub-period is estimated at 14 percent, yet for the stable sub-period 18 percent of households update in each period. Nevertheless, for the volatile sub-period, whilst

[129] The results for $k = 1$ for all three specifications across the three sub-sample periods are generally analogous to those reported in Table 5.3.6

β_1 from the unrestricted specification indicates that the rate which households update their expectations utilising naïve backward-looking rules is significant, the proportion estimated by the unrestricted specification of 12 percent is not significant. Moreover, the Wald χ^2 test indicates that the rate of updating reported by the restricted specification is again lower than the estimate of 0.35 presented by Lanne et al. (2009).

Differences are also observed for the nested specification (5.3.4) across the three sub-periods. Firstly, for both the Greenspan-Bernanke and stable periods, the values of β_1 are larger relative to both Lanne et al.'s (2009) estimates and those for the whole sample period as presented in Table 5.3.6, whereas the values of β_2 are smaller. For these periods of reduced macroeconomic volatility and uncertainty, not only does the rate which households update their information increase relative to the whole sample period, but also, the relative degree of attentiveness to the professional forecast also increases. Specifically, for the Greenspan-Bernanke sub-period approximately 20 percent of agents update their information in any given period, of which 50 percent absorb the professional forecast; moreover, for the stable sub-period, approximately 40 percent of households update their information, of which over 60 percent absorb the professional forecast. Unlike for the survey-updating model, the rate of updating presented for the nested naïve sticky information model for the volatile sub-period is significant. Namely, the estimates indicate that approximately 15% of agents update their information in any given quarter during the recent period of macroeconomic uncertainty; however, the coefficients associated with the two information sources are insignificant at conventional levels. Therefore, during periods of increased macroeconomic volatility, the naïve sticky information indicates that the frequency of information updating amongst households falls; moreover, there is an increased likelihood that upon updating their information an agent absorbs the naïve predictor. These results correspond with the hypothesis that households report more sophisticated expectations during periods of greater macroeconomic stability.

5.3.1.3. Aggregate Michigan Survey Inflation Forecasts and the Rational Updating Hypothesis

A further extension to the epidemiology hypothesis identified in section 5.1 relates to the rational-updating model presented by Nunes (2009) which proposes that households update towards the 'rational' expectation as opposed to the SPF; the rational-updating model can thus be tested for both household and professional forecasts. To re-examine the results presented by Nunes (2009), (5.2.11) and (5.2.12) shall be examined for 4-period ahead Michigan Survey and SPF forecasts ($h = 4$) over the four-previously identified sample periods, with the results presented in Table 5.3.7.

As highlighted in 5.1, the inclusion of the current rational expectations requires tests of (5.2.12) to be conducted using GMM estimation rather than OLS, and thus requires the use of instrumental variables. The instrument set employed is based on those utilised by Galí and Gertler (1999), Galí, Gertler and López-Salido (2001) and Nunes (2009), consisting of four lags of CPI, two lags of own inflation forecasts, the current inflation forecast of the other agent class, the output gap[130], and wage inflation[131]. For the whole sample period, Table 5.3.7 presents the results from testing Nunes's (2009) rational updating model on both SPF and Michigan Survey forecasts[132]:

[130] The output gap is defined as real GDP less real potential GDP, and calculated from data accessed from FRED, published by the Federal Reserve Bank of St. Louis.

[131] Following the second measure presented by Coibion and Gorodnichenko (2013), wage inflation shall be measured as the compensation per hour in the non-farm business sector, with data accessed from FRED.

[132] In accordance with Nunes (2009), and the previous empirical investigations, standard errors are corrected utilising the four lag Newey-West covariance matrix.

Table 5.3.7: Rational Updating Model – Whole Sample Period 1982Q3 – 2011Q1

Testing Equation:

$$E_{i,t}[\pi_{t+h}] = \gamma_0 + \gamma_1 E_{RE,t}[\pi_{t+h}] + \gamma_2 E_{i,t-1}[\pi_{t+h-1}] + v_t$$

		γ_0	γ_1	γ_2	Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat	J-Stat
				Period: Whole 1982Q3 – 2011Q1					
MS	(1)		0.189*** (0.046)	0.807*** (0.044)	$\gamma_1 + \gamma_2 = 1$ 0.524	0.218	0.211	1.974	9.666
	(2)		0.147*** (0.037)	0.853*** (0.037)	$\gamma_1 = 0.16$ 0.129	0.265	0.265	2.121	8.501
	(3)	1.005*** (0.108)	0.025 (0.060)	0.650*** (0.055)		0.418	0.407	2.042	19.555***
	(4)	0.009 (0.016)	0.202*** (0.050)	0.798*** (0.050)	$\gamma_1 = 0.16$ 0.723	0.200	0.193	1.937	8.950

The results for the baseline specification of (5.2.11), where $\gamma_0 = 0$, are presented in row (1), whilst row (2) imposes the restriction $\gamma_1 + \gamma_2 = 1$, whilst rows (3) and (4) estimate the two specifications respectively with the inclusion of the constant term. In contrast with the results presented by Nunes (2009), the value of γ_1 for the Michigan Survey is larger than the rate of updating presented in Table 5.3.2 for the survey updating model. Examining the restriction $\alpha_1 + \alpha_2 = 1$ in row (1), the Wald χ^2 test cannot reject the null hypothesis indicating that the rational updating model is an appropriate explanation of aggregate Michigan Survey expectations. Similarly, row (2) estimates that approximately 15 percent of agents update each quarter which is again larger than the prediction presented in Table 5.3.2 for the survey updating model; moreover, it is not possible to reject the Wald χ^2 null hypothesis that approximately 16 percent of agents rationally update their expectations each quarter, in line with the estimate presented by Nunes (2009). It therefore appears that Carroll's (2003, 2006) hypothesis fails to appreciate the extent of rational behaviour amongst households. Nevertheless, the inclusion of the constant to the baseline model in row (3) results in insignificance of γ_1 suggesting that the significance of rational updating is spurious; in contrast, under the restricted specification in row (4), the constant is insignificant whilst the Wald χ^2 test again indicates that the estimate of γ_1 is statistically equal to the estimate of 0.16 presented by Nunes (2009).

The rational updating model is also estimated for aggregate Michigan Survey expectations across the Greenspan-Bernanke, stable and volatile sub-periods to determine whether agent attentiveness to the information embodied within rational expectations is time-variant. The results for both the restricted and unrestricted specifications are presented in Appendix 5.4. Considering the baseline model in row (1), it is evident that compared to the whole sample period, the rate of updating predicted by the rational updating model is lower for the Greenspan-Bernanke sub-period, whereas for the stable sub-period, the rate of updating increases. Nevertheless, whilst the proportion of updating agents estimated by the restricted specification in row (2), is significant, albeit low at 9 percent, for the Greenspan-Bernanke sample period, it is insignificant for the stable sub-period. Moreover, the inclusion of the constant in rows (3) and (4) result in insignificance of γ_1 for the Greenspan-Bernanke period indicating that the significance of rational-updating for this ample period is proxying for some alternative manner of expectation formation.

Furthermore, for the restricted specification, whereas the rejection of the Wald χ^2 test for the Greenspan-Bernanke sub-period indicates that the rate of updating is less than that predicted by Nunes (2009), the null hypothesis that $\gamma_1 = 0.16$ cannot be rejected for the stable sub-period. Nevertheless, these results are likely to be dependent upon the instruments employed; whereas the J-statistic is unable to reject the validity of instruments for the whole, Greenspan-Bernanke and volatile sample periods, for the stable sub-period the instruments appear weak, indicative of estimation bias affecting the inference from the testing procedure.

For the volatile sub-period, the rate of updating remains significant; however, the value of γ_1 for both the baseline and restricted specifications is lower than previously observed for the naïve sticky information model and for the Greenspan-Bernanke sample periods. Moreover, evaluation of the Wald χ^2 test reveals that the rate of updating for the volatile period is again statistically lower than the estimate presented by Nunes (2009). These results again indicate that the rate at which agents update their information is time-variant with a lower degree of attentiveness exhibited during the most recent period of macroeconomic uncertainty. As previously highlighted, this thus questions the relevance of the sticky information hypothesis of Mankiw and Reis (2002) which implicitly proposes that the degree of information friction is constant.

5.3.1.4. Aggregate Michigan Survey Inflation Forecasts and the Rational Updating Hypothesis

The analysis in this section has thus far highlighted that agents update their expectations from various information sources with significant coefficients attached to professional expectations, current or lagged inflation values and rational expectations. Consequently, one may argue that neither the survey updating hypothesis, the naïve sticky information model, nor the rational updating specification, are able to adequately accommodate the varied nature of information attentiveness exhibited by agents. An alternative model is thus required which nests the previous three specifications. In accordance with Carroll (2003), Lanne et al. (2009), and Nunes (2009), it is assumed that only a proportion of households update their expectations in each period; however, updating may occur towards the professional forecast, the current or lagged inflation value, or towards RE. The model can thus be described by (5.3.5):

$$E_{t,H}[\pi_{t+h}] = \phi_0 + \phi_1 E_{t,P}[\pi_{t+h}] + \phi_2 \pi_t + \phi_3 E_{t,RE}[\pi_{t+h}] + \phi_4[\pi_{t+h-1}] + \epsilon_t \qquad (5.3.5)$$

In accordance with Nunes (2009), and the estimation of the rational updating model, the rational expectation is proxied with the actual realisation of future inflation; consequently, (5.3.5) shall also be estimated utilising both OLS and GMM methodologies with the results for aggregate Michigan Survey expectations across the whole period presented in Appendix 5.5[133].

For both the whole and Greenspan-Bernanke sample periods, the baseline OLS and GMM models predict that a high proportion of agents are inattentive, with λ greater than 0.7; however, the degree of inattentiveness is lower in comparison to the three individual updating hypotheses.. Nevertheless, for both these sample periods α is insignificant at the conventional five percent level under both estimation procedures; therefore, survey-updating, as proposed by Carroll (2003) appears to play little role in the formation of household expectations. Instead, the OLS estimation indicates that agents only update their information in response to current inflation according to the naïve sticky information hypothesis of Lanne et al. (2009); the significance of β

[133] OLS estimations for each sample period are presented in rows (1) and (3) whilst the GMM estimation is presented in rows (2) and (4).

for these two sample periods under OLS is robust to the inclusion of the constant in row (3). In contrast, the GMM procedure prefers rational-updating akin to Nunes (2009) for the whole sample period, but for the Greenspan-Bernanke sample period, ϕ_1, ϕ_2 and ϕ_3 are all insignificant at the five percent level suggesting that agents are inattentive to all information sources. Nevertheless, for both these sample periods, upon inclusion of the constant in row (4), all three coefficients are significant indicating that agents update their information in response to various sources information sources; however, whist $\phi_1$and ϕ_2 are both positive, with the former associated with survey-updating the larger, ϕ_3 is negative suggesting some cancelling out effect in updating behaviour.

For the stable sub-period, the OLS estimation indicates that households update in response to all three sources of information with the values of α, β and γ approximately equal. However, in row (3), the coefficients associated with survey and rational updating are both insignificant indicating that their significance under the baseline specification proxies for the omitted constant. In contrast, under the GMM estimation, after controlling for the previously identified instrument set, only rational updating coefficient is found to be significant; moreover, in accordance with the observation in Chapter 3 that household expectations are more consistent with the predictions of the REH for periods of reduced macroeconomic volatility, the value of γ is larger relative to the whole sample period further indicating greater rational behaviour on the part of households. The significance of γ and rational-updating is found in row (4) to again be robust to the inclusion of the constant.

Akin to the analysis of the naïve sticky information and rational updating model, it is also possible to determine the proportion of agents updating to each of the information sources utilising the following model:

$$\begin{aligned} E_{t,H}[\pi_{t+h}] = \lambda\big(\phi_1 E_{t,P}[\pi_{t+h}] + \phi_2 \pi_{t-1} \\ + (1 - \phi_1 + \phi_2) E_{t,RE}[\pi_{t+h}]\big) \\ + (1 - \lambda) E_{t,H}[\pi_{t+h-1}] + \epsilon_t \end{aligned} \qquad (5.3.6)$$

The proportion of updating agents is again represented by λ, whilst ϕ_i represent the proportion of the updating agents attentive to the individual information sources. The results from testing the restricted specification on aggregate Michigan Survey expectations across the four sample periods are presented in Appendix 5.6.

In accordance with the results presented in Appendix 5.5, both the OLS and GMM specifications predict a higher rate of updating for the stable sub-period relative to the whole and Greenspan-Bernanke sample periods further supporting the argument that agents are more attentive where the costs associated with information processing and acquisition are lower. Comparing the rate of updating across the two specifications for the whole sample period, the OLS procedure predicts that approximately 22 percent of agents update their information each period, approximately double the estimate under GMM. Furthermore, for the whole, Greenspan-Bernanke and stable sample periods, whilst the Wald χ^2 test again cannot reject the null hypothesis that a quarter of the population update each period, the null hypothesis is rejected for the GMM estimation.

As previously noted, for the stable sub-period, both OLS and GMM specifications estimate an increase in the rate of updating relative to the longer whole and Greenspan-Bernanke sample periods. Nevertheless, whilst the OLS procedure predicts that approximately a third of updating agents absorb each type of information, the GMM suggests that whilst 35 percent form expectations consistent with survey updating, the remaining 65 percent undertake rational updating behaviour. Contrastingly, for the volatile sub-period, the rate of information updating under both procedures is found to be insignificant, with none of the three forms of updating significant at a five percent level. These results thus support the argument that agents are more attentive when information acquisition and processing costs are lower; moreover, for periods of reduced macroeconomic uncertainty, agents appear to refer to a more diverse information set.

5.3.1.5. Evaluation of Epidemiological Models

This section has re-evaluated the literature regarding epidemiological expectations for aggregate household expectations across a variety of macroeconomic conditions. The results indicate that whilst agents update information relatively frequently during periods of reduced macroeconomic uncertainty, for periods of greater volatility, agents are more inattentive. Moreover, it is evident that Carroll's (2003, 2006) survey updating model, Lanne et al.'s (2009) naïve sticky information model nor Nunes's (2009) rational updating model are not able to adequately accommodate the formation of Michigan Survey inflation expectations. Instead, it is proposed that agents utilise a range of information sources to formulate their expectations. As macroeconomic volatility increases, there appears to be a greater propensity for agents to utilise naïve forecasting procedures, whilst agents absorb more varied information during periods of reduced uncertainty. The dependence of updating behaviour on the sample period and macroeconomic conditions however questions the relevance of the sticky information hypothesis proposed by Mankiw and Reis (2002) which proposes a constant rate of updating; instead these results may be considered to be more in line with predictions of noisy information as proposed by Woodford (2001), Sims (2003) and Maćkowiak and Wiederholt (2009). The next sub-section further evaluates these models of information diffusion for disaggregate Michigan Survey forecasts to determine whether the updating behaviour of agents is dependent upon household demographics.

5.3.2. Epidemiology of Disaggregate Michigan Survey Inflation Forecasts

The analysis of the epidemiological model presented by Carroll (2003, 2006) focuses solely on aggregate expectations, implicitly assuming that all agents have the same probability of encountering news concerning inflation. Nevertheless, the results presented in 4.2 and 4.3 clearly indicate that household expectations are heterogeneous with forecast errors dependent upon demographic characteristics. To proxy for the various economic explanations identified in Chapter 4 regarding the occurrence of expectational heterogeneity, it is proposed that households with contrasting demographic characteristics update their information sets at different rates. Moreover, those demographics which realise small forecast errors relative to alternative groups, as detailed in 4.2, are hypothesised to update their information more frequently. Nevertheless, due to the construction of the Michigan Survey, it is further hypothesised that the diffusion across disaggregated household expectations is likely to be similar to the results for aggregate expectations observed in 5.3.1, with a lower frequency of information updating for periods of increased macroeconomic uncertainty. This chapter further seeks to identify whether the epidemiological hypothesis can be deemed a more appropriate characterisation of the expectations of certain demographic groups in comparison to others.

The rate of information diffusion across disaggregated Michigan Survey inflation forecasts can thus be analysed utilising the various specifications of the epidemiological model. Assuming that greater information attentiveness leads to increased forecast accuracy and lower levels of forecast disagreement, the results presented in Chapter 4 advocate the hypothesis that households with higher levels of education or income, and men, exhibit the highest degree of attentiveness whilst limited difference would be expected to be observed across age and region disaggregations. As noted in 5.1, previous research has observed heterogeneous rates of attentiveness across demographics, with Pfajfar and Santoro's (2008) percentile time-series identifying that more socio-advantaged groups update their information more frequently relative to less advantaged groups.

As highlighted in 5.1, there may be conflicting forces acting upon the rate at which different demographic groups update their information. For example, those households with relatively large forecast errors, including those with low levels of educational attainment or income, have arguably greater incentives to update their information more frequently; however, these households are found by Bruine de Bruin et al. (2010c) and Burke and Manz (2010) to have the lowest levels of financial and economic literacy. These groups are thus likely to incur greater costs in the acquisition and processing of information, which consequently reduces their frequency of information updating to more advantaged households. Similarly, whereas Lombardelli and Saleheen (2003) and Malmendier and Nagel (2009) argue that older respondents rely more heavily on past inflation experiences when reporting their forecasts, and may thus be less attentive to news, Fishe and Idson (1990) indicate that older respondents are likely to possess greater asset levels which can be employed to acquire and process wider sources of information.

5.3.2.1. Disaggregate Michigan Survey Inflation Forecasts and the Survey Updating Hypothesis

To examine whether the rate of information diffusion is dependent upon demographic characteristics, the epidemiological model (5.2.9) shall be further tested on disaggregate Michigan Survey forecasts across the four sample periods. As a preliminary check of the relevance of the epidemiological model, Appendix 5.7 to Appendix 5.11 analyses bi-directional Granger-causality between the SPF and Michigan Survey forecasts. Whereas SPF forecasts were deemed to Granger-cause aggregate Michigan Survey forecasts over the whole, Greenspan-Bernanke and stable periods, the evidence in favour of causality from professionals to disaggregate households is more limited, and again restricted to the three longer sample periods. Namely, Granger-causality is observed for younger households, those with higher levels of education and income, and males; there is also weak evidence of causality across all regions. These results indicate that the epidemiological model may be an inappropriate description of the manner which middle aged and older respondents, those with low levels of education and income, and women form their inflation expectations. One may thus expect the epidemiological model to report low values of attentiveness for these agents.

The results from testing the unrestricted baseline epidemiological model, where $\alpha_0 = 0$, on disaggregate Michigan Survey forecasts are presented in row (1) of Appendix 5.12 through to Appendix 5.31, whilst row (2) imposes the restriction

$\alpha_1 + \alpha_2 = 1$. For the whole, Greenspan-Bernanke and stable periods, Carroll's (2003) assumption that household expectations are formed as a weighted average of the current professional and own one-period lagged forecasts is generally accepted by the data, indicating that the epidemiological hypothesis can be deemed appropriate for the formation of household inflation forecasts. Moreover, for both the whole and Greenspan-Bernanke sample periods, α_1 in row (1) is significant at the five percent level for all groups indicating that where the sample period is sufficiently long, a degree of attentiveness is exhibited by all agents. Nevertheless, several interesting relationships between the degree of attentiveness and agent expectations are observed.

Firstly, in Appendix 5.12 and Appendix 5.13, the value of α_1 generally falls as age rises; however, in accordance with the previous analysis of age disaggregated expectations in 4.2 and 4.3, there is some evidence of a U-shaped relationship. Specifically, for both the whole and Greenspan-Bernanke sample periods α_1 is larger for the elderly, aged 65-97, compared to the next oldest group aged 55-64; moreover, for the Greenspan-Bernanke sample period, the lowest degree of attentiveness is exhibited by the "middle-aged" group, aged 45-54. Similar results are reported for the unrestricted specification presented in row (2) indicating that a larger proportion of younger agents update their information in any given period compared to middle-aged and older respondents.

In accordance with the earlier analysis of disaggregated expectations in 4.2, and the hypothesis stated above, the value of α_1 is generally higher as either education or income increases. Considering the unrestricted version of (5.3.1) over the whole, Greenspan-Bernanke and stable sample periods, there is some evidence that α_1 is larger for the least advantaged households compared with those with modest levels of education or income. Recalling from 4.2 that these agents realise the largest forecast errors, there could be larger incentives for the least advantaged to update their information more frequently relative to those with modest levels of education or income whose marginal cost of inattentiveness is lower.

In a similar manner to education and income disaggregations, row (1) of Appendix 5.20 and Appendix 5.21 present lower values of α_1 for women relative to men for both the whole and Greenspan-Bernanke sample periods. Nevertheless, the results for the restricted specification for the whole sample period suggest that the proportion of agents who updated in any given period is approximately 13 percent for both genders. For the Greenspan-Bernanke period, the proportion of men who exhibit attentiveness is however much larger relative to women, with 22 percent updating For the stable period, consistent with aggregate expectations where significance of α_1 is only observed at the 10 percent level, α_1 is insignificant for both genders; for this extended period of reduced macroeconomic volatility, neither gender frequently updates their information.

Whereas the MFE and MSFE results indicate little difference across regionally disaggregated expectations, there appear substantial differences in the rate of information diffusion. Specifically, the α_1 values associated with the baseline model for the whole and Greenspan-Bernanke sample periods are larger for agents from the North-Eastern and Western regions relative to those from the North-Central and Southern regions. Considering the restricted model for the whole period, in row (2), approximately 11 percent of those from the North-Central and Southern regions update their information in any given period, the proportion rises to over 20 percent for the North-Eastern and Southern regions.

In accordance with aggregate Michigan Survey expectations, the value of α_1 for the baseline model is generally larger for all disaggregations relative to the whole and Greenspan-Bernanke sample periods indicative of a greater rate of information diffusion for periods of reduced macroeconomic volatility. Nevertheless, the results from the restrictive specification indicate that the frequency of updating remains heterogeneous. Some demographics, including the youngest and oldest age groups, those with graduate school education and in the uppermost income quartile having approximately 40 percent of agents updating in each period. In contrast, the proportion of other groups is as low as 20%, including for the middle-aged, women, the first income quartile (Y14) and those from the Southern region. Nevertheless, for both the unrestricted and restricted specifications, α_1 is not invariantly significant across demographic groups; specifically, at a five percent level, α_1 is not significant for those with less than high school or with college degree education, middle income groups, the North-Eastern and Southern regions, and both genders. These demographics may thus employ more backward-looking behaviour in the formation of inflation forecast relative to other groups and to periods of increased macroeconomic volatility.

For the volatile sub-period, consistent with the results for aggregate Michigan Survey expectations, the value of α_1 is much larger, generally around 1.000 or larger, for all demographic groups. Whilst for the baseline specification, α_1 is significant for all disaggregations, the restriction $\alpha_1 + \alpha_2 = 1$ is rejected across groups[134]; moreover, the relevance of the epidemiological hypotheses for the most recent period of macroeconomic volatility is questionable as compared to the three longer sample periods, the Durbin-Watson statistic for all groups is much lower, commonly around 1.500 or lower. Nevertheless, testing the restricted specification across demographics α_1 is almost invariably observed to be small and insignificant[135], indicative of a much lower rate of updating across groups in response to the forward-looking professional forecast relative to the Greenspan-Bernanke and stable sample periods. Additionally, reductions in R^2 statistics across disaggregations relative to those for the stable sample period, and Durbin-Watson statistics roughly ranging between 1.2 and 1.8, again indicate that the survey-updating model is unable to adequately accommodate the formation of household expectations.

Recalling that Mankiw and Reis (2002) and Carroll (2003) estimate that a quarter of agents update their information in any given period, Wald χ^2 tests of $\alpha_1 = 0.25$ are examined for the restricted specification for each demographic group. For the whole sample period, the restriction is rejected for middle-aged and older respondents, lower education and income groups, women, and the North-Central and South regions. Given that the value of α_1 reported for the whole sample period for each of these groups is lower than 0.25, this further supports the premise that more advantaged households and women update their information more frequently than lesser advantaged counterparts, whilst there are asymmetries in the rate of updating across regions. For the Greenspan-Bernanke sample period, the Wald χ^2 null

134 For the volatile sub-period, the restriction $\alpha_1 + \alpha_2 = 1$ is rejected at a 5 percent level except for highest income quartile (Y14), where the restriction is rejected at a 10 percent level of significance.
135 The fourth income quartile is the only group for which significant value of α_1 is observed for the restricted specification of the survey-updating model for the volatile sample period further supporting the notion that information updates during the most recent period of macroeconomic volatility are sufficiently costly to prevent households from obtaining the latest information.

hypothesis of $\alpha_1 = 0.25$ can only be rejected at a five percent level of significance for those households in the first income quartile; similarly, Mankiw and Reis's (2002) and Carroll's (2003) estimate that a quarter of households update their information in any given quarter of the stable sample period cannot be rejected for any demographic group. In addition to the previously acknowledged increased rate of information diffusion across households, for periods of reduced macroeconomic uncertainty, there is also an apparent increased homogeneity in the updating frequency across the various demographic groups.

For the volatile sub-period, the Wald χ^2 test is again unable to reject the null hypothesis that $\alpha_1 = 0.25$ across demographics; however, as previously noted, the value of α_1 estimated by the restricted specification of the survey-updating model is almost invariably insignificant, with relatively large forecast errors. Therefore, it is deduced that agents across most demographic groups fail to update their information in response to the professional forecast during the most recent period of macroeconomic volatility. Nevertheless, the value of α_1 for the fourth income quartile is observed to be significant; moreover, the Wald χ^2 test cannot reject that a quarter of these household update each quarter across the volatile period. This thus indicates that the costs associated with information acquisition and processing are sufficiently large during the volatile sub-period, that only those with the highest levels of income are willing to incur the necessary expenses.

Following Carroll (2003), and the analysis in 5.3.1 for aggregate Michigan Survey expectations, both a constant and inflation[136] are introduced to the baseline survey-updating specification, as represented by (5.2.5), to establish whether there are further differences which households across demographic groups update information. The results for the modified specifications of the survey-updating model are presented in rows (3) to (5) respectively of Appendix 5.12 through to Appendix 5.31.

Across all demographic disaggregations, for the whole, Greenspan-Bernanke and stable sample periods, , the value of α_0 is generally around 1.000 or greater and highly significant; these results correspond with those presented by Carroll (2003)

[136] Only the results for current inflation ($k = 0$) are presented. In accordance with the results for aggregate Michigan Survey forecasts, tests utilising $k = -1$ indicate that α_3 and lagged inflation are insignificant across demographics.

and Luoma and Luoto (2009). As highlighted in reference to aggregate expectations in 5.3.1, the significance of the constant could indicate some level anchoring behaviour on the part of all demographic groups, or may represent updating on other information sources which the professional forecast is unable to accommodate. For the whole, Greenspan-Bernanke and stable periods, the value of α_0 is generally larger for older respondents, the less educated, and lower income quartiles[137]. However, in accordance with the results for aggregate expectations, across demographics the inclusion of the constant results in relatively modest improvements in R^2; this is particularly notable for the stable sample period, and for the young, more educated and women. Recalling that Hobijn and Lagakos (2005), McGranahan and Paulson (2006) and Hobijn et al. (2009) observe higher group-specific rates of inflation for these demographics[138], this could indicate that these households include some additional premium on their expectations to account for price experiences.

In accordance with the results presented by Luoma and Luoto (2009), current inflation in row (4) is generally significant across demographics and sample periods. Nevertheless, for the whole sample period, the value of α_1 associated with the middle-aged and older households, those with lower levels of education or income, women, and the North-East and South regions is insignificant; similar results are also observed for the Greenspan-Bernanke and stable sample periods indicting that these households utilise more naïve updating rules than assumed by Carroll's (2003) survey-updating hypothesis, and other demographic groups. Additionally, whereas Carroll (2003) observes that the inclusion of the constant term, along with lagged inflation, results in insignificance for the latter, α_3 in row (5) remains generally insignificant across demographic groups and sample periods. The significance of the current inflation rate can thus not be dismissed as spurious. Instead, in the presence of both the constant and inflation, there is much greater insignificance associated with the professional forecast with α_1 generally insignificant across demographics for all four sample periods. These results thus question the relevancy of the survey-updating hypothesis for demographically disaggregated inflation expectations and

[137] For gender and regionally disaggregated expectations, there is no discernible relationship between the value of α_0 and household demographics.
[138] Michael (1979) was also noted to observe higher rates of inflation for older respondents attributable to higher health care expenditure which is deemed to experience higher levels of inflation relative to other commodities.

therefore necessitates further investigation regarding the updating behaviour of households, which the Lanne et al. (2009) naïve sticky information hypothesis and Nunes (2009) rational-updating models are obvious candidates.

5.3.2.2. Disaggregate Michigan Survey Inflation Forecasts and the Naïve Sticky Information Hypothesis

Although the results concerning Carroll's (2003) survey-updating model indicate that the rate which households update their information is heterogeneous and dependent upon both demographics and macroeconomic conditions, upon inclusion, the current rate of inflation was observed to be significant across both sample periods and demographic groups. These results thus indicate that a proportion of updating agents do not absorb forward-looking information, and instead update their expectations naïvely in response to news. Moreover, the observation of insignificance of α_1 across demographics may additionally indicate that agents update their information in response to a range of news sources utilising a combination of forward-looking and backward-looking information.

To establish the extent of heterogeneity in information updating behaviour across the various demographic groups, the unrestricted, restricted and nested specifications of Lanne et al.'s (2009) naïve sticky information model, as presented in (5.3.3) and (5.3.4), shall be examined across disaggregated Michigan Survey inflation forecasts for each of the four sample periods. Recalling that tests of both the survey-updating and naïve sticky information models for aggregate expectations indicate that the use of current inflation is better suited to Michigan Survey inflation forecasts relative to lagged inflation, only the results of $k = 0$ shall be presented[139]. The results of these tests are presented in Appendix 5.32 through to Appendix 5.51.

Across all disaggregations the baseline and restricted specifications of the naïve sticky information model, presented in rows (1) and (2) of each panel respectively, indicate that the rate of information updating on current inflation is time-dependent; namely, the value of β_1 is generally largest for the stable sub-period, whilst for the volatile sub-period, β_1 is smaller, further supporting the previous findings that

[139] In accordance with the results for aggregate expectations and those for the survey-updating model, coefficient associated with lagged inflation ($k = 1$) are generally insignificant across demographics and the four sample periods.

information diffuses more rapidly for periods of reduced macroeconomic uncertainty. Moreover, in accordance with the results for models of survey-updating, the value of β_1 is generally larger for those with higher levels of education or income, men, and the North-East and West regions; an approximate U-shaped relationship is again observed between the rate of information updating and age.

For the whole sample period, the unrestricted and restricted specifications presented in rows (1) and (2) of Appendix 5.32 to Appendix 5.51 indicate generally higher rates of updating for households with high levels of education[140] or income, men, and the North-East and West regions; an approximate U-shaped relationship is observed between household age and information attentiveness indicating that young and old respondents update their information more frequently than middle-aged households[141]. The restricted specification estimates that as few as 12 percent of the least advantaged agents update their information in each quarter, ranging up to 35 percent for those with higher levels of income or education. These values are however lower than those presented for the survey-updating model indicating that agents devote greater attention to forward-looking news than the values of current macroeconomic variables when reporting expectations. Nevertheless, consistent with Lanne et al.'s (2009) estimate for aggregate expectations, for all demographic groups except those with college degree or graduate school education, the Wald χ^2 test is unable to reject the null hypothesis that 18 percent of agents update their information in response to current inflation in each period. These results are thus in accordance with those for the survey-updating model, indicating that the proportion of highly educated households updating in each period is higher relative to other demographic groups. This supports the idea that more advantaged households have greater resources available, either cognitive or financial, to employ in the processing and acquisition of information.

Similar relationships are again observed for the Greenspan-Bernanke and stable periods. Nevertheless, for the Greenspan-Bernanke period, a small reduction in β_1 is

[140] In accordance with the results for the survey-updating model, those with less than high school education (ELHS) have a higher rate of updating relative to those with high school degree education. Given that in Chapter 4, the least educated were observed to realise larger forecast errors, they may experience higher opportunity costs of inattentiveness relative to other lower education groups.

[141] The estimates for the restricted specification indicate that for the whole sample period, 21-24 percent of those aged 18-45 update their expectations each period compared to approximately 18 percent of those over 45.

generally observed across demographic groups, thus indicative of a reduced rate of information attentiveness across households upon exclusion of the Volcker era. In contrast, for the stable sample period, β_1 is generally larger with the restricted specification indicating that approximately 20 percent or more agents across most demographic groups update in each quarter. At a five percent level of significance, the Wald χ^2 test can only reject the null hypothesis of $\beta_1 = 0.18$ for those with graduate school education for the Greenspan-Bernanke sample period, but cannot reject the null hypothesis for any demographic for the stable sample period. This is thus indicative of a strong degree of homogeneity in the rate of updating across households, particularly for periods of greater macroeconomic stability. Nevertheless, for the volatile sub-period, the β_1 coefficients across demographics are generally smaller; moreover considering the restricted specification in row (2) of each panel, the proportion of agents updating across demographics is generally found to be insignificant. These results thus conform with the results for aggregate expectations presented in Appendix 5.3 indicating that the rate of attentiveness to current macroeconomic conditions falls during the recent period of macroeconomic uncertainty. Nevertheless, the two groups with the highest levels of education continue to report significant levels of information updating indicating that the degree of attentiveness exhibited by these agents is insensitive to macroeconomic conditions.

Similar relationships across demographics and sample periods are again observed for the nested specification presented in row (3) of each panel. Additionally, there is a higher propensity for households with higher levels of education or income to update in response to the forward-looking professional forecast whilst less advantaged households are more likely to absorb the current inflation rate into their information set when updating. Moreover, compared to the whole sample period, β_2 is generally smaller for the Greenspan-Bernanke and stable sample periods, indicating that households are more likely to absorb the forward-looking professional forecast, in preference to the current rate of inflation, during periods of reduced macroeconomic uncertainty.

For the whole sample period, the nested specification indicates that younger households, those with higher educational attainment or income, men and those from the North-East and Western regions report a higher rate of updating to any information than other disaggregations. Differences are particularly notable across education disaggregations. Namely, whereas only 15-20 percent of those households with some college education or less update in each period, the updating proportion of those with college degree or graduate level education is estimated by the nested specification at 51 and 62 percent respectively. Similarly, whereas only 14 percent of the first income quartile are attentive each period, 46 percent of those in the fourth income quartile update each period. To examine whether the differences between demographic groups, and with respect to the estimate reported by Lanne et al. (2009) are significant, the Wald χ^2 test examines whether $\beta_1 = 0.25$.

At a five percent level of significance, the null hypothesis that a quarter of households update each quarter, as proposed by Mankiw and Reis (2002), Carroll (2003) and Lanne et al. (2009), cannot be rejected by the Wald χ^2 test for all age groups, those with less than high school, or some college, education, both genders, the top three income quartiles, and the West region; this is also consistent with the results presented by Lanne et al. (2009). There is thus some degree of homogeneity in the rate of updating amongst demographic groups. Nevertheless, the Wald χ^2 test indicates that under 25 percent of high school degree educated, the first income quartile, and the North-Central and South regions update each quarter; in contrast, the proportion of the college degree or graduate school educated, and those from the North-East and South regions that update each period is found by the Wald χ^2 test to be over 25 percent. In accordance with tests of the survey-updating model, the frequency which agents update information is not homogeneous across demographic groups, thus further questioning the constant rate of updating proposal embodied within Mankiw and Reis's (2002) sticky information hypothesis.

Additionally, the coefficient attached to the professional forecast is insignificant for low education and low income groups, whereas both β_2 and $1 - \beta_2$ are significant for more advantaged demographics. Therefore, not only do more advantaged groups update more frequently than the less advantaged, upon updating, they exhibit a greater probability of absorbing the forward-looking forecast. Similarly, whereas the young, and the North-East and West regions update in response to both information sources, the coefficient attached associated with forward-looking updating is insignificant for the two oldest age groups, and the North-Central and South regions.

For the Greenspan-Bernanke sub-period, the rate of updating is again increasing in education and income, whilst men, and the North-East and West regions, exhibit more frequent information updating than women and the North-Central and South regions. Nevertheless, for age disaggregations the U-shaped relationship is once more evident for the Greenspan-Bernanke sample period. Similar relationships are also observed for the stable sample period across age, education and income disaggregations; however, the value of β_1 is roughly equal for men and women, whilst the South region has a lower frequency of information updating relative to the three other regions. Moreover, consistent with Lanne et al.'s (2009) estimate, the Wald χ^2 null hypothesis of 25 percent of each group updating each quarter again cannot be rejected for most demographics. However, for the Greenspan-Bernanke sample period those with high school degree or some college education, women, the first income quartile and the south region update less frequently, whilst those with college degree or graduate school education, update more frequently. Consistent with a greater degree of homogeneity in the rate of updating, the Wald χ^2 test that $\beta_1 = 0.25$, in accordance with Lanne et al.'s estimate, cannot generally be rejected across demographics. Nevertheless, the updating proportion of both college degree and graduate school educated households is again significantly greater than a quarter, with the nested specification estimating that over 60 percent of those with higher levels of education update to either the naïve or forward-looking predictor in any given period.

In accordance with the baseline naïve sticky information specifications, the rate of information diffusion from the nested specification for the volatile sub-period is again lower across demographic groups[142]; additionally there appears greater heterogeneity in the degree of information updating relative to periods of reduced macroeconomic uncertainty. Whereas over the three larger sample periods, a significant proportion of each demographic group update their information each quarter, for the volatile sub-period, at a five percent level β_1 is statistically insignificant for those aged 65-97, the three lowest education groups, women , the first income quartiles and the North-Central and North-East regions. Moreover, the coefficients attached to the distinct information sources are only significant for the

[142] The results for the nested naïve sticky information specification for the volatile sub-period for age, education, gender, income and regional disaggregations are presented in row (3) of each panel in Appendix 5.35, Appendix 5.39, Appendix 5.43, Appendix 5.47 and Appendix 5.51 respectively.

two highest education groups, the fourth income quartile and men, with greater weight attached to the professional forecast. Therefore, not only do more advantaged groups, and men, maintain higher rates of updating during periods of increase volatility, they also continue to utilise forward-looking updating behaviour; furthermore, for those with graduate school education, the Wald test continues to indicate that the proportion updating each quarter is in excess of 25 percent. This contrasts to the less advantaged, and women, who resort to backward-looking expectation formation.

5.3.2.3. Disaggregate Michigan Survey Inflation Forecasts and the Rational Updating Hypothesis

Whilst Lanne et al.'s (2009) naïve sticky information hypothesis advocates that agents are more backward-looking in their updating behaviour relative to Carroll's (2003) survey updating model, Nunes (2009) proposes that agents are more forward-looking when updating their information, absorbing the rational forecast. In accordance with the analysis for aggregate expectations in 5.3.1, (5.2.12) shall be examined across disaggregate Michigan Survey expectations over the four sample periods; again, as the rational forecast is proxied by the actual four-period ahead realisation of inflation, GMM estimation is required to account for endogeniety[143]. The results for the baseline and restricted specifications of the rational-updating model are presented in rows (1) and (2) of each panel in Appendix 5.52 to Appendix 5.71. Across all disaggregations, the baseline and restricted specifications of (5.2.12) clearly indicate that the rate of rational updating is time-variant with the value of γ_1 particularly large for the stable sub-period; this correspond with the results from Chapter 3 that household expectations are more consistent with the predictions of RE during periods of reduced macroeconomic uncertainty. In contrast, despite the assumption of greater opportunity cost associated with inattentiveness, for the volatile sub-period, the value of γ_1 is generally insignificant across demographic groups supporting the argument that due to increased costs associated with the acquisition and processing of information, agents exhibit greater inattentive behaviour during periods of increased macroeconomic uncertainty.

[143] The instrument set is identical to that employed for aggregate expectations, and is based on those utilised by Galí and Gertler (1999), Galí, Gertler and López-Salido (2001) and Nunes (2009).

In accordance with the analysis of the survey updating and naïve sticky information models, significant differences are observed in the rate of updating across demographic groups, with higher rates of updating observed for men, those with higher levels of education and income, and the North-East and West regions. However, in contrast to alternative models of information diffusion which predict approximate U-shaped relationships between attentiveness and age, younger households generally appear to update more frequently in response to the rational forecast relative to older counterparts. Specifically, for the whole sample period, the restricted specification estimates that over 30 percent of those aged 18-34 update each period, whilst approximately 17 percent of those aged 55 or over incorporate the most recent 'rational' information into expectations. Furthermore, whilst the Wald χ^2 test cannot reject that the proportion of updating agents for those aged 34 or older is equal to Nunes's (2009) estimate of 18 percent, the null hypothesis rejected at a high level of significance for the youngest age group indicating a significantly higher rate of updating amongst these agents. Nevertheless, a reasonable degree of homogeneity is evident in the rate of updating for the whole sample period across groups as the Wald χ^2 null hypothesis cannot be rejected for any education level, either gender, any region and the second and third income quartiles. However, the Wald χ^2 null hypothesis of $\gamma_1 = 0.18$ is rejected for both the first and fourth income quartiles; for the former, a lower rate of attentiveness is observed with approximately 9 percent updating each quarter, whilst for the latter, the rate of attentiveness is much higher with in excess of 30 percent updating in response to the rational forecast. This adds to the evidence that higher income groups are more willing to incur the costs associated with information acquisition and processing.

For the Greenspan-Bernanke sub-period, tests of the baseline and restricted specifications of (5.2.12) yield lower estimates of γ_1 across all demographic groups relative to the whole sample period. This appears to indicate that following the Volker era when inflation was particularly high, the rational updating behaviour of all agents falls, consistent with agents utilising more backward-looking behaviour during periods of reduced macroeconomic uncertainty. Nevertheless, similar relationships regarding the frequency of rational updating and demographics are observed with larger values of γ_1 presented for the young, those with higher levels of education and income, and the North-East and West regions.

As highlighted above, for the stable period, much larger values of γ_1 are observed across all demographic groups relative to the whole and Greenspan-Bernanke sample periods indicating that agent attentiveness is more forward-looking during periods of reduced macroeconomic uncertainty. Nevertheless, lower values of γ_1, compared to other groups, are observed for the least educated, the first income quartile and women. Furthermore, whilst the Wald χ^2 null hypothesis for the restricted specification of $\gamma_1 = 0.18$, in accordance with Nunes's (2009) estimate cannot be rejected for these groups, the percentage of agents updating from all other groups is found to be significantly greater. Therefore, during periods of greater stability there is again some evidence of heterogeneity in updating behaviour with the least advantaged, and women, more inattentive to the rational forecast.

In contrast, the results for the baseline specification for the volatile period, indicates strong degree of homogeneity in the rate of updating relative to rational information; specifically, the value of γ_1 is generally insignificant from zero, with only the North-East region exhibiting a significant, albeit low value of γ_1. Nevertheless, the Wald χ^2 null hypothesis $\gamma_1 = 0.18$ is invariably rejected indicating that the proportion of agents rationally updating, across all demographic groups is much lower for the recent volatile period than predicted by Nunes (2009).

Results from testing the nested rational updating model for each disaggregation, where agents update towards either the professional forecast or RE are presented in row (3) of each panel of Appendix 5.52 to Appendix 5.71. As previously observed, across disaggregations the proportion of agents receiving information updates is time-variant; a lower rate of updating is observed for the Greenspan-Bernanke sample period in comparison to the whole sample period, whilst for the stable and volatile sub-periods, a much larger rate of updating is observed across demographics for the former relative to the latter. Moreover, for the whole and stable periods households across demographic groups appear more likely to update towards RE than towards the professional forecast with γ_2 commonly observed in excess of 0.700; these results are in the same direction as those presented by Nunes (2009) whose results for aggregate expectations find a larger weight upon RE than the SPF forecast. In contrast, for the Greenspan-Bernanke sample period, the coefficient associated with either information source is generally insignificant, resulting from the smaller proportion of agents updating in each period. Nevertheless, for the volatile sub-period, despite observing relatively small values of γ_1, the coefficient on the professional forecast is generally large and significant, indicating that for the recent period of macroeconomic uncertainty, where households are attentive, they are less likely to update their information rationally, instead relying on the professional forecast as published by the media. These results support the argument from Chapter 3 that household expectations exhibit larger deviations from rationality during periods of increased macroeconomic uncertainty.

Additionally, in accordance with the results in rows (1) and (2) and those presented for the survey-updating and naïve sticky information models, the rate of updating across demographic groups is heterogeneous. Specifically, for the whole, Greenspan-Bernanke and stable sample periods, higher rates of updating are again observed for those households with higher levels of education or income. Indeed, for the whole sample period, Wald χ^2 tests of the null hypothesis $\gamma_1 = 0.25$ indicate that less than a quarter of lower education and income groups update each quarter whilst more advantaged households update more frequently[144].

For the volatile sub-period, the proportion of households updating to any information source is much lower relative to the stable sample period; however, γ_1 is only insignificant for women and the high school educated. Moreover, the rate of updating again appears dependent upon household demographics with higher proportion of agents updating observed for younger households, men, those with higher levels of education or income, and the West region. Nevertheless, examination of the Wald χ^2 test null hypothesis that a quarter of agents update each quarter reveal the extent of differences across demographic groups. At a five percent level of significance the null hypothesis cannot be rejected for any age group except those aged 65-97, the second and third income quartiles and the North-East and West regions. In contrast, the Wald null hypothesis is rejected for all other demographic groups; however, whilst women, the oldest age group, those with some college education or less, the first income quartile and the North-Central and South regions update less frequently, men and higher education or income groups update more frequently. Whilst there is some homogeneity in the rate of updating amongst age

[144] For the whole sample period, the Wald χ^2 null hypothesis $\gamma_1 = 0.25$ cannot be rejected for those households with some college education, and those in the second and third income quartiles.

groups, these results support the argument that 'more advantaged' households update more frequently, whilst greater heterogeneity in the rate of updating is observed across all other disaggregations for the recent period of macroeconomic volatility.

In accordance with the results from the nested specification, there is further heterogeneity across demographics in the information absorbed by agents upon updating. For the whole sample period, a significant proportion of agents update to RE, whilst the coefficient associated with the SPF is insignificant; these results support those presented by Nunes (2009). Nevertheless, groups where a high proportion of agents update each period, namely those aged 18-34, with graduate school education, or from the North-East or West regions exhibit significant values of updating towards both RE and the professional forecast; in contrast, groups with lower rates of updating, including the two older age groups, women and the first income quartile, do not significantly update to either information source. These results may indicate that as agents update with increasing frequency, they are more likely to encounter and absorb different sources of information whilst those with lower levels of attentiveness update to more backward-looking information which the rational updating model fails to accommodate.

For the Greenspan-Bernanke sample period, the lower rates of updating, as previously observed, generally result in insignificance for the coefficients attached to both rational updating and survey updating. Greater heterogeneity is observed for the stable with higher rates of updating observed for the young and the old, and the more educated; nevertheless, across all disaggregations, agents appear to update more towards RE than towards the SPF. In contrast, for the volatile sub-period, the coefficient associated with rational updating is generally insignificant, with agents attaching much greater weight to updating towards the professional forecast indicative of a reduction in forward-looking behaviour; moreover, the results support the observations in Chapter 3 that agents report inflation forecasts less consistent with the predictions of the REH for the recent period of macroeconomic uncertainty.

The results presented in this section evidently indicate that the manner which agents update their information is not homogeneous as suggested by the sticky information hypothesis presented by Mankiw and Reis (2002). Instead, the frequency of information updates is both time-variant and group-specific. In accordance with the results for aggregate expectations presented in 5.3.1, the frequency of information updating increases across demographics for periods of reduced macroeconomic uncertainty, yet are substantially lower for periods of greater volatility. Additionally, the results presented in this section indicate that those demographic groups who were found in 4.2 and 4.3 to realise lower forecast errors, and report lower levels of forecast disagreement, update their information more frequently.

For the whole and Greenspan-Bernanke sub-periods, a negative relationship is evident between the proportion of agents updating each period and the age of respondents; however, in accordance with the results for the naïve sticky information model and the baseline specification of the rational-updating model, an approximate U-shaped relationship is observed for the stable sub-period. Nevertheless, for the whole sample period, the invariant non-rejection of the Wald χ^2 test null hypothesis $\gamma_1 = 0.25$ at a five percent level of significance supports the notion that for a reasonable degree of homogeneity exists in the rate of information updating amongst age groups. In contrast, for the Greenspan-Bernanke and stable period, significant differences in the rate of updating are observed. Specifically, for the Greenspan-Bernanke period Wald χ^2 tests indicate that older households update less frequently than younger counterparts whilst for the stable sub-period, those aged 45-54 have a lower rate of updating relative to all other age groups.

5.3.2.4. Disaggregate Michigan Survey Inflation Forecasts and the Heterogeneous Updating Hypothesis

From the analysis in this section, it is evident that the information updating behaviour amongst households is not homogeneous; instead attentiveness to various information sources appears time-variant and dependent upon demographics. To analyse the relative frequency which each demographic group updates to the three distinct sources of information, the multiple updating model, as presented by (5.3.5) and (5.3.6) in section 5.3.1 shall be analysed with the results presented in Appendix 5.72 to Appendix 5.91; row (1) presents the baseline specification (5.3.5) with row (2) imposing the restriction $\phi_4 = 1 - \phi_1 + \phi_2 - \phi_3$, whilst row (3) presents the results for the nested specification (5.3.6).

Again, the results for the baseline and restricted specifications of (5.3.5) are presented in rows (1) and (2) of each panel respectively, clearly indicate that the updating behaviour of agents is time-dependent and varies across demographic groups. In accordance with the results for the rational-updating across demographics, the value of ϕ_4 is generally smaller for the stable sub-period relative to either the whole or Greenspan-Bernanke sample periods; these results support the previous observations that agents update information more frequently during periods of reduced macroeconomic volatility.

For the whole sample period, the baseline and restricted specifications indicate that younger households, those with higher levels of education and income, men and those households resident in the North-East or West regions update more frequently relative to other groups. Whilst all demographics predominantly update in accordance with the rational updating hypotheses, amongst the aforementioned groups, differences in updating behaviour are observed. Specifically, updating to a combination of the professional forecast and the rational updating predictor is exhibited by those households aged 18-34 or with graduate school education, whilst male and the third income group update in response to a combination of the naïve sticky information and rational updating predictors. In contrast, those aged 35-44 or with college degree education update to solely the naïve sticky information predictor yet the fourth income quartile update in accordance with all three of the survey updating, naïve sticky information and rational updating hypotheses. These results appear to indicate that the youngest and most advantaged agents are most likely to update towards the professional forecast; moreover, the attentiveness of the highest education and income groups further supports the argument that only these agents possess the necessary financial or cognitive resources to acquire and process the information in the professional forecast.

In contrast, for the Greenspan-Bernanke sub-period, the baseline and restricted specifications indicate that across the various disaggregations, the rate of updating to the distinct information sources is generally insignificant. Nevertheless, groups with high levels of education exhibit significant rates of attentiveness to some combination of the forward-looking professional forecast, and the naïve sticky information predictor. In addition, consistent with the rate of updating presented by Carroll (2003) for those households with some college education or greater, it is not possible to reject the Wald χ^2 null hypothesis that 25 percent of agents absorb the professional forecast each period. Similarly, whilst the coefficient attached to the naïve sticky information predictor for these groups is smaller, it is again not possible to reject the Wald χ^2 null hypothesis that 25 percent of those with graduate school education absorb the information content of current inflation each period.

As highlighted above, the results for the stable sample period indicate that households across disaggregations update more frequently relative to the whole and Greenspan-Bernanke sample periods. Moreover, across disaggregations and demographic groups, households appear to generally update more frequently in accordance with the rational-updating hypothesis rather than the survey-updating or naïve sticky information hypotheses suggesting that, in general, households are more forward looking during periods of reduced macroeconomic uncertainty. Moreover, for the baseline specification of the heterogeneous updating model, the Wald χ^2 null hypothesis $\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$ cannot generally be rejected across disaggregations[145], Nevertheless, there is also evidence showing that younger age groups, those with higher levels of education or income, and the North-East region exhibit greater attention to the professional forecast or naïve sticky information predictor for the stable period relative to other demographic groups. These groups have previously been observed in 5.3.2.1 and 5.3.2.2 to be amongst those with higher rates of updating for the individual updating hypotheses suggesting that as agents update more frequently, there is an increased probability that they will encounter and absorb the content of various sources of information.

Examinations of the Wald statistics for the unrestricted specification over the stable sample period further demonstrate differences in the rate which agents update information. Despite the value of ϕ_1 for the stable period being generally insignificant, Wald tests of $\phi_1 = 0.25$ cannot be rejected for various demographic groups including all five age groups, both genders and those with some college, college degree and graduate school education. Therefore, for the period associated with reduced macroeconomic volatility, some support is gain observed for Carroll's (2003) prediction that a quarter of agents update towards the professional forecast

[145] The null hypothesis is however rejected for the high school degree educated, the first income quartile and women, suggesting that fir less advantaged households, expectations are formed inconsistently with the predictions of the heterogeneous updating model.

each quarter. Nevertheless, due to the general insignificance and relatively large standard errors associated with ϕ_1, broad conclusions regarding survey updating within the heterogeneous updating model must be avoided.

Moreover, at a five percent level of significance it is not possible to reject the null hypothesis that a quarter of graduate school educated respondents, or those resident in the North-East region update in response to the naïve sticky information predictor each quarter[146]. There is thus no evidence that less advantaged households are more attentive to naïve information relative to more advantaged counterparts or to updating in response to the forward-looking predictors.

In accordance with the results presented for the survey-updating hypothesis, tests of the baseline heterogeneous updating model for the volatile sub-period reveal large significant values of ϕ_1, often in excess of 1.000, whilst the coefficients associated with the naïve sticky information and rational updating hypotheses are generally insignificant. These results suggest that for the recent period associated with greater macroeconomic uncertainty, agents across demographic groups exhibit a high degree of attentiveness to the forward-looking professional forecast; however, as previously observed for the survey updating model, these results are not robust to the imposition of the weighted average restriction. Instead, the results indicate that a large proportion, commonly in excess of 80 percent, is inattentive to any information, forming expectations consistent with outdated plans. Nevertheless, lower levels of inattentiveness are again observed for men, the two highest education categories, and the fourth income quartile with ϕ_1 significant for the top education and income groups[147]. Moreover, for all these groups, it is not possible to reject that $\phi_1 = 0.25$, corresponding with Carroll's (2003) prediction that a quarter of agents update each period. Additionally, in accordance with Lanne et al.'s (2009) prediction for the naïve sticky information model, the Wald χ^2 null hypothesis $\phi_2 = 0.25$ cannot be rejected for the top education or income groups further supporting the argument that highly advantaged agents remain highly attentive to multiple sources of information regardless of macroeconomic conditions.

[146] At a 10 percent level of significance, the Wald χ^2 null hypothesis $\phi_2 = 0.25$ can also not be rejected for those respondents aged 35-44 or those resident in the West region.
[147] In accordance with the results for other the majority of other demographics groups, the values of ϕ_2 and ϕ_3 are insignificant.

As for aggregate expectations, and in a similar manner to the analysis of the naïve sticky information and rational updating models in 5.3.2.2 and 5.3.2.3, the nested specification of the heterogeneous updating model (5.3.6) shall be examined for disaggregate Michigan Survey inflation forecasts to determine the proportion of agents from each demographic updating to the distinct sources of information. The results from tests of (5.3.6) are presented in row (3) of Appendix 5.72 to Appendix 5.91. Firstly, considering the values of λ, representing the proportion of agents updating to any information in any given quarter, it is again evident that the rate of information diffusion is dependent upon both the sample period and household demographics. Consistent with the previous analysis for the individual updating hypotheses, and those for aggregate expectations presented in Appendix 5.6, the value of λ is generally large for the stable sample period, whilst a smaller proportion update each quarter during the recent volatile sub-period.

For the whole sample period the value of λ ranges widely across demographics; specifically, significant values of approximately 0.400 or above are observed for those households aged 18-34, with college degree or graduate school education, and the fourth income quartile, whilst the rate of updating for those aged 65-97, women and the North-Central and North-East regions is insignificant. Moreover, the demographic trends in updating previously observed across the various models is again evident with the updating proportion of agents larger for men, younger age groups, and those with higher levels of education or income. Despite these observations, for the whole sample period, the Wald χ^2 tests suggests that the rate of updating is relatively homogeneous across demographic groups with the null hypothesis $\lambda = 0.25$ only rejected for those with graduate school education and the first income quartile, with the former updating more frequently and the latter exhibiting greater attention. These results thus support the predictions of Mankiw and Reis (2002) of Carroll (2003) and Lanne et al. (2009) that a quarter of agents update each period, whilst additionally suggesting some role for demographic characteristics for the rate of information diffusion amongst households in a similar manner to Pfajfar and Santoro (2008).

In accordance with the results for the baseline specifications and the rational updating model presented in 5.3.2.3, the value of λ associated with the Greenspan-

Bernanke sample period is generally much smaller relative to the whole sample period, suggesting that the rate of updating amongst households falls upon exclusion of the Volcker era. Nevertheless, the general trends observed for the whole sample period are again found for the Greenspan-Bernanke sample period with higher rates of updating for men, younger households, and those with higher levels of education and income; indeed, whilst the Wald χ^2 test null hypothesis $\lambda = 0.25$ cannot generally be rejected for these groups[148], a lower rate of updating is apparent for other demographics.

As highlighted above, the rate of updating estimated by the nested heterogeneous updating model for the stable sub-period is generally a lot higher relative to the whole and Greenspan-Bernanke sample periods and significant across demographics. Comparing demographic groups, higher rates of updating are again observed for men, higher education and income groups, and the North-East and West regions, whilst an approximate U-shaped relationship is observed across age groups. Nevertheless, examination of the Wald χ^2 statistics cannot reject the null hypothesis $\lambda = 0.25$ for various groups including those with lower levels of education and income, and those in the 35-44 and 45-54 age groups; these results support those of Mankiw and Reis (2002), Carroll (2003) and Lanne et al. (2009) that a quarter of agents update each period. The Wald null hypothesis $\lambda = 0.25$ is however rejected for various other groups including older age groups, those with college degree education, higher income groups and the North-East region; the larger value of λ observed for these groups, indicates that these households update more frequently than once a year. Whilst the $(1 - \phi_1 - \phi_2)$ coefficient on rational updating is generally significant across demographics, with particularly large values observed for older age groups, the more educated and higher income groups, only those with high rates of updating, including those with college degree education or the third and fourth income quartiles significantly update towards a combination of information sources.

Although the Wald null hypothesis of $\lambda = 0.25$ is rejected for both men and women for the stable sub-period, significant differences are observed in the rate of updating

[148] The Wald χ^2 null hypothesis $\lambda = 0.25$ is rejected for both men and those with graduate school education with the former updating information less frequently, whilst over a quarter of the latter group update each period.

between the two genders. Specifically, the rejection of the Wald null hypothesis, along with the values of λ presented in Appendix 5.82 indicate that whereas significantly more than 25 percent of men update each period, women are more inattentive with less than a quarter updating their information each period. Moreover, upon updating whereas women significantly absorb the forward-looking professional forecast, men update towards the rational forecast.

For the volatile sample period, the nested heterogeneous updating model again reveals distinct differences in the rate of updating between demographic groups. The Whereas the value of λ for those groups with low levels of updating for the three alternative sample periods is generally insignificant, higher rates of updating to any information source are again observed for men and more advantaged households. Specifically, whereas around 50 percent or above of men, those with graduate school education or in the fourth income quartile update each period, over 90 percent of women, those aged 65-97, or the first and second income quartiles are inattentive. Furthermore, Wald coefficient tests generally reject the null hypothesis that a quarter of respondents from these demographic groups update in response to any information source for any given quarter of the volatile sub-period, further supporting the argument that agents exhibit greater inattentive behaviour during periods of increased macroeconomic uncertainty. Upon updating, the coefficients on the three updating hypotheses are generally insignificant; nevertheless, ϕ_1 is significant for both those with graduate school education or in the fourth income quartile, indicating that even during periods of greater volatility, the most advantaged agents remain able to devote the necessary resources to absorbing forward-looking information.

The results for the heterogeneous updating model further emphasises the results presented for the individual hypotheses in 5.3.2.1, 5.3.2.2, and 5.3.2.3 that the information updating behaviour amongst agents is dependent upon both agent demographics and macroeconomic conditions for the analysed sample period. To summarise the findings from this sub-section, higher rates of updating are again observed for the stable sample period where macroeconomic volatility is generally reduced further supporting the argument that agents update more frequently where the costs of information processing and acquisition are lower. Additionally, higher rates of updating are observed for men and more advantaged agents; these household are likely to be able to employ greater resources, both financial and cognitive in information updating activities whilst these groups are additionally identified by Bruine de Bruin et al. (2010c) and Burke and Manz (2010) to generally possess greater economic and financial literacy and interest further enhancing their attentiveness. Furthermore, upon updating, those agents who exhibit greater levels of attentiveness are more likely to absorb a combination of information content; however, rather than updating towards the naïve sticky information predictor, those groups who update more infrequently continue to update towards the forward-looking rational forecast.

5.3.2.5. *Evaluation of Epidemiological Models for Disaggregate Expectations*

As for aggregate household expectations, several epidemiological style models akin to Carroll (2003) have been examined in this sub-section, with households updating their information to survey forecasts, naïve information and rational expectations respectively. The results presented in this section suggest that information updating behaviour across, and within, demographic groups is not homogeneous; instead agents update their information in response to a variety, or combination, of information sources. Across the various models, higher rates of updating are observed for men and those with higher levels of education and income; In contrast, a U-shaped relationship is generally observed for age disaggregated expectations, whilst only limited differences in the rate of updating were observed across regions. There is however no substantial evidence that less advantaged agents substitute attentiveness to forward-looking information to updating towards naïve predictors.

The analysis in this section clearly indicates that agents do not solely update to a single information source, and instead absorb some combination of both current information regarding current macroeconomic events, and forward-looking information as embodied in professional forecasts and rational expectations. To accommodate agents simultaneously updating to various information sources, the heterogeneous updating model is empirically examined across disaggregations. The rate of updating to the various sources for older respondents, women, and less advantaged groups is generally insignificant. This supports the hypothesis as presented by Malmendier and Nagel (2009) and Madeira and Zafar (2012) that these groups are more likely to form their expectations relying upon previous inflation experiences. Additionally, the lower attentiveness exhibited by these groups is indicative of incurring higher information acquisition and processing costs, which Bruine de Bruin et al. (2010c) and Burke and Manz (2010) attribute to lower levels of financial economic and financial literacy, and a generally reduced level of interest regarding these issues.

The asymmetric information updating behaviour across demographic groups identified in this section is likely to be a key contributor to the extent of expectation heterogeneity and differences in forecast errors observed in Chapter 4. Furthermore, the results for disaggregate Michigan Survey inflation expectations further emphasises the existence of an inverse relationship between the rate of updating and forecast accuracy across both sample periods and household demographics. Consequently, the optimal communication strategy employed by policymakers may thus be multi-tiered as previously emphasised by Sims (2009) and Menz and Poppitz (2013).

5.4. Discussion of Epidemiological Updating Hypotheses

The sticky information and epidemiology models of Mankiw and Reis (2002) and Carroll (2003) respectively have provided various interesting insights regarding agent behaviour and expectation behaviour; however, several studies have questioned the relevance of the models predictions. Comparing epidemiological models to those of rational-updating, Nunes (2009) favours the latter arguing that within a nested specification, Michigan Survey expectations fail to respond to professional forecasts; in contrast, Coibion (2010) argues that models inspired by the Calvo (1983) notion of sticky prices better accommodate the actual response of expectations and inflation to monetary and non-monetary shocks.

Re-examining Carroll's (2003) epidemiological model, the results presented in this chapter indicate that for extended sample periods, the rate of information diffusion is generally over-estimated by previous studies. This conforms with the results from Table 5.3.1 which presented weaker evidence of Granger causality between the inflation forecasts of the SPF and Michigan Survey than previously observed by Carroll (2003). Nevertheless, extensions to the survey-updating model, namely the naïve sticky information and rational-updating hypotheses, indicate that Carroll's (2003, 2006) epidemiological approach fails to fully accommodate the updating behaviour of households. Whilst Lanne et al. (2009) and Nunes (2009) incorporate backward-looking behaviour and rational expectations into epidemiological expectations models, this chapter has additionally introduced a nested specification featuring aspects of all three updating hypotheses.

Tests of the three individual epidemiological hypotheses on aggregate Michigan Survey inflation expectations reveal that households are only infrequently attentive to information embodied in either professional expectations, realised inflation values, or the rational forecast. For the whole sample period, the rate of updating estimated by the survey updating and naïve sticky information models is lower compared to the predictions of Carroll (2003) and Lanne et al. (2009) respectively; in contrast, the estimates for the rational updating model are more consistent with those presented by Nunes (2009). Nevertheless, for the stable sub-period, associated with reduced levels of macroeconomic volatility, across the three models, households appear more attentive with a larger proportion of agents updating each period.

For the volatile sub-sample period, the survey-updating, naïve sticky information, and rational updating models all indicate that the frequency of information updating exhibited by households falls relative to the whole sample period and the stable sub-period. These results thus cast doubt upon the proposed hypothesis that households update more frequently in response to the realisation of larger forecast errors or where macroeconomic conditions are less favourable; this thus questions the suggestion proposed by Mankiw and Reis (2002) and Pfajfar and Santoro (2010) that the attentiveness of household expectations increases when inflation matters. Instead, a greater rate of information updating is observed for periods of increased macroeconomic stability, consistent with the notion that agent attentiveness increases where the information acquisition and processing costs are lower.

The epidemiological hypotheses were also examined for demographically disaggregated Michigan Survey inflation forecasts. Whilst the direction of the results for disaggregated expectations across the four sample periods are generally consistent with those for aggregate expectations, across the various specifications, heterogeneity in the updating frequency of households was observed; specifically, those with higher levels of education and income, and men, exhibiting higher levels of attentiveness across the various sample periods relative to their less advantaged, or female, counterparts. Those with higher levels of education or income are likely to be able to devote greater resources, either cognitive or financial, in acquiring and processing information, whereas the opportunity cost of information updating for less advantaged households are likely to be higher despite their larger forecast errors as reported in 4.2. Moreover, men, and those with higher levels of education and income, are reported by Bruine de Bruin et al. (2010c) and Burke and Manz (2010) are likely to have increased levels of interest and literacy in finance and economics, and thus exhibit greater attentiveness to news regarding aggregate inflation. Contrastingly, less frequent updating, and larger forecast errors, exhibited by those with lower levels of education and income may be representative of agents forming expectations in relation to specific prices as proposed by Bates and Gabor (1986), Ranyard et al. (2008), Bruine de Bruin et al. (2011b) and Georganas et al. (2014) or inflation experiences in the manner identified by Lombardelli and Saleheen (2003) and Malmendier and Nagel (2009).

In contrast, the manner which agents update appears to be less dependent upon households age or region of residence. These results appear to indicate that inflation inequality across age groups, as reported by Michael (1979) and McGranahan and Paulson (2006) does not impact upon household attentiveness to news; similarly, regional inflation differentials have little effect on the updating frequency across regions. Nevertheless, some evidence of higher rates of updating was observed for younger households, whilst both negative and U-shaped relationships were reported between age and information attentiveness. Similarly, the North-East and West regions were found in several instances to exhibit a higher degree of attentiveness relative to the North-Central and South regions; however a greater degree of homogeneity in the rate of updating was reported for regionally disaggregated expectations compared to other disaggregation of the Michigan Survey dataset.

The results presented in 5.3.1 and 5.3.2 thus question the relevance of Mankiw and Reis's (2002) sticky information hypothesis which implicitly proposes that agents face a constant probability of receiving information updates. Nevertheless, deviations from RE and the presence of information rigidities, across both aggregate expectations and those reported by individual demographic groups, with greater information frictions observed during periods of increased macroeconomic uncertainty. Instead, expectations may be more consistent with the predictions of noisy information; recalling the summary of information rigidity models presented by Coibion and Gorodnichenko (2012), various theories of noisy information predict that forecast errors may differ in response to shocks, consistent with varying rates of information friction across sample periods and demographics.

The heterogeneous updating model examined in 5.3.1.4 and 5.3.2.4 proposes combining the survey updating, naïve sticky information and rational updating hypotheses to accommodate agents updating in response to a multitude of information. The results for the nested specification further emphasise differences in updating behaviour, including the degree of attentiveness, across sample periods and households. Whilst for aggregate expectations across the whole sample period it is not possible to reject the estimate presented by Mankiw and Reis (2002), Carroll (2003) and Lanne et al. (2009) that a quarter of agents update each period, the proposition is rejected for various demographic groups across the four sample periods. Moreover, households appear to predominantly update in accordance with Nunes's (2009) rational updating hypothesis, particularly for the stable sub-period, however, those households who update most frequently, are deemed to have a greater probability of encountering and absorbing multiple sources of information. It can thus be concluded that agents face asymmetric probabilities of receiving information updates; this finding further questions the relevance of Mankiw and Reis's (2002) sticky information hypothesis.

The results presented in this chapter thus appear to indicate that where attentive, households appear to update more frequently in response to the rational forecast in preference to the professional expectation or current values of macroeconomic variables. However, these results may be influenced by the estimation procedure with GMM used to estimate the rational and heterogeneous updating models, controlling for instrumental variables, as opposed to OLS for the survey updating and naïve sticky information hypotheses. Whilst the J-statistics cannot generally reject the validity of the instrument set across household groups or sample periods the results for the rational and heterogeneous updating models are likely to be subject to the instrument employed.

The sample period employed by this study considers approximately 30 years of data obtained from the SPF and Michigan Survey. Furthermore, for examination of the survey updating hypothesis, this chapter has adopted Carroll's (2003) assumption that households update their information sets by infrequently absorbing the information content of newspaper published forecasts, which reflect professional expectations. This concept however fails to acknowledge any heterogeneity in information reporting, implicitly assuming that there exists a single forecast published by all newspapers. Instead, maintaining the assumption that all newspapers report a professional forecast, heterogeneity may arise with newspapers reporting a variety of the mean and median professional expectation[149].

In addition, since the early 1980's, household access to information has undergone substantial changes with greater availability and choice of television news

[149] One may further assume that whilst some agents obtain information regarding future inflation from national newspapers, others read local newspapers whose reports may concern regional inflation levels.

broadcasts[150], and the proliferation of the internet. Moreover, the Pew Research Center (2011) report that in 2002 over 80 percent of agents report television as one of their two main sources for national and international news whilst, for the same year, only 42 percent report newspapers as one of their main news sources[151]. Data from the Newspaper Association of America (NAA) shows that this is accompanied with a fall in aggregate daily newspaper readerships which have fallen from in excess of 70 percent of adults in 1979 to less than 40 percent by 2010. Interestingly, this fall appears independent of recent economic conditions with readership uniformly falling during the recent period of macroeconomic uncertainty[152]. In contrast, between 2007 and 2009, Curtin (2009) documents a rise from 42 percent to 48 percent of agents obtaining information from internet sources.

Given the greater availability of information, in recent years the rate of information diffusion across agents may thus be significantly greater and less costly, thus information rigidity studies, including Mankiw and Reis (2002), Carroll (2003) and Lanne et al. (2009), may overestimate the degree of information frictions across agents. Alternatively, one may argue that the internet provides scope for a wide range of potentially contradictory commentary regarding the economy, providing a forum for extreme views which publications, such as newspapers, would likely filter out[153]. Consequently, the increased quantity of information may further complicate the decision making process as agents must decide which information sources to absorb whilst remaining inattentive to others, thus increasing the information acquisition and processing costs thus resulting in greater information frictions. These issues provide interesting opportunities for future research.

[150] Including 24-hour 'rolling news' channels such as CNN, Fox News Channel and ABC News Now, launched in 1980, 1996 and 2004 respectively.

[151] Similar figures regarding the manner which households obtain information regarding the economy are presented by Curtin (2009)

[152] Data obtained from the NAA indicate that average weekday readerships were 49.9 percent of adults in 2006, 48.4 percent in 2007, 45.1 percent in 2008, 44.4 percent in 2009 and 39.6 percent in 2010. Data accessed from http://www.naa.org/Trends-and-Numbers/Readership/Age-and-Gender.aspx (last accessed 08/05/2014).

[153] Furthermore, it is argued by Lein and Maag (2011) that households would likely have greater recollections of extreme viewpoints that they have encountered which thus may exaggerate biases in reported expectations.

CHAPTER 6: PROFESSIONAL FORECASTERS AND INFORMATION RIGIDITIES

Tests of the epidemiological model, as proposed by Carroll (2003, 2006), were found in Chapter 5 to indicate that household inflation forecasts are subject to information rigidities due to the infrequent absorption of professional forecasts reported by the news media. The model relies on the proposition that professional forecasters are more economically rational than those of households. Tests of the REH in Chapter 3 were unable to conclude that the US SPF is fully consistent with the properties required for rationality. Recent research has attempted to investigate whether departures from rationality amongst professional forecasters arise due to information rigidity. If professional forecasts are characterised by some form of informational rigidity, the epidemiological model (Carroll, 2003, 2006) will be unable to capture the full degree of outdated information embodied within household forecasts.

Both Andrade and Le Bihan (2010) and Clements (2012) recognise that some economists may openly dismiss the hypothesis that professional forecasts are characterised by information rigidities. Given their available resources, it is unlikely that professionals would consider systematic inattentiveness appropriate in the formation of optimal forecasts. Instead the presence of information rigidity in professional forecasters is argued by Andrade and Le Bihan (2010) to be more plausible where professionals are assumed unwilling to incur the processing costs required to form appropriately revised or updated forecasts. Moreover, given the current direction regarding empirical predictions, Clements (2012) argues in favour of information rigidity in the absence of any superior alternative.

Two prominent approaches to informational rigidities have been applied to the analysis of professional forecasts. Firstly, noisy information models (Woodford, 2003, Sims, 2003, Maćkowiak and Wiederholt, 2009) propose that disagreement amongst professional forecasts arises from the interpretation of noisy signals concerning inflation. Secondly, Andrade and Le Bihan (2010), Coibion and Gorodnichenko (2010, 2012) and Clements (2012) consider models of sticky information where agents have a distinct probability of updating information to incorporate macroeconomic news. Other approaches have also been proposed which consider inherent heterogeneity amongst agent priors and signals (Patton and

Timmermann, 2010), and asymmetric loss (Capistrán and Timmermann, 2009). Although these models vary considerably in their construction and predictions, Coibion and Gorodnichenko (2012) observe that all these models make a common prediction: that is, forecasts respond more gradually to a shock than the forecasted variable. Consequently, in violation of the properties of rational expectations, serially correlated forecast errors will be observed.

The empirical analysis of informational rigidity amongst household forecasts was constrained by the four period ahead outlook of the Michigan Survey. Information rigidity could thus only be examined across period to period forecast updates rather than revisions across multiple horizons for a single period. The composition of the SPF includes multi-horizon forecasts[154] thus the degree of information rigidity can be established under both forecast updating and forecast revision. Furthermore, advancing on the analysis by Dovern et al. (2013), it shall be possible to determine whether the degree of information rigidity varies as the forecast horizon shortens.

The objective of this chapter is to reassess the properties of professional forecasts and determine whether they are consistent with the predictions of information rigidity models. Firstly, the existing literature will be reviewed, with the properties of information rigidity models identified and an assessment on the current debate regarding which model is most appropriate for professional inflation forecasts. The following section re-introduces the SPF, examines the multi-horizon structure of forecasts within the survey and analyses the difference between revisions to fixed-event forecasts and updates to fixed-horizon forecasts. Next, attention is devoted to empirical analysis of these forecast revision and forecast update series and whether they are consistent with the properties of information rigidity models as detailed in the literature review. Further empirical investigations follow, with disagreement amongst professional inflation forecasts again being analysed in relation to the predictions of information rigidity models. The final section shall summarise the empirical findings of the previous sections and shall provide a conclusion regarding the consistency of SPF inflation forecasts with the predictions of information rigidity models and determine which of the competing models best capture the evolution of professional expectations.

[154] The SPF requests participants to report inflation forecasts for the previous, current and next four quarters.

6.1. Literature Review

The rational expectations hypothesis has been a key component of contemporary macroeconomic modelling. The empirical analysis in 3.2 was unable to confirm that SPF inflation forecasts are fully consistent with the properties of the REH. Nevertheless, the literature has emphasised that agents are commonly faced with restraints in forming expectations. Models of incomplete information, including the Lucas-Phelps islands model, and adaptive learning (Evans and Honkapohja, 2001) were previously introduced in section 3.3.3. An interesting development in recent years has concerned whether professional forecasts are characterised by information frictions. In recent years, economists including Mankiw et al. (2003), Coibion and Gorodnichenko (2010, 2012), Andrade and Le Bihan (2010) and Dovern et al. (2012, 2013), have employed various approaches in evaluating whether professional forecasts are consistent with information rigidity theory with empirical analysis considering forecast revisions, forecast updates and disagreement.

In accordance with the efficiency property analysed in relation to Rational Expectations in Chapter 3, Nordhaus (1987) acknowledges the requirement for forecast revisions to be independent of past forecast errors and past revisions; forecast revisions therefore solely arise to accommodate the arrival of news. The correlation of revisions with own lags and past errors indicates that the forecaster has not been able to efficiently incorporate available information into forecasts. Establishing a novel approach to examining informational frictions amongst professional forecasts, Coibion and Gorodnichenko (2010) consider the relationship between forecast revisions and forecast errors, relating rejections of the null of full information rational expectations as supporting evidence of information rigidities. The Mankiw and Reis (2002) sticky information model requires that agents are either attentive or inattentive with respective probabilities of $(1-\lambda)$ and λ. The average duration between information updates is thus $1/(1-\lambda)$. Utilising Mankiw and Reis's framework with Reis' (2006b) time dependent updating, Coibion and Gorodnichenko (2010) denote the average period t forecast as:

$$E_t[\pi_{t+h}] = (1-\lambda)E_t^R[\pi_{t+h}] + \lambda E_{t-1}[\pi_{t+h}] \quad (6.1.1)$$

Specifically, the average forecast $E_t[\pi_{t+h}]$ is the weighted average of the one period lagged average forecast and current rational expectations. As noted in previous chapters, the RE error is uncorrelated with information at time t thus:

$$E_t^R[\pi_{t+h}] = \pi_{t+h} + \epsilon_{t+h,t} \qquad (6.1.2)$$

Combining (6.1.1) and (6.1.2) Coibion and Gorodnichenko (2010) provide a relationship between forecast errors and forecast revisions, specifically:

$$\pi_{t+h} - E_t[\pi_{t+h}] = \frac{\lambda}{1-\lambda}\Delta E_t[\pi_{t+h}] + \epsilon_{t+h,t} \qquad (6.1.3)$$

Where the coefficient on the forecast revision, $\Delta E_t[\pi_{t+h}] = E_t[\pi_{t+h}] - E_{t-1}[\pi_{t+h}]$, is demonstrated to be solely dependent on the degree of information rigidity. Specifically the following model is examined:

$$\pi_{t+h} - E_t[\pi_{t+h}] = c + \beta(E_t[\pi_{t+h}] - E_{t-1}[\pi_{t+h}]) + \epsilon_t \qquad (6.1.4)$$

Where $\beta \neq 0$, the null of full information RE is rejected as forecast errors are predictable from forecast revisions. Moreover, Coibion and Gorodnichenko (2010) propose that where $\beta > 0$, expectations are characterised by information rigidities. The exact level of rigidity within the model is determined by $\lambda = \beta/(1+\beta)$. Utilising SPF expectations of the GDP price index, Coibion and Gorodnichenko (2010) report coefficient values $\beta = 1.23, \lambda = 0.55$ consistent with professionals updating their information every six to seven months.

The analysis of information rigidities is extended by Coibion and Gorodnichenko (2010) by decomposing the forecast revision into its two distinct elements. This allows for individual analysis of the contemporaneous and lagged forecasts to determine whether their respective coefficients are consistent with the underlying information rigidity theory. Therefore, (6.1.4) can be restated as:

$$\pi_{t+h} - E_t[\pi_{t+h}] = c + \beta_1 E_t[\pi_{t+h}] + \beta_2 E_{t-1}[\pi_{t+h}] + \epsilon_t \qquad (6.1.5)$$

Where information rigidities are present Coibion and Gorodnichenko (2010) indicate that $\beta_1 > 0, \beta_2 < 0$ and $\beta_1 + \beta_2 = 1$. For SPF three period ahead forecasts of the GDP price index, Coibion and Gorodnichenko (2010) again report coefficient values consistent with information rigidities.

The information rigidity model (6.1.4) proposed by Coibion and Gorodnichenko (2010) can also be applied to household inflation forecasts. However, as Michigan Survey inflation forecasts are only available for a four-quarter ahead forecast horizon (6.1.4) requires appropriate modification as demonstrated by Coibion and Gorodnichenko (2010). Specifically, the forecast revision is replaced by the one-period forecast update to yield:

$$\pi_{t+4} - E_t[\pi_{t+4}] = c + \beta(E_t[\pi_{t+4}] - E_{t-1}[\pi_{t+3}]) + \epsilon_t \qquad (6.1.6)$$

As this specification uses fixed-horizon rather than fixed-event forecasts, OLS estimation is noted by Coibion and Gorodnichenko (2010) to be inappropriate. Instead, GMM estimation is employed utilising oil price innovations as instruments[155]. Testing (6.1.6), Coibion and Gorodnichenko (2010) observe that β is significant for both SPF and Michigan Survey forecasts. The coefficient associated with professional forecasts is however larger than that of household forecasts. Given that β directly maps to the degree of information rigidity λ, such that $\lambda = \frac{\beta}{1+\beta}$, the coefficient values imply that households and professionals update their information infrequently. Specifically, whilst professionals update their information every 6 to 7 months, households update their information sets every 5 months on average[156].

The original sticky information framework proposed by Mankiw and Reis (2002) assumed that the degree of information rigidity to be exogenous and constant. Recent studies have questioned this assumption with Dovern et al. (2013) proposing that information rigidities are determined by the forecast horizon. Similarly, considering whether multi-horizon quarterly forecasts from the SPF are consistent with the annual forecast and most recent data releases, Clements (2012) observes significant discrepancies for several macroeconomic variables, indicative of inattentiveness. Specifically, Dovern et al. (2013) note that at longer forecasting horizons, agents may encounter noisier signals or be unable to effectively incorporate news into contemporaneous forecast revisions.

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[155] Oil price innovations are shown by Coibion and Gorodnichenko (2010) to be uncorrelated with both past information and the rational expectations error, and are also significant predictors of changes in agent inflation forecasts.

[156] Market-based The β coefficient observed by Coibion and Gorodnichenko (2010) for these forecasts

To test for information frictions across the forecast horizon, Dovern et al. (2013) regress the contemporaneous one-period forecast revision on lagged revisions. Utilising average Consensus Economics fixed-event GDP growth forecasts, the correlation between the current revision and the one-month lagged revisions is found by Dovern et al. (2013) to be highly significant; information rigidities are thus deemed to be present at very short horizons. The revisions at forecast horizons of approximately one year are also significant[157] whilst at alternative horizons there is no evidence of informational rigidities. Two suggestions for this result are provided by Dovern et al. (2013). Firstly, they suggest that some link exists between the expectations of four-quarter ahead growth rates and those for annual growth rates; and secondly, they suggest some transformation in agent attentiveness from current year forecasts to those for the subsequent year.

A novel approach to examining information rigidities in professional forecasts is proposed by Clements (2012). Exploiting the multi-horizon structure of the SPF, Clements (2012) examines whether annual forecasts are consistent with a sum of quarterly forecasts and recent data releases, with significant discrepancies deemed indicative of inattentiveness. The framework is based around the assumption that annual forecasts[158] should equal the average of the corresponding quarterly forecasts and published estimates of realised values. For 2000Q4 to 2002Q1, illustrates the forecasts formed by SPF professionals at each survey date:

Table 6.1.1: Forecast Horizons Available from the SPF

Survey Date	Backdated Forecast	Current Period Forecast	h-Step Ahead Forecasts				Annual Forecasts	
			$h = 1$	$h = 2$	$h = 3$	$h = 4$		
2000:Q4	2000:Q3	2000:Q4	2001:Q1	2001:Q2	2001:Q3	2001:Q4	2000	2001
2001:Q1	2000:Q4	2001:Q1	2001:Q2	2001:Q3	2001:Q4	2002:Q1	2001	2002
2001:Q2	2001:Q1	2001:Q2	2001:Q3	2001:Q4	2002:Q1	2002:Q2	2001	2002
2001:Q3	2001:Q2	2001:Q3	2001:Q4	2002:Q1	2002:Q2	2002:Q3	2001	2002
2001:Q4	2001:Q3	2001:Q4	2002:Q1	2002:Q2	2002:Q3	2002:Q4	2001	2002
2002:Q1	2001:Q4	2002:Q1	2002:Q2	2002:Q3	2002:Q4	2003:Q1	2002	2003

In the first two quarters of a calendar year, professionals provide forecasts for some variable for each of the four quarters in the calendar year. This is not the case for the

157 The revision at the 10 month horizon is significant for emerging economies whilst for advanced economies significant revision is observed for the 13 month horizon.
158 The SPF requests participants to provide annual forecasts of many macroeconomic variables for the current calendar year and the next calendar year.

third and fourth quarters; in 2001Q3 professionals report forecasts for 2001Q2 through to 2002Q3 whilst for 2001Q3 forecasts for 2001Q3 to 2002Q4 are provided. The proposition of Clements (2012) implies that the difference between annual and quarterly forecasts for the first two quarters of a calendar year is zero:

$$\delta_{Q1,t} = E_{Q1,t}[\pi_{A,t}] - \frac{1}{4}(E_{Q1,t}[\pi_{Q1,t}] + E_{Q1,t}[\pi_{Q2,t}] + E_{Q1,t}[\pi_{Q3,t}] + E_{Q1,t}[\pi_{Q4,t}]) \quad (6.1.7)$$

$$\delta_{Q2,t} = E_{Q2,t}[\pi_{A,t}] - \frac{1}{4}(E_{Q2,t}[\pi_{Q1,t}] + E_{Q2,t}[\pi_{Q2,t}] + E_{Q2,t}[\pi_{Q3,t}] + E_{Q2,t}[\pi_{Q4,t}]) \quad (6.1.8)$$

Where $E_{Qi,t}[\pi_{Qj,t}]$ is the forecast in quarter i of the calendar year t for quarter j in the same calendar year $t$and $E_{Qi,t}[\pi_{A,t}]$ is the forecast of annual inflation for the calendar year t produced in quarter i. The difference $\delta_{Qi,t}$ will only differ from zero in the event of random errors. Little evidence is found by Clements (2012) that discrepancies $\delta_{Q1,t}$ and $\delta_{Q2,t}$ are large. Regressing $\delta_{Q1,t}$ and $\delta_{Q2,t}$ upon a constant c, Clements (2012) is unable to reject that the quarterly forecasts add up to the annual forecast.

As the SPF requests a single back-dated forecast for the immediately preceding quarter, the SPF annual forecast in the third and fourth quarters of a calendar year will be composed of a combination of quarterly expectations and estimates of the realised value of the target variable. It is assumed that information regarding the target variable will be available with a single period lag. Maintaining Clements (2012) proposition that the annual forecast is consistent with beliefs concerning the four quarters of the calendar year, δ_{Q3} and δ_{Q4} can be presented as:

$$\delta_{Q3,s} = E_{Q3,s}[\pi_{A,s}] - \frac{1}{4}(\tilde{\pi}_{s,Q1,Q3} + E_{Q3,s}[\pi_{Q2,s}] + E_{Q3,s}[\pi_{Q3,s}] + E_{Q3,s}[\pi_{Q4,s}]) \quad (6.1.9)$$

$$\delta_{Q4,s} = E_{Q4,s}[\pi_{A,s}] - \frac{1}{4}(\tilde{\pi}_{s,Q1,Q4} + \tilde{\pi}_{s,Q2,Q4} + E_{Q4,s}[\pi_{s,Q4}] + E_{s,Q4}[\pi_{s,Q4}]) \quad (6.1.10)$$

Where s denotes the calendar year $\tilde{\pi}_{s,Qj,Qi}$ is the quarter i estimate of realised inflation in quarter j in calendar year s. If the forecaster is attentive in the third and fourth quarters then $\tilde{\pi}_{s,Qj,Qi} = \pi_{s,Qj}$ with the estimate equalling realised inflation[159].

[159] This detracts from the argument put forward by Clements (2012) as the CPI inflation data employed by this study is not systematically revised following publication.

Should instead forecasters be inattentive to releases in the inflation rate then $\tilde{\pi}_{s,Qj,Qi} = \pi_{s,Qj-k}$ where $j - k$ denotes the most recent period in which an agent updated their information. The values of $\delta_{s,Q3}$ and $\delta_{s,Q4}$ are again found by Clements (2012) to be small.

The framework proposed by Clements (2012) can be related to information rigidities. In the third and fourth quarters of a calendar year, rather than utilising the most recently available published estimate of the forecasted variable in forming annual forecasts, Clements (2012) recognises that professionals may use earlier vintages instead. To determine whether the discrepancies are characterised by significant professional inattentiveness, Clements (2012) regresses $\delta_{s,Q3}$ and $\delta_{s,Q4}$ upon the most recent data revision; specifically the following formal hypothesis test is employed:

$$\delta_{s,Q3} = c + \beta(\phi_{s,Q1} - \phi_{s-1,Q4}) + \epsilon_{s,Q3} \tag{6.1.11}$$

$$\delta_{s,Q4} = c + \beta(\phi_{s,Q2} - \phi_{s,Q1}) + \epsilon_{s,Q4} \tag{6.1.12}$$

Where $\beta = 0$, discrepancies can be classified as independent of the data revision, consistent with attentive forecasters. Evidence across various macroeconomic variables is found by Clements (2012) to be mixed. For four out of eight macroeconomic variables, including the GDP price index, third quarter forecasts are found to be consistent with attentive forecasters. In contrast, only for fourth quarter forecasts of real personal consumption forecasts can the null hypothesis of attentiveness be rejected. The alternative hypothesis of inattentiveness is not however dismissed for fourth quarter forecasts by Clements (2012). Instead, it is argued that (6.1.11) has low power. Large revisions are observed for all eight macroeconomic variables in 1993Q4 and 1999Q4. Due to the nature of these revisions, it is highly likely that a large proportion of professionals are attentive to this news, distorting the value of β. Consequently, the degree of information rigidity embodied within fourth quarter forecasts is understated. Removing those revisions is argued by Clements (2012) to increase the degree of attentiveness across professional forecasts. The attentiveness model presented by Clements (2012) provides mixed evidence as to whether professional forecasts are subject to information rigidities. There is however little evidence that professionals are inattentive to data releases concerning inflation.

The empirical results presented by Coibion and Gorodnichenko (2010), Clements (2012), and Dovern et al. (2012) indicate that information rigidities are present amongst inflation forecasts. However, a variety of imperfect information models where agents are faced with distinct frictions in the acquisition and processing of information have been established by economists, including sticky information (Mankiw and Reis, 2002; Mankiw et al., 2003), noisy information (Sims, 2003; Woodford, 2003; Maćkowiak and Wiederholt, 2009), strategic interaction (Morris and Shin, 2002) and heterogeneity amongst agent priors and signals (Capistran and Timmermann, 2009; Patton and Timmermann, 2010). Interestingly, across these models Coibion and Gorodnichenko (2012) observe a common inference: "the average forecast across agents should respond more gradually to a shock to fundamentals than the variable being forecasted" (2012:118). Consequently, forecast errors have the same sign as, that is they are serially correlated with the shock to the forecast variable.

To establish the most appropriate model of information rigidity consistent with professional inflation forecasts Coibion and Gorodnichenko (2012) empirically investigate the properties of SPF GDP deflator forecasts. To determine the response of mean forecast errors to shocks the following model is examined:

$$\pi_{t+h} - E_t[\pi_{t+h}] = c + \sum_{k=1}^{K} \beta_k(\pi_{t+h-k} - E_{t-k}[\pi_{t+h-k}]) + \sum_{j=0}^{J} \gamma_j(\Omega_{t-j}) + \epsilon_t \tag{6.1.13}$$

Specifically, the current forecast error is regressed upon previous forecast errors and past shocks Ω_{t-j} with K and J selected by the Bayesian information criteria. For technology, news, oil price and unidentified shocks Coibion and Gorodnichenko (2012) reject the RE null hypothesis of no response of forecast errors to shocks; instead the direction of forecast errors is consistent with that predicted by information rigidity models.

As previously acknowledged, the competing models of information rigidity make distinct predictions regarding the properties of agent forecasts. To distinguish between models of information rigidities Coibion and Gorodnichenko (2012) further investigate the response of forecast errors to lagged inflation. The previous specification (6.1.13) is modified to:

$$\pi_{t+4} - E_t[\pi_{t+4}] = c + \beta(\pi_{t+3} - E_{t-1}[\pi_{t+3}]) + \gamma[\pi_{t-1}] + \epsilon_t \qquad (6.1.14)$$

It is noted by Coibion and Gorodnichenko (2012) that whilst both the sticky information and (baseline) noisy information models predict that $\gamma = 0$, representative of the independence of forecast errors to inflation, models which incorporate inherent heterogeneity in priors or signals predict that forecast errors are correlated with past conditions. Considering tests akin to (6.1.14), Coibion and Gorodnichenko (2012) are unable to reject the null hypothesis of $\gamma = 0$ for professional forecasts; thus they adjudge information rigidities within professional forecasts to be incompatible with models with inherent heterogeneity in agent priors or signals, and instead advocate in favour of sticky information and (baseline) noisy information models[160].

In addition to determining whether updates and revisions to consensus forecasts are consistent with frictions in acquiring and processing information, recent contributions by Patton and Timmermann (2010), Andrade and Le Bihan (2010), Badarinza and Gross (2012), Coibion and Gorodnichenko (2012), and Dovern et al. (2012) have identified relationships between the cross-sectional distribution of agent expectations and information rigidities. As previously highlighted, disagreement has been a key component of many macroeconomic theories under imperfect information including the islands model of Lucas (1973) which generates disagreement amongst producers of a single good who can only observe own island prices. Following some shock, producers must determine the impact upon the general price level and the idiosyncratic effect on own island prices. Moreover, subsequent changes in own island prices need to be interpreted as changes in relative prices as well as in response to the general price level. As individual islands have different information, forecasts of prices and inflation will exhibit some degree of disagreement. More recently, utilising the Mankiw and Reis (2002) sticky information framework, Mankiw et al. (2003) generate dispersion in inflation expectations which matches the level of dispersion observed in Livingston Survey and Michigan Survey forecasts. Furthermore, they observe that greater variation in the inflation rate results in an

[160] Similar results are obtained by Coibion and Gorodnichenko (2012) for various other agent classes.

increase in disagreement; this is deemed by Mankiw et al. (2003) to be consistent with informational rigidity.

As highlighted above, Coibion and Gorodnichenko (2012) provide a comparison between the predictions of several variants of information rigidity including the properties of disagreement under each competing theory. Specifically, whereas a positive shock to disagreement following some shock is deemed consistent with sticky information, noisy information models are demonstrated to predict disagreement as independent of shocks[161]. Consistent with the latter, Coibion and Gorodnichenko (2012) present baseline results indicating that disagreement does not respond to a range of macroeconomic shocks[162], disputing the empirical findings of Mankiw et al. (2003)

Using a fixed-effects panel estimator, Dovern et al. (2012) also establish the manner which average disagreement across G7 countries evolves overtime. Whilst the average level of disagreement regarding inflation is found to be 0.311, the level of disagreement for several G7 countries, including the US, is strongly counter-cyclical, rising 30 percent during recessions[163]. Similarly, Andrade and Le Bihan (2010) find high values of disagreement for the 2008-2009 recession. The positive response to recessionary shocks may be considered consistent with Coibion and Gorodnichenko's (2012) predictions for disagreement under sticky information models. Similarly, for one-year ahead HICP inflation forecasts from the ECB-SPF, Andrade and Le Bihan (2010) report an average disagreement $\bar{\sigma}_t = 0.26$; which is equal to 42% of the underlying standard deviation in inflation. Furthermore, for the sample period 2000-2010, it is observed by Dovern et al. (2012) that disagreement falls by 16% compared to the 1989-2010 sample period. Nevertheless, utilising both SPF and Livingston Survey expectations, Mankiw et al. (2003) report that the relationship between professional disagreement and the state of the economy is less pronounced compared to disagreement amongst consumer expectations. Consequently, the appropriate model of information rigidity may differ between agent classes.

[161] Under noisy information where there is heterogeneity in signal-to-noise ratios, Coibion and Gorodnichenko (2012) report a positive response in disagreement to shocks.
[162] Coibion and Gorodnichenko (2012) evaluate the response of disagreement to news, technology, oil price and unexplained shocks.
[163] Specifically, Dovern et al. (2012) report higher levels of disagreement are reported during the 1990-1991 and 2007-2009 recessions.

The disagreement amongst professional expectations has also been related to information rigidities by Andrade and Le Bihan (2010). Utilising individual responses from the ECB Survey of Professional Forecasters (ECB-SPF), the standard deviation σ_t of inflation forecasts is calculated as a measure of cross-sectional disagreement. As observed by Coibion and Gorodonichenko (2010, 2012) and Dovern et al. (2012), Andrade and Le Bihan (2010) find professional forecasts of inflation, unemployment and real GDP to be characterised by some degree of information rigidity. In a sticky information environment, σ_t captures the disagreement in forecasts which arises from only a proportion of individuals updating their information in any given period. The greater the size of any given shock, the greater is the difference between the forecasts of those agents who recently updated their information and those using outdated information. Thus, under sticky information the degree of disagreement σ_t is demonstrated by Andrade and Le Bihan (2010) and Coibion and Gorodnichenko (2012) to vary according to the size of the shock. In contrast, under noisy information σ_t is dependent upon idiosyncratic noise which arises from observation of the signal following some shock. It is assumed by Andrade and Le Bihan (2010) and Coibion and Gorodnichenko (2012) that the variance of the signal is equal across individuals and independent of inflation. Within a simple noisy information framework it is thus argued that the magnitude of macroeconomic shocks does not impact upon σ_t.

The results presented by Dovern et al. (2012) indicate that the level of disagreement, measured as the cross-sectional IQR[164], is dependent upon both the sample period and macroeconomic conditions. Whilst the IQR is more robust to outliers relative to using the standard deviation, it fails to fully capture the level of disagreement across forecasters. Furthermore, the disagreement amongst professional inflation forecasts for the US was found to be one of the highest for G7 countries. The evolution of professional disagreement in the US may thus be misrepresented by the aggregate G7 results reported by Dovern et al. (2012). Consequently, despite the limitations, the analysis of disagreement in this chapter shall focus upon the standard deviation of SPF inflation forecasts.

[164] The IQR is also utilised by Mankiw et al. (2003).

To empirically examine the relationship between disagreement and information rigidities Andrade and Le Bihan (2010) and Badarinza and Gross (2012) propose formal models which assess the impact of news shocks on the level of disagreement. Regressing disagreement within the inflation forecasts of European professionals on the last absolute change in inflation, the most recent squared forecast error and the current absolute forecast error, Andrade and Le Bihan (2010) find only limited evidence that macroeconomic shocks impact upon the level of disagreement. Although Badarinza and Gross (2012) find that the effect of news intensity on disagreement to be negative and significant, an insignificant relationship is observed with inflation volatility. There is thus limited evidence that macroeconomic shocks impact upon professional disagreement. Consequently, professional disagreement appears most consistent with the predictions of noisy information.

Information rigidity is analysed by Patton and Timmermann (2010) who identify disagreement amongst professional GDP and inflation forecasts, measured by the cross-sectional dispersion, does not result from differences in private information signals. Instead, disagreement is argued to result from heterogeneous priors. Using a Bayesian learning model, Lahiri and Sheng (2008) similarly report that disagreement amongst Consensus Economics annual GDP growth forecasts arises due to specific prior beliefs. Furthermore, due to uncertainty regarding public information, Lahiri and Sheng (2008) note that disagreement persists over the longer-run. However, where agents observe the same public signal, forecast disagreement results solely from initial prior beliefs; therefore, there will be no response in disagreement following some macroeconomic shock, as demonstrated by Coibion and Gorodnichenko (2012).

Between the 24- and 12- month ahead horizons, the disagreement observed by Lahiri and Sheng (2008) amongst US GDP growth forecasts is persistently high. For longer horizon inflation forecasts of 24 months ahead Patton and Timmermann (2010) also observe individual forecasts to be widely dispersed around the mean. Both studies observe that disagreement reduces substantially with the forecast horizon from the 12-month ahead horizon. The fall in disagreement is noted by Andrade and Le Bihan (2010) to arise due to a reduction in uncertainty concerning the forecasted event. Furthermore, ranking individual forecasters into bottom, middle and top terciles, Patton and Timmermann (2010) find that the probability that a forecaster remains within a given tercile is greater than 33% which would be expected in the absence of persistent views. These results are argued by Patton and Timmermann (2010) to be indicative of differences in prior beliefs and inconsistent with different private information signals and information rigidities.

Utilising a selection of forecast revisions, forecast updates and disagreement, exisiting studies find some general consensus that professional forecasts are consistent with the presence of information rigidities. The weight of evidence suggests that either the sticky information or noisy information hypotheses are preferable to the various alternatives with Badarinza and Gross (2012) favouring the former and Coibion and Gorodnichenko (2010, 2012) and Andrade and Le Bihan (2010) presenting evidence concerning the latter. The remainder of this chapter reconsiders the nature and degree of information rigidities amongst professional forecasts for the previously identified sample periods, with three main objectives. Firstly, we seek to confirm whether professional forecasts are consistent with the predictions of information rigidity models; secondly, tests will be conducted over the previously identified sample periods to determine whether information rigidities are larger during periods characterised by greater macroeconomic stability or volatility; and thirdly, attempt to establish whether professional forecasts are consistent with the predictions of a single model of information rigidity. In 6.2, the properties of professional forecast revisions, forecast updates and forecast dispersion are analysed whilst 6.3 empirically examines the consistency of SPF forecasts with the predicitions of information rigidity theory.

6.2. Forecast Revisions, Forecast Updates and Forecast Dispersion: A Re-examination of the Properties of Professional Expectations

Prior to estimating the degree of information rigidity embodied within professional inflation forecasts, a distinction between fixed-horizon and fixed-event forecasts and subsequently between forecast revision and forecast updating is required. In addition to the analysis of consensus forecasts, the literature review identified that the level of cross-sectional disagreement could indicate the furthermore, a reassessment of the dispersion of professional forecasts is also required.

As previously identified, in period t, SPF respondents report expectations of inflation for periods $t-1$ through to $t+4$. Therefore, the SPF can be analysed in terms of fixed-horizon and fixed-event forecasts. Fixed-horizon forecasts can be defined as forecasts reported n-periods apart which estimate inflation for specific periods which are also n-periods apart. Alternatively, fixed-event forecasts can be defined as forecasts reported n-periods apart which estimate inflation for the same specific period; the forecast horizon is thus variable. Much of the literature, including Carroll (2003) and Mankiw et al. (2003), focuses on fixed-horizon forecasts which are argued by Dovern et al. (2012) to be preferable in determining disagreement as the uncertainty and cross-sectional dispersion of fixed-event forecasts varies across forecasts for different horizons. Nevertheless, both fixed-horizon and fixed-event forecasts are useful in determining expectation formation and the class and degree of information rigidity which best characterises professional inflation forecasts.

Whereas attention has generally been limited to the analysis of consensus forecasts, advocating in favour of the presence of information rigidities implies that whilst a fraction of agents formulate expectations which incorporate recent news, the remaind utilise outdated information. Consequently, the slow diffusion of information leads to professionals possessing different expectations regarding inflation. In accordance with these predictions, Mankiw et al. (2003) recognise that professional inflation forecasts are characterised by substantial levels of disagreement, as was previously observed for household expectations in Chapter 4. Recent contributions by Patton and Timmermann (2010), Andrade and Le Bihan (2010), Dovern et al. (2012) and

Badarinza and Gross (2012) have examined the cross-sectional distribution of forecasts. This has provided an intriguing extension to the previous analysis concerning information rigidity. An analysis of the disagreement amongst SPF forecasts shall thus be presented to provide further insight to the manner which professional inflation expectations are formed. It shall be specifically considered whether periods of increased macroeconomic stability and volatility impact upon the degree of disagreement and whether the dispersion of forecasts evolves over the forecast horizon.

6.2.1. Differences between Forecast Updates and Forecast Revisions

As highlighted above, the multi-horizon structure of the SPF allows for the analysis of both updates to fixed horizon forecasts and revisions to fixed-event forecasts. This section seeks to define these concepts and examines the statistical evolution of forecasts over the forecast horizon and across macroeconomic conditions.

Suppose that $E_t[\pi_{t+i}]$ is used to represent the i-step ahead forecast of inflation in period $t + i$; for example $E_t[\pi_{t+4}]$ would denote the four-step ahead forecast of period $t + 4$ inflation using information available in t. A forecast update can be defined as the adjustment made to fixed-horizon forecasts. The update can thus be illustrated as:

$$U_{t,h} = E_t[\pi_{t+i}] - E_{t-h}[\pi_{t+i-h}] \qquad (6.2.1)$$

It is recognised that $E_t[\pi_{t+i}]$ and $E_{t-h}[\pi_{t+i-h}]$ are forecasts of the inflation rate expected to occur in two different periods. Equation (6.2.1) further explains how forecasts evolve over time with the expected evolution in inflation. The epidemiological model presented by Carroll (2003) attempts to characterise the updating of expectations for household inflation forecasts.

Information rigidity embodied in agent expectations can also be captured by forecast revisions. These are defined as the adjustments made to fixed-event forecasts. Forecast revisions can thus be illustrated as:

$$R_{t,h} = E_t[\pi_{t+i}] - E_{t-h}[\pi_{t+i}] \qquad (6.2.2)$$

It is recognised that $E_t[\pi_{t+i}]$ and $E_{t-h}[\pi_{t+i}]$ are forecasts of the inflation rate expected to arise for a given period $t + i$ formed h periods apart. Equation (6.2.2) explains how forecasts for inflation in period $t + i$ evolve with changes in the information set across various forecast horizons. Tests of information rigidities of this form are employed by Coibion and Gorodnichenko (2010) whilst utilising Consensus Economics growth forecasts, Dovern et al. (2013) document that the magnitude of forecast revisions is not monotonic and is instead dependent upon both the forecast horizon and whether the economy is advanced or emerging. The focus here reconsiders the nature of revisions over various forecast horizons and determines whether periods of increased macroeconomic stability and volatility significantly impact upon the manner which agents revise their inflation forecasts.

Difficulty arises in empirically testing forecast revisions for Michigan Survey household inflation forecasts as only forecasts for a single horizon (four quarters ahead) are provided. This technique can however be employed upon professional forecasts from the SPF which requests inflation forecasts for various horizons. The focus shall mainly consider the manner which forecasts of future inflation are revised, namely the forecasts formed 1- to 4- periods ahead. Forecasts of current period inflation will occasionally be employed, mainly in establishing the latest revision[165].

Applying (6.2.1) and (6.2.2) to the median forecast data available from the SPF provides a series of forecast updates and forecast revisions for empirical analysis. Table 6.2.1 below presents the forecasts formed by participants of the SPF in periods $t-4$ to t with examples of a forecast update and a forecast revision:

Table 6.2.1: Forecast Horizons Available from the SPF

	$t-4$		$t-3$		$t-2$	$t-1$	t
0-Step Ahead	$E_{t-4}[\pi_{t-4}]$		$E_{t-3}[\pi_{t-3}]$		$E_{t-2}[\pi_{t-2}]$	$E_{t-1}[\pi_{t-1}]$	$E_t[\pi_t]$
1-Step Ahead	$E_{t-4}[\pi_{t-3}]$		$E_{t-3}[\pi_{t-2}]$	U_{t-2} →	$E_{t-2}[\pi_{t-1}]$	$E_{t-1}[\pi_t]$	$E_t[\pi_{t+1}]$
2-Step Ahead	$E_{t-4}[\pi_{t-2}]$		$E_{t-3}[\pi_{t-1}]$		$E_{t-2}[\pi_t]$	$E_{t-1}[\pi_{t+1}]$	$E_t[\pi_{t+2}]$
3-Step Ahead	$E_{t-4}[\pi_{t-1}]$	U_{t-3}	$E_{t-3}[\pi_t]$	R_{t-2},	$E_{t-2}[\pi_{t+1}]$	$E_{t-1}[\pi_{t+2}]$	$E_t[\pi_{t+3}]$
4-Step Ahead	$E_{t-4}[\pi_t]$	→	$E_{t-3}[\pi_{t+1}]$	↗	$E_{t-2}[\pi_{t+2}]$	$E_{t-1}[\pi_{t+3}]$	$E_t[\pi_{t+4}]$

Specifically, forecast updates relate to moving across columns along a given row, meanwhile forecast revisions concern moving diagonally up m rows and along m columns. The empirical examination of forecast revision and updates for SPF data commences with an analysis of forecast updates for the five separate forecast

[165] Given the quarterly structure of the SPF data employed throughout this study, these horizons would generally be considered by economists as short-run forecasts; however, to distinguish differences in the forecasting process as the event horizon shortens, $h < 2$ shall be termed short horizon forecasts, whereas $h > 2$ shall be termed longer horizon forecasts.

horizons. Elementary statistics are presented in Appendix 6.1 and Appendix 6.2[166] for single period updates and revisions.

Appendix 6.1 Panel A indicates that the mean update of professional forecasts is negative for each of the forecast horizons across all four sample periods. Therefore, on average professionals downwardly update their expectations over a single period horizon. Nevertheless, the mean revision value is not statistically significant from zero at the 5% level for any forecast horizon or sample period. Moreover, the mean update values are not heavily influenced by the forecast horizon. The Welch F-test, which permits unequal variances across forecast horizons, is unable to reject the null of equal mean updates across all forecast horizons and for all sample periods whilst the Kruskal-Wallis test is also unable to reject the equality of medians. These results are, however, influenced by positive and negative updates cancelling out. Panel B presents more robust statistics concerning mean absolute updates which remove the cancelling out effect.

In contrast to simple mean updates, all mean absolute updates are found to be highly significant and influenced by the forecast horizon. For updates concerning shorter forecast horizons, the mean absolute update is ubiquitously greater in value for a given sample period to those for longer forecast horizons. This is particularly evident in comparing 1-period ahead to 0-period ahead forecast updates. Considering all forecast horizons, the Welch F-test and Kruskal-Wallis test respectively reject the equality of means and medians for all four sample periods. Removing the 0-period ahead forecasts from the analysis does not affect the non-rejection of equality of means for the whole, Greenspan-Bernanke and volatile sample periods. For the stable sub-period, however, removal of the 0-period ahead forecast updates, rejection of equality of means is only observed at a 10% significance level rather than the conventional 5% level. For the Kruskal-Wallis test, the removal of 0-step ahead forecast updates results in the non-rejection of equality of medians for both the stable and volatile sub-periods. Therefore, for forecasts of future inflation over certain sample periods there is some evidence that the

[166] Updates and revisions are only analysed across forecasts formed one period apart. It would be expected that the results hold for revisions and updates where the forecasts are formed more than one period apart.

magnitude of updates to professional forecasts does not depend upon the forecast horizon.

It is evident from Appendix 6.2 that the significance of forecast revisions is dependent upon the forecast horizon. For short horizon forecasts, the mean and median of R_t and R_{t-1} are generally insignificant[167] whilst for longer horizon forecasts, the mean and median of R_{t-2} and R_{t-3} are generally significant. Nevertheless, for the volatile sub-period, both mean and median revisions are insignificant for all forecast horizons. This suggests that during the most recent period of uncertainty, professionals are less inclined to revise their forecasts and indicates either a lack of information concerning π_t arriving between periods $t-h-1$ and $t-h$ or information acquisition and processing constraints. As previously observed for actual forecast updates, it is not possible to reject the equality of means or the equality of median null hypotheses for any sample period using the Welch F-test and Kruskal-Wallis tests respectively. The manner which professionals revise their forecasts is apparently independent of the forecast horizon and suggests that forecasts are revised in the same manner between periods $t-1$ and t as it is between periods $t-4$ and $t-3$. However, as previously noted for forecast updates, utilising actual revisions fails to accommodate for positive and negative revisions, thus the cancelling out effect reduces the magnitude of revisions.

Using absolute revisions instead, it is evident from Appendix 6.2 that forecast revisions are in fact larger for shorter forecast horizons contrasting with the results presented in Panel A. This suggests that information regarding period t inflation is absorbed by professionals at a higher frequency as the forecast horizon falls. It may also suggest the information relevant to period t inflation becomes increasing available as t nears. Furthermore, the Welch F-test and Kruskal-Wallis test reject the equality of absolute mean and median revisions across all forecast horizons for all four sample periods at the 1% significance level. Whilst the smallest mean absolute revisions for all forecast horizons occurs during the stable sub-period consistent with reduced levels of inflation uncertainty, large mean absolute revisions are observed during the volatile period. Nevertheless, for R_{t-2} and R_{t-3} the mean

[167] Both mean and median values of R_{t-1} are significant for the whole sample period, however, they are insignificant for the three sub-periods.

absolute revision is smaller for the volatile period in comparison to the whole period. Revisions of professional forecasts are thus dependent not only on the forecast horizon but also on the underlying macroeconomic conditions.

The distribution of forecast revisions and forecast updates are illustrated in Appendix 6.3 and Appendix 6.4 respectively for SPF forecasts formed 4- to 0 periods ahead. The distributions are generally bell-shaped and unimodal as previously observed by Dovern et al. (2013) for revisions to professional growth forecasts for both advanced and emerging economies. The distributions show that consensus inflation forecasts for all horizons are frequently updated and revised. Nevertheless, the highest densities are observed around zero indicating that updates and revisions are generally small in magnitude. Nevertheless, the tails of the latest revision and shortest horizon forecast updates ($h = 0$) are considerably longer than those for earlier revisions and longer horizon forecast updates. This indicates that short horizon professional inflation forecasts are frequently subject to large revisions and updates, perhaps in response to surprise inflation shocks. Whilst longer horizon forecasts evolve much more smoothly in response to permanent macroeconomic innovations, shorter horizon forecasts have greater sensitivity to transitory shocks, a feature that shall be returned to later.

The fixed-event structure of SPF inflation forecasts allows the determination of whether forecast revisions are consistent with full information RE. Following Dovern et al. (2013) the contemporaneous forecast revision can be regressed upon past forecast revisions for some fixed-event inflation rate:

$$R_{t-h} = c + \beta R_{t-h-1} + \epsilon_t \tag{6.2.3}$$

The null hypothesis of efficiency requires $\beta = 0$; alternatively, forecast revisions are significantly correlated. The results presented in Appendix 6.5 Panel A indicate that forecast efficiency cannot be rejected for any set of horizons for the whole, Greenspan-Bernanke and stable periods at the conventional 5% level. Nevertheless, the null hypothesis is rejected for $h = 1$ and $h = 2$ for the volatile sub-period indicating that for horizons greater than one period ahead, forecast revisions during periods of increased macroeconomic uncertainty are significantly correlated and dependent upon lagged revisions. This is inconsistent with the predictions of RE.

Given that the coefficient on lagged revisions is also positive, the results indicate that the forecasts formed four, three and two periods ahead for some inflation event are revised in the same direction.

The analysis in this section demonstrates that SPF inflation forecasts are subject to significant absolute revisions and updates over various forecast horizons and macroeconomic conditions. It is thus apparent that professional forecasts are inconsistent with underlying assumptions of full information. Imperfect information assumptions have been extensively utilised by economists for several decades with several recent contributions to expectations theory most notably the models of information rigidity of sticky information (Mankiw and Reis, 2002) and noisy information (Sims, 2003; Woodford, 2003; Maćkowiak and Wiederholt 2009). Section 6.3 shall empirically re-examine several key models of information rigidity to explore the manner in which available information is employed by professionals in forming inflation forecasts.

6.2.2. Properties of Professional Forecast Disagreement

In addition to the analysis of forecast revisions and forecast updates to consensus forecasts, the literature review identified that the cross-sectional dispersion of forecasts provides a further indicator regarding the presence of information rigidities. Prior to examining formal empirical tests of the determinants of disagreement and the relationship with informational rigidities, the properties of the dispersion of professional forecasts shall be re-assessed. The evolution of disagreement across the five forecast horizons and four sample periods is of particular interest. In accordance with Lahiri and Sheng (2008) and Patton and Timmermann (2010), it is hypothesised that as the forecast horizon falls, disagreement will increase. In addition, it is also expected that disagreement will be particularly high during the volatile sub-period, as previously observed by Andrade and Le Bihan (2010), due to the increase of uncertainty concerning macroeconomic variables.

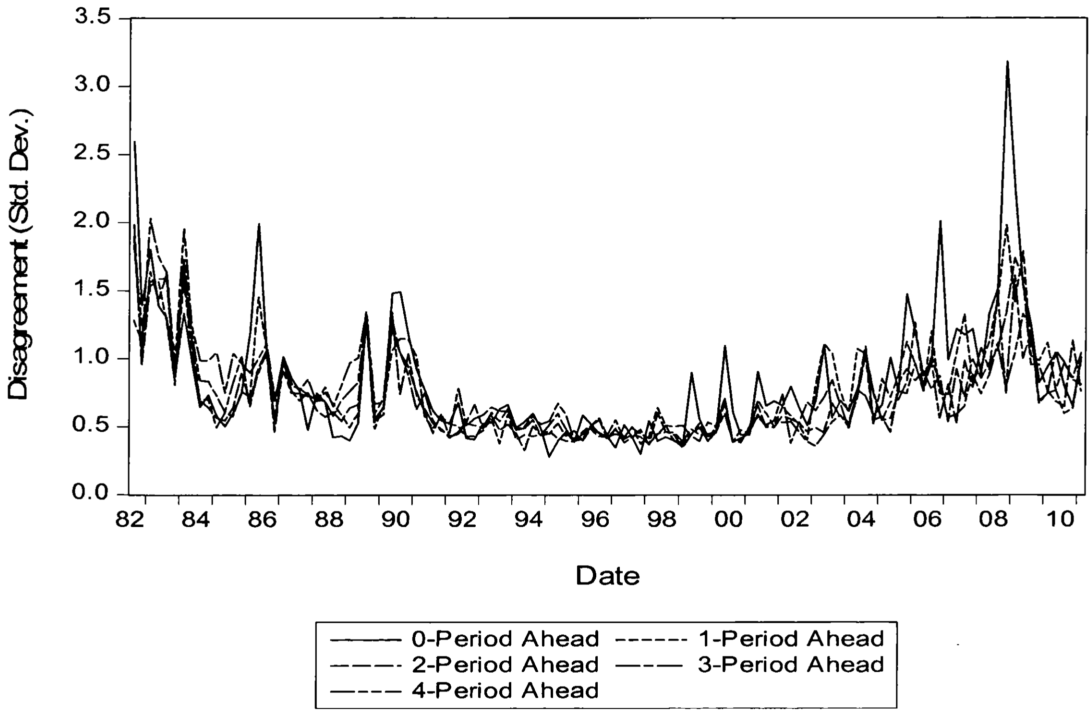
As mentioned in 6.1, the disagreement amongst professional forecasters shall be measured as the standard deviation of individual inflation forecasts from the US SPF[168]. For forecasts formed in period t for period $t+h$ inflation, the level of disagreement can be denoted as:

$$\sigma_{t.t+h} = \left[\frac{1}{n_t}\sum_{i=1}^{n_t}\left(E_{i,t}[\pi_{t+h}] - \bar{E}_t[\pi_{t+h}]\right)^2\right]^{1/2} \qquad (6.2.4)$$

where $E_{i,t}[\pi_{t+h}]$ and $\bar{E}_t[\pi_{t+h}]$ denote individual and mean forecasts of $t+h$ inflation respectively. The level of disagreement for horizons $h = 0, \dots, 4$ is illustrated in Figure 6.2.1 whilst Appendix 6.1 presents the associated descriptive statistics.

[168] This methodology is further consistent with the analysis of household disagreement in Chapter 4.

Figure 6.2.1: SPF Multi Horizon Forecast Disagreement



In accordance with Lahiri and Sheng (2008), Patton and Timmermann (2010) and Andrade and Le Bihan (2010), Appendix 6.1 and Figure 6.2.1 illustrate that the level of disagreement across the inflation forecasts of individual professionals is not constant across the five forecast horizons nor for the four sample periods[169]. Additionally, from Figure 6.2.1 it is observed that the level of disagreement across all five horizons is larger at the beginning and end of the sample period compared to the mid- to late-1990's and early 2000's when macroeconomic conditions were less uncertain. This is emphasised in Appendix 6.1 with lower mean and median disagreement across all forecast horizons during the stable sub-period in comparison to either the whole or volatile sample periods, with disagreement particularly large in the latter. Furthermore, the evolution of disagreement over the volatile sub-period closely matches that presented by Andrade and Le Bihan (2010) for ECB-SPF forecasts during the 2008-2009 recession. The average disagreement reported in Appendix 6.1 is however larger than that reported by Dovern et al. (2012); this is unsurprising however, as the measure of disagreement preferred here considers the full sample of SPF inflation forecasts rather than the IQR.

[169] Andrade and Le Bihan (2010) further note that the disagreement amongst professional inflation expectations is strongly correlated with respective expectations for unemployment and real GDP.

Interestingly, for the whole, Greenspan-Bernanke and stable period, the mean and median level of disagreement appears U-shaped with the forecast horizon. Disagreement is lowest for $h = 2$ and greater for both shorter and longer horizons. Nevertheless, for these sample periods, the Welch F-test and Kruskal-Wallis test are unable to reject their respective hypothesis that the mean and median are equal across forecast horizons. In contrast, for the volatile sub-period, mean and median disagreement generally increases as the forecast horizon shortens. Furthermore, the Welch F-test rejects the equality of means at a 10% significance level whilst the Kruskal-Wallis test rejects equality of medians at the 5% level. Nevertheless, excluding the disagreement concerning forecasts of current period inflation $h = 0$, it is not possible to reject the null hypothesis of equal means or medians[170]. The results thus indicate that whilst there may be higher levels of disagreement amongst professional forecasts at the shortest available horizon, particularly during periods of increased macroeconomic uncertainty, it is otherwise possible to deduce that for each sample period, the level of disagreement is equal across forecasting horizons.

The standard deviation is also examined in Appendix 6.1 to determine the variability of disagreement across the four sample periods. It is observed that at longer forecasting horizons disagreement is generally less dispersed than for shorter horizons. Moreover, for the whole, Greenspan-Bernanke and stable periods, the Brown-Forsythe test rejects the null hypothesis of equal variances. Similarly to the Welch and Kruskal-Wallis tests detailed above, by excluding $h = 0$ from the Brown-Forsythe tests, the rejection of the equal variances null hypothesis is not possible at conventional significance levels for these three sample periods. Nevertheless, for the volatile period, the Brown-Forsythe test is unable to reject the null hypothesis of equal variances across forecasting horizons with or without the inclusion of forecasts for current period inflation. The results therefore indicate that for each sample period there is no significant difference in the dispersion of disagreement across forecast horizons, particularly if forecasts for current period inflation are excluded.

As noted in 6.1, Patton and Timmermann (2010) observe a general positive relationship between the consensus forecast and disagreement. From Appendix 6.1 Panel E the correlation between the SPF median forecast and $\sigma_{t,t+h}$ is observed to

[170] For the whole, Greenspan-Bernanke and stable periods, the exclusion of disagreement for $h = 0$ results in the Welch F-test and Kruskal Wallis test reporting even higher p-values.

depend upon both the forecast horizon and sample period. Whilst for the stable sub-period, the correlation is positive for all h, correlation between the median forecast and disagreement for all forecast horizons in the volatile sub-period is negative. Furthermore, for the whole, Greenspan-Bernanke and stable periods whilst the correlation is generally positive for longer forecast horizons, it becomes smaller and occasionally negative as the forecast horizon shortens. This suggests that for shorter forecast horizons, disagreement amongst professional forecasters falls as the expected rate of inflation increases.

Consistent with existing empirical studies, SPF inflation forecasts have been shown to exhibit substantial disagreement. The degree of forecast dispersion persists across the forecast horizon; however, greater disagreement is observed for shorter forecast horizons and the most recent period of increased macroeconomic uncertainty. Nevertheless, unlike the results presented by Lahiri and Sheng (2008) and Patton and Timmermann (2010), for any given sample period, formal tests indicate that the level and variability of disagreement is generally equal across forecast horizons. Nevertheless, whilst the two aforementioned studies evaluate disagreement across 24 monthly horizons, the choice of SPF data limits the analysis to five quarterly horizons. Should inflation forecasts of five or more quarters ahead have been available, the results may have indicated that disagreement is significantly larger for longer forecast horizons than those nearer the event. The next sub-chapter considers whether the disagreement identified in this sub-chapter can be considered consistent with informational rigidities.

6.3. Empirical Evaluation of the Presence of Information Rigidities in Professional Forecasts

The analysis in the previous section established that although mean forecast updates and mean forecast revisions are in general statistically insignificant, the absolute values are significant. Furthermore, the results presented in 6.2.1 illustrated that the magnitude of forecast updates and revisions were dependent upon both the forecast horizon and sample period. Additionally, SPF inflation forecasts were observed in 6.2.2 to exhibit substantial levels of disagreement, with the magnitude varying across forecast horizons and macroeconomic conditions. Utilising updates to fixed-horizon forecasts, revisions to fixed-event forecast, and the cross-sectional dispersion, formal empirical testing shall examine whether SPF inflation forecasts are subject to information rigidities and attempt to determine whether the predictions are aligned to those of the sticky information or noisy information models as presented by Coibion and Gorodnichenko (2012).

Section 6.1 established that some general consensus exists across previous studies that professional forecasts, like those of households, are subject to informational rigidities. Recent studies have provided several alternative frameworks to better understand the information frictions encountered by professionals; whilst the sticky information hypothesis is preferred by Mankiw et al. (2003), the results of Coibion and Gorodnichenko (2012) are consistent with noisy information models. The empirical investigations in this section seek to exploit updates and revisions to SPF forecasts, and the resultant disagreement amongst forecasters to address the following issues: are professional inflation forecasts consistent with the predictions of information rigidity models and secondly, which of the competing models of information restraints best characterises the expectations formation process of professionals.

The analysis begins by considering revisions to fixed-event forecasts; specifically, the Clements (2012) framework which considers consistency between annual and quarterly forecasts shall be examined. Next, attention shall be devoted to the relationship between forecast errors and revisions akin to Coibion and Gorodnichenko (2010). In 6.3.2, the analysis focuses on fixed horizon forecasts and associated errors and updates. Following Coibion and Gorodnichenko (2012), impulse response functions are presented to analyse the common prediction of models with information constraints that forecast errors respond to shocks but asymptotically decline as information is acquired and processed by agents. Furthermore, analysing whether the response of forecast errors are independent of past inflation, it is possible to hypothesise which model of information constraint best characterises professional forecasts. Next, 6.3.3 empirically assesses the determinants of disagreement to determine whether the cross-sectional dispersion of SPF inflation forecasts are consistent with predicitions of information rigidity models. The final section provides a discussion regarding the presence of information rigidities amongst professional inflation forecasts and considers whether the evidence is consistent with the predictions of a specific model as presented by Coibion and Gorodnichenko (2012).

6.3.1. Professional Forecast Revisions and Information Rigidities

In 6.2.1, despite actual revisions realised at the shortest horizons and for the volatile sub-period not being statistically significant, the absolute revisions to SPF inflation forecasts, across all sample periods and available horizons reported in Appendix 6.2, were found to be significant. Furthermore, revisions were found to be inconsistent with the properties of RE. In accordance with Coibion and Gorodnichenko (2010) and Clements (2012) forecast revisions from the SPF shall now be examined using formal empirical tests to determine whether the expectations formation process employed by professional forecasters is consistent with the properties of information rigidity models.

The model proposed by Clements (2012), as identified in the literature review, analyses whether multi-horizon forecasts are consistent with the annual forecast following the publication of new information through data releases. Any discrepancies are indicative of the presence of informational rigidities. Exploiting the availability of multi-horizon forecasts from the SPF for $t + h, h = -1, \ldots, 4$, the discrepancy series for CPI inflation forecasts can be formulated in a similar manner to equations (6.1.7) to (6.1.10)[171]. Whereas the discrepancies from Q1 and Q2 forecasts will only differ from zero in the event of random errors, for Q3 and Q4 discrepancies, where $\tilde{\pi}_{s,Qj,Qi} = \pi_{s,Qj}$ such that the estimate of Q1 and Q2 inflation is equal to the realised value, the forecaster can be considered attentive[172]. Instead, should forecasters be inattentive to releases in the inflation rate then $\tilde{\pi}_{s,Qj,Qi} = \pi_{s,Qj-k}$ where k denotes the number of periods which have passed since the agent last updated their information.

Descriptive statistics for the discrepancy series generated from (6.1.7) to (6.1.10) are presented in Appendix 6.8. Considering the discrepancies for all quarters $i = 1, \ldots, 4$ it is not possible to reject the null hypotheses at a 5% significance level that the mean or median discrepancy is significantly different from zero for any sample period[173]. In accordance with Clements (2012), there thus appears little evidence against the

[171] Appendix 6.7 formally examines the calculation of the discrepancy series between annual and quarterly SPF inflation forecasts for each of the four quarters of a calendar year.
[172] This detracts from the argument put forward by Clements (2012) as the CPI inflation data employed by this study is not systematically revised following publication.
[173] The zero mean null hypothesis is however rejected at a 10% level for the stable sub-period.

adding up of quarterly beliefs to the annual forecast. There is however limited evidence that beliefs for specific quarters do not add up. The zero mean null hypothesis is rejected at a 5% level for first quarter forecasts formed during the volatile period meanwhile the zero median null hypotheses is rejected for second quarter forecasts formed during the whole and Greenspan-Bernanke periods[174].

The discrepancies for the third and fourth quarters can however be further analysed, as identified by Clements (2012) to determine whether professional forecasts are characterised by significant inattentiveness to the most recently available information. It was previously noted that a potential advantage of utilising the CPI measure of inflation is the absence of systematic revision subsequent to publication; agents are therefore not required to be attentive to revisions of realised values, in addition to updates, to remain informed. The model proposed by Clements (2012) is founded upon attentiveness to these revisions, thus (6.1.11) and (6.1.12) require appropriate modification to capture inattentiveness to inflation updates, as shown by (6.3.1) and (6.3.2):

$$\delta_{s,Q3} = c + \beta(\pi_{s,Q1} - \pi_{s-1,Q4}) + \epsilon_{s,Q3} \tag{6.3.1}$$

$$\delta_{s,Q4} = c + \beta(\pi_{s,Q2} - \pi_{s,Q1}) + \epsilon_{s,Q4} \tag{6.3.2}$$

Specifically, the discrepancies in the third and fourth quarters of a calendar year are regressed upon the difference in the actual rate of CPI published two and three quarters previously. Where β is significant, it can be deduced that the discrepancies in the median SPF forecast are correlated with changes in the inflation rate, indicative of inattentiveness.

Appendix 6.9 presents the results for (6.3.1) and (6.3.2) for SPF forecasts for all four sample periods. For the third quarter forecasts the results indicate that β is ubiquitously small and positive. Moreover, β is insignificant thus there is no evidence in favour of the inattentiveness hypothesis for third quarter forecasts which corresponds with the results presented by Clements (2012) for GDP price index forecasts. In contrast to Clements (2012), who again finds β to be small and

[174] The zero median null hypothesis is also rejected by the Wilcoxon signed rank test at a 10% level for first quarter forecasts formed in the Greenspan-Bernanke and stable sub-periods and for second quarter forecasts formed during the stable sub-period.

insignificant, the values of β associated with fourth quarter CPI forecasts for the whole, Greenspan-Bernanke and stable period are large and significant. For forecasts to be characterised by inattentiveness, Clements (2012) highlights that a negative correlation between the discrepancy and the change in inflation is required. However, as the values of β presented in Appendix 6.9 are positive for all four sample periods, it is not possible to attribute discrepancies to inattentiveness. The difference to the results presented by Clements (2012) may arise due to the methodology employed; whilst the results above are from tests conducted upon median expectations from the SPF and changes to the realised value of CPI, Clements (2012) utilises individual expectations and the difference between data revisions.

Prior to determining whether forecast revisions are consistent with the predictions of informational rigidities, it shall first be determined whether forecast revisions are inconsistent with the efficiency property required under RE. Following Nordhaus (1987) and Dovern et al. (2013) the contemporaneous forecast revision at various forecast horizons is regressed on the one-period lagged revision:

$$R_{t-h} = c + \lambda R_{t-h-1} + u_t \qquad (6.3.3)$$

where R_{t-h} is the one period revision to median SPF inflation forecasts for target period t formed at horizon h as previously defined in 6.2.1. The null hypothesis of efficiency requires $\beta = 0$; otherwise, forecast revisions are significantly correlated. Although rejection of the null hypothesis cannot be considered as direct evidence of information rigidities, it does indicate that available information could have been used to improve forecast efficiency.

The results from tests of (6.3.3) are presented in Appendix 6.5 Panel A. As previously noted, for the whole, Greenspan-Bernanke and stable periods it is not possible to reject the null hypothesis that $\lambda = 0$ for horizons $h = 0,1,2$[175]; there is thus no evidence that forecast revisions are correlated. This contrasts with the results of Dovern et al. (2013) who observe significant correlation between the contemporaneous revision and the one-month lag; nevertheless, the four month lag is

[175] The null hypothesis of efficiency can be rejected for $h = 0$, which relates to the forecast revision between 1- and 0- period ahead forecasts, at the 10% significance level for the Greenspan-Bernanke sub-period.

insignificant for both advanced and emerging countries. For the volatile sub-period, the null hypothesis $\lambda = 0$ can be rejected for $h = 0,1,2$. Therefore, professional forecasts are less efficient during the most recent period of increased macroeconomic uncertainty; this supports the efficiency results presented in Chapter 3 in relation to RE. To summarise, the results in Appendix 6.5 Panel A suggest that forecast revisions during the volatile sub-period are most likely to be consistent with informational rigidities.

To examine whether forecast inefficiency is indicative of informational rigidities, and furthermore whether informational rigidities vary across the forecast horizon, (6.3.3) is extended, akin to Dovern et al. (2013), to consider the sum of lagged revisions:

$$R_{t-h} = c + \sum_{k=1}^{k} \lambda_k \, R_{t-h-k} + u_t \qquad (6.3.4)$$

Whereas Dovern et al. (2013) solely consider the one-period ahead forecast and its relationship with lagged forecasts formed up to 16 months previously, here the value of h is varied to determine whether forecasts for longer horizons exhibit larger rigidities than those for shorter horizons. The composition of the SPF determines that for $h = 0$, $k \leq 3$ can be utilised whilst for $h = 2$, just a single lagged revision R_{t-3} is available[176].

Results from testing (6.3.4) are presented in Appendix 6.5 Panel B. Whereas Dovern et al. (2013) observe significant positive correlation for both advanced and emerging economies between the contemporaneous revision and the first lag, β and λ_1 are generally insignificant for the whole, Greenspan-Bernanke and stable periods. This suggests that information rigidities are not pronounced within professional inflation forecasts during periods of greater macroeconomic stability; forecast revisions instead conform to the predictions of rational expectations. This corresponds with the efficiency results presented in Panel A.

[176] Despite the availability of R_{t-3}, it is not possible to analyse the revision and consequently information rigidities that arise in forming four-step forecasts from the SPF as data concerning five-step ahead and longer forecasting horizons is not requested by the Federal Reserve Bank of Philadelphia.

Nevertheless, in Panel B, the contemporaneous revision $h = 0$, exhibits significant positive correlation with the one-period lagged revision for the whole sample period and significant negative correlation with the two quarter lagged revision for the Greenspan-Bernanke sub-period. The positive correlation indicates the presence of information rigidities and, consistent with the results for GDP forecasts presented by Dovern et al (2013), suggest that for the whole sample period, professional forecasters update their information approximately every six months. The negative correlation implies that revisions are in opposite directions. Rather than indicating information rigidities, this result is most likely to arise from professionals devoting greater capacity to the processing of relevant information at shorter forecasting horizons. As the forecast horizon falls, signals may also become less noisy. The negative correlation may indicate overshooting behaviour on the part of professional forecast revisions. As the forecast horizon shortens, professional revisions attempt to rectify this behaviour which seems particularly apparent for the volatile sub-period. Positive λ_1 and negative λ_2 coefficients, both of which are significant for $h = 0$ and $h = 1$, further supports the notion that short-run forecasts are highly subject to transitory shocks during the recent period of increased macroeconomic uncertainty.

For advanced economies, Dovern et al. (2013) observe significant correlation between the contemporaneous revision and the 13 month lagged revision[177]. They explain this occurrence by indicating that annual and quarterly forecasts are intrinsically linked. This could however indicate some seasonality effect within forecast revisions. Meanwhile it is further suggested by Dovern et al. (2013) that agents attentiveness switches from current year to new year forecasts at horizons of approximately one year. Due to the construction of survey forecasts, it is not possible to assess Dovern et al.'s (2013) observation of large information rigidities at approximately one-year ahead horizons[178]. Nevertheless, the λ_3 coefficients, associated with the revision at the longest available horizon, are not significantly correlated with the contemporaneous revision R_t for any of the four sample periods.

[177] For emerging economies, significant correlation between the contemporaneous and 10 month lagged revision is observed. For comparison with US SPF inflation forecasts, the results concerning advanced economies are considered most relevant.

[178] The revision with the longest horizon available from the SPF concerns the three-period lagged value. Specifically, this revision R_{t-3} concerns that which arises between the four quarter ahead and three quarter ahead forecasts.

The results indicate that information rigidities are not prominent in professional inflation forecasts. The addition of further λ_k terms to (6.3.4), for larger k, could alter this result. Although Dovern et al. (2013) do not observe significant correlation between the contemporaneous and 10-month lagged revision for advanced economies, their coefficient value is positive. The λ_3 coefficients reported in Appendix 6.5 for the whole, Greenspan-Bernanke and volatile periods are instead negative.

As identified in 6.1, Coibion and Gorodnichenko (2010) present a novel approach to determining whether professional forecasts are embodied by information rigidity; specifically, ex-post forecast errors are reconciled with ex-ante forecast revisions. Their model, identified by (6.1.4) shall be reconsidered utilising multi horizon SPF forecasts of CPI inflation. This shall yield an indirect comparison with the results presented in Chapter 5 concerning the degree of information rigidity within household inflation forecasts as identified by Carroll's (2003, 2006) epidemiological model. In the earlier examination of the model, it was established that where $\beta \neq 0$ the null hypothesis of full information RE is rejected; instead, should $\beta > 0$, information rigidities are present.

For the previously identified sample periods, tests of (6.1.4) are examined for horizons $h = 0, \dots, 3$ with the results presented in Appendix 6.10. In comparison to the results presented by Coibion and Gorodnichenko (2010), the values of β are generally much smaller; this indicates that CPI forecasts are subject to smaller information constraints than those for the GDP price deflator. Nevertheless, across horizons $h = 1,2,3$ for the whole sample period, β is both positive and significant implying a rejection of the full information RE null hypothesis in favour of the presence of information rigidities. In contrast, for the Greenspan-Bernanke and stable sub-periods, β is not statistically significant at the 5% level for $h = 1,2,3$. Even though β is positive for these forecasts, the results indicate that during periods of increased macroeconomic stability, professional forecasts are not subject to information constraints.

Following Coibion and Gorodnichenko (2010), column (5) maps the degree of information rigidity, β to the frequency of updating λ estimated by sticky information models. For the whole sample period the value of λ implies that professionals update their information every four to six months on average, with information being updated most frequently for one-period ahead forecasts. This is more frequent than the rate of updating of six to seven months reported by Coibion and Gorodnichenko (2010) for SPF GDP deflator forecasts. For the Greenspan-Bernanke and stable sub-periods, the degree of information rigidity is generally not significant, consistent with a higher frequency of information updating[179]. Information rigidities are however present for one-step ahead forecasts formed during the Greenspan-Bernanke sub-period; significance is observed at a 10% level for β, whilst λ is significant at a 1% level and implies that information is updated every three to four months[180].

For the volatile sub-period, whilst β is significant for $h = 1$ and $h = 2$[181], β is not significant for $h = 3$. Furthermore, the corresponding λ values for $h = 1$ and $h = 2$ is also observed to be highly significant. Nevertheless, the frequency of information updates is lowest for this sub-period. For one-period ahead forecasts the value of λ implies that information is updated approximately every five to six months, whilst for two-period ahead forecasts, information is updated every eight to nine months.

In contrast to $h = 1,2,3$ the value of β associated with $h = 0$ is negative for all four sample periods; professional 0-step ahead forecasts are thus not consistent with the presence of information rigidities[182]. Nevertheless, for the whole, Greenspan-Bernanke and stable periods, β is observed to be statistically significant at the 5% level, which is demonstrated by Coibion and Gorodnichenko (2010) to indicate the rejection of the full information RE hypothesis. In contrast, it is not possible to reject the null of full information RE for 0-step ahead professional forecasts formed in the volatile sub-period as β is not statistically significant at conventional levels. This suggests that professionals are more efficient at collecting and processing information for imminent forecast horizons during periods of greater macroeconomic

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[179] For the Greenspan-Bernanke period the λ values in column (5) indicates that professionals update their information at least every four months, whilst for the stable sub-period, information is updated at least every three months.

[180] Although β and λ are larger for the corresponding two-period ahead forecasts formed in the Greenspan-Bernanke sub-period, implying that information is updated every four to five months, the degree of information rigidity exhibits a t-statistic with associated p-value of 0.105 and thus is not found to be statistically significant at conventional levels.

[181] Whilst β is significant at the 1% level for $h = 1$, for $h = 2$ β is significant at the 10% level.

[182] $\beta < 0$ is also observed for $h = 3$ for the volatile period.

uncertainty. However, as β is significant for $h = 1$ and $h = 2$, it is not currently possible to provide comprehensive conclusions regarding information rigidities for the volatile period.

In the literature discussion, (6.1.5) identified an additional test presented by Coibion and Gorodnichenko (2010) which decomposes the forecast revision into two component forecasts. Employing this specification, Coibion and Gorodnichenko present results which provide additional evidence that professional GDP price deflator forecasts are subject to informational rigidities. To determine whether the conclusions regarding informational rigidity from tests of (6.1.4) are robust, (6.1.5) shall be applied to SPF CPI forecasts with the results presented in Appendix 6.11.

As previously observed for the baseline model, the values of β_1 and β_2 for the whole, Greenspan-Bernanke and stable periods are much lower than those reported by Coibion and Gorodnichenko (2010); this again suggests that professional CPI forecasts are less subject to information constraints than for the GDP price deflator. Whilst the signs on the β coefficients associated with one, two and three period ahead forecasts formed in the whole, Greenspan-Bernanke and stable periods are consistent with the presence of information rigidities, the β coefficients are generally insignificant; these results contrast with those presented by Coibion and Gorodnichenko (2010), and are in conflict with the predictions of information rigidity models. This is particularly evident across forecasts for all future horizons during the stable sub-period and longer forecasting horizons in the whole and Greenspan-Bernanke periods. These results are consistent with those presented in Appendix 6.10. Nevertheless, for one-period ahead forecasts formed in the whole and Greenspan-Bernanke periods, the χ^2 null hypothesis that β coefficients sum to zero cannot be rejected at any reasonable significance level. The absolute values of the coefficients upon the two most recent forecasts is thus equal, which Coibion and Gorodnichenko (2010) argue to be consistent with information rigidities.

The results for the volatile period are substantially distinct to those for the whole, Greenspan-Bernanke and stable periods. Although for $h = 0$ both β coefficients are significant, indicating the rejection of full information RE, they exhibit the incorrect sign to be consistent with information rigidities as previously observed for the whole, Greenspan-Bernanke and stable periods. The positive values observed for β_2

for $h = 1$ and $h = 3$ further indicate that models of information rigidity are inappropriate for periods of increased macroeconomic uncertainty. In contrast, despite large absolute coefficient values, the signs on β_1 and β_2 for two-step ahead forecasts in the volatile sub-periods are appropriate with the presence of information rigidities. Furthermore, the χ^2 tests cannot reject that the absolute values of the β coefficients are equal. However, neither c, β_1 nor β_2 are significant at the 5% level, thus there is no evidence to reject the full information RE null hypothesis for these forecasts.

The evidence thus far indicates that the presence of information rigidities within professional forecasts is dependent upon both the forecast horizon and the sample period. The results presented in Appendix 6.10 and Appendix 6.11 indicate that the correlation between forecast errors and past revisions is larger for shorter forecast horizons. Information rigidity thus appears to be decreasing with the forecast horizon. This is in direct conflict with Dovern et al. (2013) who argue that information rigidities are likely to be monotonically increasing with the forecast horizon as relevant signals are noisier at longer horizons. Additionally, in accordance with the results for household forecasts presented in relation to the epidemiological model, information rigidities amongst professional forecasts appear less pronounced during periods of greater macroeconomic stability and appear more consistent with the predictions of full information RE. This is economically reasonable as periods of greater stability are often associated with reduced costs regarding the acquisition and processing of information. The evidence does however refute the notion that the degree of information rigidity is determined by an exogenously given constant as proposed by Mankiw et al. (2003). Further analysis shall thus be conducted utilising forecast updates and trhe cross-sectional dispersion to attempt to confirm the observed relationships regarding information rigidity and establish some firmer conclusions.

6.3.2. Professional Forecast Updates and Information Rigidities

In 6.3.1, the examination of forecast revisions indicated that the presence of information rigidities amongst SPF inflation forecasts are not constant; instead, they are dependent upon both the forecast horizon and sample period. As previously acknowledged, in addition to analysing revisions to fixed-event forecasts, the multi-horizon structure of forecasts from the SPF also allows for the analysis of updates to fixed-horizon forecasts. Utilising these forecasts and associated forecast errors, the this section determines the consistency of forecast updates with the predictions of information rigidity models and attempts to verify the observations concerning professional forecast revisions detailed in the previous section.

A key set of predictions considered by Coibion and Gorodnichenko (2012) of information rigidity models relates to the response of forecast errors to shocks: the sticky information and baseline noisy information models both predict that forecast errors respond in the same direction as the forecasted variable, and asymptotically decline (Coibion and Gorodnichenko, 2012). This contrasts to the predictions of RE which involve a complete and instantaneous response in agent forecasts following any shock; consequently, the response of forecast errors to any macroeconomic disturbance or shock would be zero.

In accordance with Coibion and Gorodnichenko (2012), the analysis shall focus upon technology, oil price, news and unidentified shocks with the last of these generated from the residuals v_t from the following regression:

$$\pi_t = c + \sum_{k=1}^{4} \beta_k \pi_{t-k} + \sum_{s \in O,N,T} \sum_{j=0}^{1} \gamma_j \varepsilon_{t-j}^{s} + v_t \qquad (6.3.5)$$

The category of shock is denoted $s \epsilon O, N, T$ for oil price, news innovation[183] and technology shocks[184] respectively.

[183] To generate the shock series we follow Coibion and Gorodnichenko (2010). Oil price shocks are defined as the residuals from running an AR(2) on the first difference of the log of oil prices. Similarly, to generate news shocks an AR(2) is run on the news intensity index.
[184] Technology shocks are generated in the same manner as Coibion and Gorodnichenko (2012). Namely, a VAR(4) is estimated on the percentage in labour productivity, the percentage change in hours worked and the CPI inflation rate. Quarterly data for labour productivity and hours worked are obtained from the BLS. The estimation sample employed is 1980Q1-2012Q4.

Following Coibion and Gorodnichenko (2012), impulse responses for GDP deflator inflation[185] shall first be considered for oil price, news intensity, technology and unexplained shocks; these are constructed by estimating the following VAR:

$$\pi_{t+h} = c + \sum_{k=1}^{K} \beta_k \pi_{t-k} + \sum_{j=1}^{J} \gamma_j \varepsilon_{t-j}^{s} + \epsilon_t \qquad (6.3.6)$$

The category of shock is denoted $s \in O, N, T, U$ for oil price, news innovation, technology and unidentified shocks respectively; whilst J and K are selected using the Akaike criterion up to a maximum of 8 lags. The impulse response results to one standard deviation shocks from testing (6.3.6) across the four sample periods, with respective two standard deviation confidence intervals, are presented in Appendix 6.12[186].

For the whole, Greenspan-Bernanke and stable sample periods, the mean response of inflation to technology and oil price shocks is positive and significant whilst the response to news intensity and unexplained shocks are generally insignificant. Furthermore, after roughly four periods, the response of inflation across these three sample periods converges approximately monotonically to zero. Whilst the direction of the response to oil shocks, and the associated convergence, is consistent with the results presented by Coibion and Gorodnichenko (2012), they contrastingly predict a significant and positive response to unidentified shocks and significant and negative response to technology and news shocks. The contrasting responses may indicate that such tests regarding information rigidity may be highly dependent upon the shock specification and the sample period[187]. Reconsidering the results utilising CPI inflation rather than the GDP deflator, similar results to the aforementioned figures

[185] The quarterly implicit price deflator is obtained from the US Bureau of Economic Analysis (BEA). The inflation rate is measured as the percentage increase in the GDP deflator over a period of four quarters.

[186] The impulse response functions impose a one standard deviation oil price, news innovation or technology shock upon the GDP deflator inflation measure.

[187] Presenting a variance decomposition by structural shocks, Coibion and Gorodnichenko (2012) report that news shocks account for approximately 10% of inflation volatility. In the analysis presented here, news intensity shocks account for no more than approximately 5% of inflation volatility. In comparison, oil price shocks generally account for over 20% of inflation volatility in the whole, Greenspan-Bernanke and stable periods. Consequently, oil price shocks are able to provide stronger predictions regarding the prevalence of information rigidities however news intensity shocks are less reliable.

are obtained, although the response to technology shocks are generally insignificant whilst the responses to unidentified shocks are significant.

For the volatile sub-period the response of inflation in Appendix 6.12 to all four shocks is insignificant. Furthermore, rather than converging to zero, the functions appear to 'explode' indicating that large responses in inflation are observed following lags of 10 periods or more[188]. Nevertheless, the shortened sample specification likely makes these results unreliable.

As highlighted by Coibion and Gorodnichenko (2012), to be consistent with the properties of RE, professional forecast need to respond to shocks in the same manner as future inflation. Consequently, under RE forecast errors are required to exhibit a zero response to shocks. A non-zero response, which possesses the same sign as the response of the forecasted variable to the shock is shown by Coibion and Gorodnichenko to be consistent with the predictions of information rigidity models. To assess whether fixed-horizon SPF inflation forecasts conform to the competing predictions of these models, the following VAR as presented by Coibion and Gorodnichenko (2012) shall be estimated for the four shocks, s, as previously specified in relation to (6.3.6):

$$\pi_{t+h} - E_t[\pi_{t+h}] = c + \sum_{k=1}^{K} \beta_k(\pi_{t+h-k} - E_{t-k}[\pi_{t+h-k}]) + \sum_{j=1}^{J} \gamma_j \varepsilon_{t-j}^{s} + \epsilon_t \qquad (6.3.7)$$

In accordance with (6.3.6), lag lengths K and J are selected using the AIC up to a maximum of 8 periods. To determine the response of forecast errors to the four shocks the IRF's relating to $h = 0, \ldots, 4$ are presented in Appendix 6.13, Appendix 6.14, Appendix 6.15, Appendix 6.16 and Appendix 6.17 for each of the four sample periods.

Firstly, the response of forecast errors to news intensity shocks is in general insignificant across both forecast horizons and sample periods; significance is only observed in the stable sub-sample period for 0- and 1-period ahead forecast errors.

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[188] Utilising the Akaike criteria with a maximum lag length of 4 periods, the impulse response functions from the VAR simulations indicate that although the response of inflation to shocks generally remains insignificant, convergence to zero is observed.

Therefore, consistent with the RE null hypothesis, a zero response of forecast errors to news intensity shocks is generally observed. Nevertheless, limited evidence is observed which favours models of information rigidity. Despite providing conflicting results to those presented by Coibion and Gorodnichenko (2012) concerning news shocks, this observation is not surprising as the variance decomposition found that news intensity shocks, across all four sample periods, only accounted for a small proportion of inflation volatility.

In contrast to news intensity shocks, the response of forecast errors to oil price shocks is positive and significant for all h across the whole and Greenspan-Bernanke sample periods and $h = 3$ and $h = 4$ for the stable sub-period. Moreover, in accordance with Coibion and Gorodnichenko's (2012) predictions for information rigidity models, the responses of forecast errors are positive, converging approximately asymptotically to zero, attributable to professionals incorporating news into information sets following some lag. Additionally, consistent with Coibion and Gorodnichenko's (2012) predictions of sticky information and noisy information models, the response of forecast errors to oil price shocks matches the direction of the reponse of inflation to this class of shock. Nonetheless, for $h = 0,1,2$ across the stable sub-period and all h for the volatile sub-period, the response of forecast errors to shocks is not significant suggesting that the associated forecasts are better characterised by the REH than models of information rigidity.

It is thus becoming evident that the response of forecast errors, and consequently inferences regarding information rigidity, are dependent upon the forecast horizon and sample period. This is again emphasised by the IRF's concerning technology shocks. For the whole, Greenspan-Bernanke and stable sample periods, the significance of forecast error responses to technology shocks is mixed. Therefore, for these sample periods, technology shocks are unable to provide any conclusive evidence in favour, or against, information rigidity models. Nevertheless, as previously observed for news intensity and oil price shocks, across the volatile sub-period, the forecast error response to technology shocks is insignificant for all h; this further suggests that professional inflation forecasts published during the most recent period of macroeconomic uncertainty are not consistent with the predictions of information rigidity presented by Coibion and Gorodnichenko (2012).

Finally, the forecast error response to unidentified shocks are, in general, significant for shorter horizon forecasts across the whole, Greenspan-Bernanke and stable sample periods, yet the response across errors for longer horizons is insignificant. Consequently, whilst the former are consistent with models of information rigidity, the latter conform to the REH. Moreover, for all h, the response of forecast errors to unidentified shocks across the volatile sub-period is again insignificant, further indicating that professional inflation forecasts are not characterised by models of information rigidity during the most recent period of macroeconomic uncertainty.

The results presented in Appendix 6.13 to Appendix 6.17 clearly indicate that the response of forecast errors to shocks is not constant; instead the responses, and consequently inferences concerning models of information rigidity, are dependent upon the macroeconomic disturbance, the forecast horizon and the sample period. To summarise, fairly strong evidence of information rigidities is observed from the IRF's for the whole and Greenspan-Bernanke sample periods, however, the evidence is more mixed for the stable sub-period. Moreover, for the volatile sub-period, the IRF's do not provide any evidence consistent with the predictions of information rigidity models. Furthermore, whilst forecast errors exhibit significant responses to oil price, technology and unidentified shocks in a manner consistent with information rigidity models, the response of forecast to news intensity shocks across forecast horizons and sample periods is generally zero, consistent with the properties of REH.

Despite a significant response in forecast errors to shocks being consistent with information rigidity models, Capistrán and Timmermann (2009) and Coibion and Gorodnichenko (2012) also identify heterogeneous loss aversion as consistent with this property. Nevertheless, Coibion and Gorodnichenko (2012) also note that under heterogeneous loss aversion, forecast errors are ubiquitously positive or negative to any shock and thus re-examine (6.3.7), replacing lagged shocks with lagged absolute shocks, as follows:

$$\pi_{t+h} - E_t[\pi_{t+h}] = c + \sum_{k=1}^{K} \beta_k (\pi_{t+h-k} - E_{t-k}[\pi_{t+h-k}]) + \sum_{j=1}^{J} \gamma_j |\varepsilon_{t-j}^{s}| + \epsilon_t \tag{6.3.8}$$

As previously, $s \in O, N, T, U$ denote oil price, news innovation, technology and unidentified shocks and K and J are selected by the Akaike criterion.

From Appendix 6.18 to Appendix 6.22, it is not evident than an invariably positive or negative shock is observed across shocks; whilst a positive response to absolute technology shocks is generally observed across forecast horizons and sample periods, a negative response is generally observed to absolute news intensity shocks. Moreover, the response to absolute oil price and unidentified shocks are neither uniformly positive nor negative[189]. Furthermore, responses across all four shocks are frequently insignificant. Therefore, the responses of forecast errors to absolute shocks do not provide any evidence that professional inflation forecasts are consistent with the properties of heterogeneous loss aversion in the manner proposed by Capistrán and Timmermann (2009). Instead, the response of forecast errors to shocks appears more aligned to the predictions of sticky information or noisy information models; this is consistent with the analysis of Coibion and Gorodnichenko (2012). However, the evidence thus far remains inconclusive and dependent upon the nature of the shock imposed upon forecasts. It shall thus be worthwhile to pursue further tests which seek to determine whether the properties of professional forecasts are consistent with these competing models.

In addition to determining whether agent expectations are subject to information rigidities, it is also possible to distinguish between the various hypotheses from analysing fixed horizon forecasts. In 6.1, equation (6.1.14) identified the model presented by Coibion and Gorodnichenko (2012) which empirically assesses whether forecast errors are correlated with lagged inflation. Prior to formal testing (6.1.14) shall be restated to accommodate the multi-horizon structure of the SPF employed in our analysis:

[189] Additionally, for all four sample periods, forecast error responses are not uniformly positive or negative across forecast horizons or shocks.

$$\pi_{t+h} - E_t[\pi_{t+h}] \\ = c + \beta(\pi_{t+h-1} - E_{t-1}[\pi_{t+h-1}]) \\ + \gamma[\pi_{t+h-1}] + \epsilon_t \quad (6.3.9)$$

where h represents the forecast horizon. Forecast errors are independent of past inflation where $\gamma = 0$ which Coibion and Gorodnichenko (2012) illustrate to be consistent with models of heterogeneous priors or signals but incompatible with either the sticky information or noisy information hypotheses. Tests of (6.3.9) for GDP deflator and CPI inflation measures are presented in Appendix 6.23 and Appendix 6.24 respectively.

Firstly, considering tests of (6.3.9) for GDP deflator forecasts, the value of γ for the whole, Greenspan-Bernanke and stable period is generally small and insignificant which is consistent with both the sticky information and noisy information models. Nevertheless, γ is positive and significant for $h = 3$ in the stable sub-period and $h = 4$ in the Greenspan-Bernanke sub-period indicating that longer horizon forecasts formulated during periods generally characterised by reduced levels of macroeconomic uncertainty may be more consistent with models with inherent heterogeneity in agent priors or signals. In accordance with Coibion and Gorodnichenko (2012), similar results are obtained for these three sample periods where a more general lag specification of forecast errors and inflation is employed.

Moreover, for the volatile sub-period, the lower panel of Appendix 6.23 shows that γ is positive and significant for all h. Thus, tests of (6.3.9) indicate that during the recent period of macroeconomic uncertainty, professional GDP deflator forecasts are consistent with the predictions of models with inherent heterogeneous priors or signals. Nevertheless, the relevancy of these results is questionable as recalling the results from Appendix 6.13 to Appendix 6.17, which analysed the response of forecast errors to a range of shocks, professional forecasts for all h were deemed to be inconsistent with models of information rigidity. Moreover, utilising a more general lag specification of forecast errors and inflation for the volatile sub-period, neither γ_1 nor γ_2 are significant for any h[190]. Unlike the initial specification, this indicates that professional forecast formulated for the most recent period of macroeconomic uncertainty are inconsistent with models of heterogeneous priors

[190] Wald t-tests generally find that the restriction $\gamma_1 + \gamma_2 = 0$ cannot be rejected although tests for $h = 3$ are an exception.

and signals; instead, sticky information and noisy information models are more compatible with these predictions. Therefore, the ambiguity regarding the degree and class of information rigidities amongst professional inflation forecasts for the volatile sub-period remains unresolved.

Tests of (6.3.9) are also considered for SPF CPI forecasts, with the results presented in Appendix 6.24. For $h = 0$, the null hypothesis that $\gamma = 0$ is rejected for all sample periods. Furthermore, $\gamma > 0$ for all sample periods; following Coibion and Gorodnichenko's (2012) these results for professional 'nowcasts' are incompatible with the predictions of either the sticky information or noisy information hypotheses. Instead, models of heterogeneous priors or signals are more likely to be important factors in the formation of these forecasts. In contrast, across $h = 1, \ldots, 4$ for each of the four sample periods γ is small and either negative or not significant. This corresponds with the results presented by Coibion and Gorodnichenko (2012) for four-period ahead forecasts from a variety of agent classes.

For $h = 1, \ldots, 4$ across the whole sample period, γ is invariably negative and generally highly significant[191]. This is inconsistent with Coibion and Gorodnichenko's predictions for any model of information rigidity[192]. Nevertheless, for the Greenspan-Bernanke and stable sub-periods $\gamma = 0$ cannot be rejected for $h \geq 1$, whilst for the volatile sub-period , the null hypothesis $\gamma = 0$ cannot be rejected for $h = 2, \ldots, 4$. There are thus apparent information rigidities embodied in fixed-horizon SPF CPI forecasts for these sample periods; moreover, in accordance with Coibion and Gorodnichenko (2012), the predictions from Appendix 6.24 suggest that SPF CPI forecasts are inconsistent with the properties of noisy information models with inherent heterogeneity in signals or priors.

The analysis in this section has empirically examined the properties of professional forecast errors and forecast updates, and furthermore investigated whether their responses to various macroeconomic shocks are consistent with the predictions of information rigidity models as presented by Coibion and Gorodnichenko (2012). The evidence suggests that professional inflation forecasts for certain forecast

[191] For $h = 1$, γ is marginally insignificant at the 10% level of significance.
[192] Similar findings are obtained utilising an additional inflation lag, with the sum of coefficients remaining negative and significant. Observing $\gamma < 0$ for FOMC forecasts, Coibion and Gorodnichenko (2012) suggest that these results may be driven by time aggregation.

horizons and sample periods are characterised by substantial information rigidities; moreover, the degree and appropriate model of information rigidity is dependent upon various assumptions and conditions. This evidently dismisses Mankiw et al.'s (2003) proposal that information rigidities are determined by an exogenously given constant. The IRF's from Appendix 6.13 to Appendix 6.22 indicate that professional forecasts are characterised by large information rigidities for the whole and Greenspan-Bernanke sample periods, yet the evidence for the stable and volatile sub-periods is less conclusive. Furthermore, the results appear sensitive to the classification and specification of the macroeconomic shocks imposed on forecast errors. Moreover, tests of (6.3.9) indicate that there is sufficient evidence to dismiss models of inherent heterogeneity amongst agent signals, priors or loss aversion as proposed by Capistrán and Timmermann (2009) and Patton and Timmermann (2010). Instead information rigidities amongst professionals appear more consistent with the sticky information or (baseline) noisy information models. The following section empirically examines whether disagreement amongst professional inflation forecasts are consistent with the various models of information rigidity.

6.3.3. Professional Disagreement and Information Rigidities

From Appendix 6.1 it was observed that SPF inflation forecasts are characterised by substantial disagreement. Furthermore, the magnitude of disagreement was established to vary across the forecast horizon and macroeconomic conditions. This section considers formal empirical tests to determine whether the disagreement amongst professionals is consistent with information rigidity models.

It was noted in 6.1 that whilst Coibion and Gorodnichenko (2012) find no evidence that professional disagreement significantly responds to a range of macroeconomic shocks, Andrade and Le Bihan (2010) observe a positive relationship between disagreement and the magnitude of macroeconomic disturbances. Consequently, the former deem expectations to be consistent with noisy information models whilst the latter propose that the sticky information hypothesis is more appropriate. These conclusions shall be re-evaluated utilising the disagreement amongst SPF inflation forecasts.

Following Dovern et al. (2012) a fixed-effects estimator is used to understand the general trend of disagreement for various forecast horizons across the whole sample period. Table 6.3.2 presents results from testing (6.3.10) which considers the manner which disagreement evolves over time, to NBER recessions as presented in Table 6.3.1, and the volatile sub-period:

$$\sigma_{t,t+h} = c + \beta_1[Rec_t] + \beta_2[post98] + \beta_3[Vol_t] + u_t \qquad (6.3.10)$$

where Rec_t denotes the dummy associated with recessions, $post98$ represents the post-1998 sub-sample dummy, and Vol_t the volatile sub-period dummy.

Table 6.3.1: NBER Recessions[193]

PEAK			TROUGH			Months	Quarters
January	1980	Q1	July	1980	Q3	6	2
July	1981	Q3	November	1982	Q4	16	5
July	1990	Q3	March	1991	Q1	8	2
March	2001	Q1	November	2001	Q4	8	3
December	2007	Q4	June	2009	Q2	18	6

[193] For the sample period within this study, the table below presents the dates of recessions published by the NBER Business Cycle Dating Committee in both months and quarters. Recessions commence at the peak of the business cycle whilst troughs denote the end. US Business Cycle Expansions and Contractions are available from the NBER at http://www.nber.org/cycles.html (last accessed 17/05/2013).

Table 6.3.2: Professional Disagreement Across Time

	Sample: Whole 1982:3 2011:1 $\sigma_{t,t+h} = \beta_0 + \beta_1 * rec_t + \beta_2 * post98 + \beta_3 * vol + u_t$					
	β_0	β_1	β_2	β_3	R^2	$\bar{R}^2$
$\sigma_{t,t}$	0.836*** (0.084)				0.000	0.000
	0.712*** (0.082)	0.510*** (0.187)	-0.053 (0.119)	0.461*** (0.166)	0.316	0.298
$\sigma_{t,t+1}$	0.763*** (0.090)				0.000	0.000
	0.681*** (0.074)	0.341** (0.149)	-0.045 (0.119)	0.328** (0.135)	0.264	0.244
$\sigma_{t,t+2}$	0.720*** (0.079)				0.000	0.000
	0.679*** (0.084)	0.295*** (0.110)	-0.108 (0.108)	0.283** (0.117)	0.208	0.187
$\sigma_{t,t+3}$	0.731*** (0.074)				0.000	0.000
	0.722*** (0.093)	0.212** (0.091)	-0.155 (0.118)	0.276** (0.101)	0.155	0.133
$\sigma_{t,t+4}$	0.755*** (0.082)				0.000	0.000
	0.790*** (0.111)	0.104** (0.046)	-0.233* (0.132)	0.298** (0.117)	0.139	0.116

In accordance with Dovern et al.'s (2012) results for the US, β_2 is invariably insignificant; for all forecast horizons, the level of disagreement is constant both pre-1999 and post-1998. This result is robust to alternative dummy years; examining post-1995 and post-2000 sub-samples, it is not possible to conclude that the level of disagreement across either sub-sample is significantly different to earlier years[194]. In contrast, the coefficients associated with both recessions and the volatile sub-period are positive and significant across all forecast horizons and sample periods. The observation that disagreement rises during recessions is consistent with the results presented by Patton and Timmermann (2010) for US CPI and Dovern et al. (2012) for both G7 and US Consensus Economics forecasts. Table 6.3.2 also indicates that disagreement has increased during the most recent period of increased macroeconomic uncertainty. This conforms to Coibion and Gorodnichenko's (2012) prediction that under sticky information the response of disagreement to any shock is positive.

Furthermore, from Table 6.3.2 the values of both β_1 and β_3 indicate that the increase in disagreement is larger for shorter forecast horizons. During recessions the

[194] These results are not presented in Table 6.3.2

increase in disagreement is estimated at $\frac{0.510}{0.836} = 61\%$ for current-period forecasts and $\frac{0.341}{0.763} = 45\%$ for one-period ahead forecasts. This compares to 29% and 14% for three- and four-period ahead forecasts respectively. The increase in disagreement associated with the onset of the volatile sub-period is also found to be largest for shorter forecast horizons, estimated at 55% for $h = 0$ and 43% for $h = 1$. The increase in disagreement associated with the volatile period at longer forecasting horizons is however approximately equal across $h = 2,3,4$. Moreover, for $h = 3$ and $h = 4$, the increase in disagreement associated with the volatile sub-period is larger than that associated with recessions.

These results support the earlier argument that disagreement, and thus associated forecasts, formed for shorter horizons are more sensitive to transitory shocks whilst the response across longer horizons is primarily dependent upon permanent macroeconomic innovations. Furthermore, that disagreement rises during recessions and the volatile sub-period is most consistent with Coibion and Gorodnichenko's (2012) predictions for sticky information that the response of disagreement to any shock is positive. Interestingly, whilst the response is greater for short-horizon forecasts, there is no evidence from Table 6.3.2 that the most appropriate model of information rigidity is dependent upon the sample period or forecast horizon. The remainder of this section shall analyse more specific shocks to determine whether this conclusion is indeed most appropriate for disagreement amongst professional forecasters.

An important determinant in the degree of disagreement amongst agents as highlighted by Carroll (2003) and Badarinza and Gross (2012) is the intensity of news coverage regarding inflation. Where inflation news coverage is high, Carroll (2003) reports that the difference between SPF and Michigan forecasts falls, whilst Badarinza and Gross (2012) report a negative relationship between household disagreement and news intensity. The news coverage concerning inflation shall be evaluated to determine the relationship between information rigidities amongst professionals and the measure of news intensity.

The degree of news intensity[195] is presented in Figure 6.3.1 and Appendix 6.25 along with the rate of inflation and the level of SPF disagreement, measured as the standard deviation of professional inflation forecasts, at various forecast horizons respectively, whilst Table 6.3.3 presents descriptive statistics for the level of news intensity:

Figure 6.3.1: News Intensity and CPI

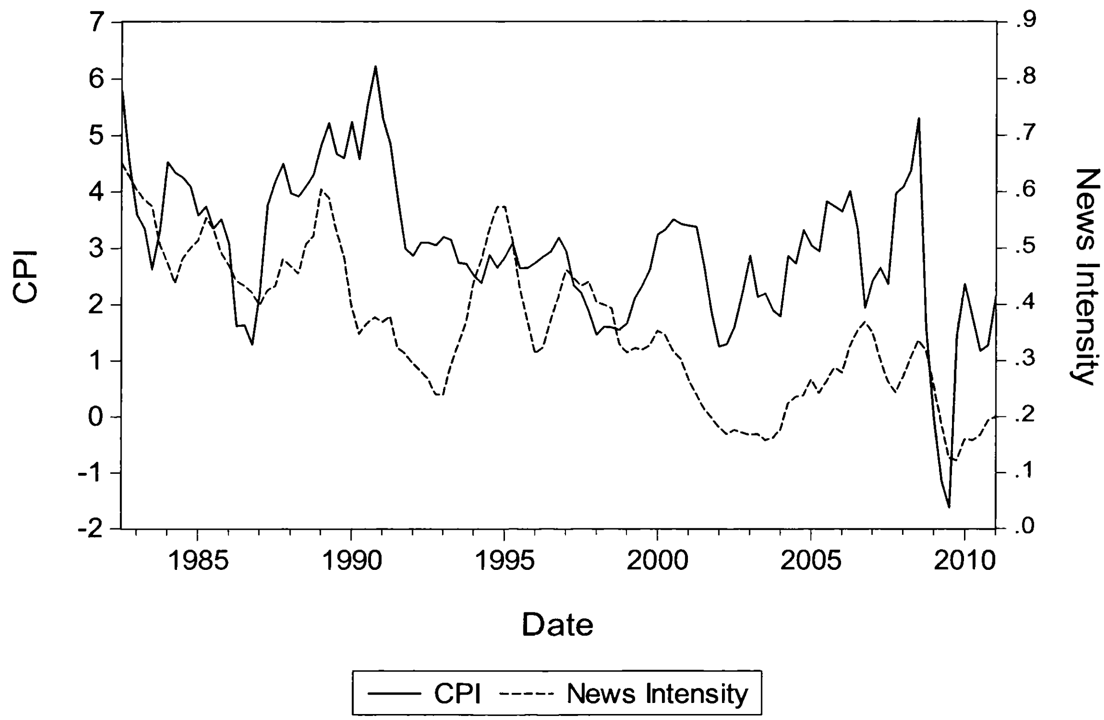

Table 6.3.3: News Intensity Descriptive Statistics

	η_t				
	Mean	**Median**	**Std. Dev.**	**Max.**	**Min.**
WHOLE 1982:3 – 2011:1	0.432	0.427	0.175	0.865	0.088
GREENSPAN–BERNANKE 1987:2 – 2011:1	0.401	0.389	0.167	0.865	0.088
STABLE 1990:1 – 2006:2	0.399	0.377	0.148	0.778	0.164
VOLATILE 2006:3 – 2011:1	0.288	0.287	0.122	0.520	0.088

[195] The index of news intensity is defined in a manner similar to Carroll (2003). Using the LexisNexis database, for each quarter between 1982Q1 and 2011Q1 a search was performed on the New York Times and Washington Post newspapers for stories containing the root 'inflation' in the headline or at the start. The results were filtered to remove duplicates and to consider reports concerned with the United States only. The number of reports in any given quarter t was then converted to an index by dividing by the maximum number of inflation reports which occurred in 1982Q1 and then taking the mean for $t-3, \dots, t$.

A key feature of Figure 6.3.1 is that the intensity of inflation news tracks the level of inflation. This is particularly evident for the mid-1980's through to the early 1990's and for the mid-2000's through to the end of the sample period. This could indicate a reporting bias by the media towards high or rising inflation as reported by Badarinza and Gross (2012).

A further feature observed from Figure 6.3.1 and Table 6.3.3 is that the level of news intensity is highest during the earliest years in the sample[196]. In contrast, more recent years are associated with relatively low levels of inflation news coverage. It is possible to speculate several reasons for this. Firstly, inflation may not have been considered as newsworthy with regards to macroeconomic conditions during the volatile sub-period in comparison with other indicators such as growth and unemployment. Secondly, lower news intensity in recent years may reflect more general trends in the media with the advent of television and online reporting rather than traditional printed newspapers. The measure of news intensity could therefore be considered outdated or inappropriate for more recent years.

Persevering with the Carroll (2003) type measure of news intensity; from Appendix 6.25, no clear relationship can be observed between inflation news intensity and professional disagreement at any forecast horizon. As professionals are well informed, their information set is likely to consist of wider sources than those available in publicly distributed newspapers. As a result, it is not unreasonable to hypothesise that professional expectations and associated disagreement is independent of news intensity. Nevertheless, to firmly establish the relationship between professional disagreement and inflation news intensity and the resulting implications regarding information rigidity, formal empirical testing is required.

As previously mentioned in 6.1, in their assessment of information rigidities amongst professional forecasters, Coibion and Gorodnichenko (2012) do not find any evidence that disagreement responds to news shocks. This was deemed consistent with the predictions of noisy information models. To re-examine the impact of news intensity upon the disagreement amongst professional forecasters (6.3.11), as presented by Badarinza and Gross (2012), shall be employed upon SPF inflation forecasts for $h = 0, \ldots, 4$.

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[196] Considering the period 1982Q3 to 1989Q4, mean news intensity is measured at 0.597.

$$\sigma_{t,t+h} = c + \beta_1 \sigma_{t-1,t-1+h} + \beta_2 \eta_t + \beta_3 \pi_t + \beta_4 \pi_t^2 + \beta_5 (\Delta\pi_t)^2 + u_t \qquad (6.3.11)$$

As Badarinza and Gross (2012) stress, the inflation level, the square inflation level and the square of the first difference in inflation are included as control measures for short term volatility and any reporting bias embodied within the measure of news intensity. Results from testing (6.3.11) are presented in Appendix 6.26 and Appendix 6.27.

Firstly, Appendix 6.26 presents the results for the unrestricted model. In accordance with Badarinza and Gross's (2012) results concerning public news, news intensity does not have a significant impact upon professional disagreement for any forecast horizon for the whole sample period. Following the predictions of information rigidity models as identified by Coibion and Gorodnichenko (2012), these results would indicate that professional disagreement is consistent with the predictions of noisy information rather than those of sticky information. Instead, the coefficient associated with lagged disagreement is highly significant[197]. Moreover, the exclusion of the lag as presented in Appendix 6.27 decreases the model's $\bar{R}^2$ value for these sample periods without affecting the general conclusions observed for the unrestricted model. This is again consistent with the results presented by Badarinza and Gross (2012). However, the results concerning the Greenspan-Bernanke, stable and volatile sub-periods suggest a greater role for the forecasting horizon in determining the appropriate model of information rigidity.

For longer forecasting horizons, β_2 remains insignificant, however, for shorter forecasting horizons, β_2 is found to be significant. Nevertheless, Coibion and Gorodnichenko (2012) document that for disagreement to be consistent with the predictions of sticky information, a positive response to shocks is required. The correlation between news intensity and disagreement is negative for the Greenspan-Bernanke and stable periods. Therefore, for periods of greater macroeconomic stability, an increase in news is associated with a fall in disagreement. In contrast, for the recent period of increased macroeconomic volatility, β_2 is generally found to be positive; an increase in news intensity thus generates greater disagreement. Consequently, only short horizon disagreement in the volatile sub-period can be

[197] Replacing contemporaneous news η_t with one-period lagged news η_{t-1} does not generally alter the conclusions inferred from Appendix 6.26 and Appendix 6.27. The values of $\bar{R}^2$ are broadly similar under both specifications too.

deemed consistent with Coibion and Gorodnichenko's (2012) predictions concerning sticky information. For the whole sample period and longer horizon forecasts in the three sub-periods the evidence is more in favour of noisy information models.

Unlike Mankiw et al. (2003) who report disagreement to be increasing in inflation, β_3 values are generally negative. This corresponds with Badarinza and Gross's (2012) post-2000 results and indicates greater agreement amongst professionals at higher levels of inflation. Moreover, for the stable sub-period, where inflation is generally low, β_3 is insignificant for all h suggesting that disagreement is independent of inflation during periods of greater macroeconomic certainty. In addition, the coefficients concerning squared inflation and the squared first-difference are generally small and positive. Both β_4 and β_5 are generally significant for the whole, Greenspan-Bernanke and volatile sub-periods yet both coefficients are insignificant across all forecast horizons for the stable sub-period. This suggests that disagreement amongst professionals is dependent upon the magnitude and volatility of inflation during periods of increased macroeconomic uncertainty.

These results are consistent with those presented by Badarinza and Gross (2012) and unsurprisingly indicate that disagreement falls during periods of reduced macroeconomic uncertainty. This feature, albeit a weak one, has been previously noted to be consistent with the predictions of sticky information as highlighted by Mankiw et al. (2003) and Coibion and Gorodnichenko (2012). It is nonetheless recognised that as (6.3.11) includes three coefficients associated with inflation, the results presented in Appendix 6.26 may be influenced by multi-collinearity issues. Of particular interest is the stable sub-period where β_3, β_4 and β_5 are collectively insignificant across all h. To firmly establish the impact of the level and magnitude of inflation independently from one another, (6.3.11) is re-examined, separately imposing the conditions $\beta_4 = 0$ and $\beta_3 = 0$, with the results presented in Appendix 6.28 and Appendix 6.29[198] respectively.

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[198] Under both specifications, the results concerning news intensity are analogous to those from the unrestricted model. Specifically, whilst sticky information is evident amongst short-horizon professional forecasts formed in the volatile sub-period, professional disagreement conforms to the predictions of noisy information models, as identified by Coibion and Gorodnichenko (2012) for the whole sample period and longer forecasting horizons across the three sub-periods. These results are unsurprising and indicate that the relationship between disagreement and news intensity, and its corresponding predictions for models of information rigidity are not dependent upon the control measures imposed.

Firstly, from Appendix 6.28, β_3 is observed to be positive for all h across the whole, Greenspan-Bernanke and stable sample periods; this is in contrast to the results presented in Appendix 6.26 where β_3 values were generally negative. These results now correspond with Mankiw et al. (2003) who observe a positive relationship between inflation and disagreement. Nevertheless, for the most recent period of macroeconomic volatility, whereas a significant negative relationship between disagreement and inflation was observed from Appendix 6.26, the value of β_3 in Appendix 6.28 is insignificant for $h \geq 1$; forecast disagreement can thus be deemed independent of inflation for the most recent period of macroeconomic uncertainty.

Similar results are observed, particularly for the stable and volatile sub-periods from imposing $\beta_3 = 0$. From Appendix 6.29, whilst β_4 is positive and significant for short horizon forecasts in the whole and Greenspan-Bernanke periods, and for all h in the stable sub-period, during the volatile sub-period, the relationship between inflation and disagreement is observed to be insignificant. From 6.1 it is recalled that Andrade and Le Bihan (2010) and Coibion and Gorodnichenko (2012) demonstrate that noisy information models predict that disagreement is independent of macroeconomic conditions, whilst sticky information predicts the reverse. Consequently, the sticky information hypothesis appears more appropriate for periods of greater macroeconomic stability, but the relationship between disagreement and inflation during the most recent period of macroeconomic volatility conforms to the predictions of noisy information[199].

Furthermore, under the unrestricted and both restricted model specifications, β_5 is positive and significant for short horizon forecasts in the whole, Greenspan-Bernanke and volatile sub-periods. For these forecasts, disagreement and inflation volatility thus possess a positive relationship which Mankiw et al. (2003) indicate to be consistent with staggered expectation adjustment. Moreover, this evidence suggests that information rigidities are more pronounced for short horizon forecasts in periods associated with greater macroeconomic uncertainty. In contrast, for longer forecast horizons and the stable sub-period, β_5 is generally insignificant.

[199] Long horizon forecasts in the whole and Greenspan-Bernanke periods are also consistent with the predictions of noisy information.

Although the SPF fixed-event and fixed horizon inflation and GDP forecasts have received widespread attention in the literature[200], probability forecasts contained in the 'Anxious Index[201]' have often been ignored[202]. This series, which refers to the probability of a decline in real GDP, as reported by SPF respondents, provides an interesting approach in determining the manner which forecasters disagree. Furthermore, these probability forecasts are likely to embody information additional to those of point forecasts and provide an indication to the uncertainty encountered by professionals in producing appropriate forecasts. Anxiety shall be examined along with news intensity and disagreement to determine whether the relationships conform to the predictions of information rigidity models.

To examine the impact of anxiety the Badarinza and Gross model (6.3.11) shall be re-formulated. Firstly, disagreement σ_t and its associated lagged value shall be replaced with the respective measure of anxiety ϕ_t[203]:

$$\phi_{t,t+h} = c + \beta_1\phi_{t-1,t-1+h} + \beta_2\eta_t + \beta_3\pi_t + \beta_4\pi_t^2 + \beta_5(\Delta\pi_t)^2 + u_t \qquad (6.3.12)$$

Results from testing (6.3.12) are presented in Appendix 6.30. The relationship between news intensity and anxiety appears dependent upon the forecast horizon. Specifically, whereas at short forecast horizons the relationship across all four sample sample periods is insignificant, at longer forecast horizons, namely $h = 3$ and $h = 4$, the relationship is positive and significant. Therefore, as inflation news intensity rises, anxiety concerning declines in real GDP at longer forecast horizons increases. Similar to tests of (6.3.11), excluding lagged anxiety does not alter these conclusions, the only difference is the fall in $\bar{R}^2$.

Rather than replacing disagreement with anxiety, the Badarinza and Gross (2012) model (6.3.11) can also be adapted by replacing news intensity with anxiety as demonstrated by (6.3.13) below:

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[200] Examples include Zarnowitz (1985), Keane and Runkle (1990) and Clements (2012).
[201] The term 'Anxious Index' was introduced by David Leonhardt in an article in the New York Times on September 1st, 2002 and refers to the probability of a decline in real GDP as reported by SPF respondents.
[202] Notable exceptions include Zarnowitz and Lambros (1987) Giordani and Söderlind (2003) and Clements (2008).
[203] The measure of news intensity employed refers to the Carroll measure as detailed earlier in this sub-chapter. Utilising the baseline measure of news intensity yields quantitatively similar results.

$$\sigma_{t,t+h} = c + \beta_1\sigma_{t-1,t-1+h} + \beta_2\phi_{t,t+h} + \beta_3\pi_t + \beta_4\pi_t^2 + \beta_5(\Delta\pi_t)^2 + u_t \qquad (6.3.13)$$

The results from tests (6.3.13) are presented in Appendix 6.31. For the whole, Greenspan-Bernanke and stable periods there is no significant correlation between anxiety and disagreement[204]. Assuming anxiety proxies for economic shocks, the lack of any response is consistent with Coibion and Gorodnichenko's (2012) predictions of noisy information models. In contrast, for $h = 0, \dots, 3$ in the volatile period, the relationship between disagreement and anxiety is both positive and significant. Following Coibion and Gorodnichenko (2012), this is consistent with the predictions of sticky information. Similar to tests of (6.3.11) and (6.3.12), the impact of excluding lagged disagreement only results in a reduction in $\bar{R}^2$.

Regressing disagreement on shocks, akin to Andrade and Le Bihan (2010), the relationship between disagreement and macroeconomic shocks shall be re-evaluated. Specifically, disagreement amongst h-period ahead forecast is regressed upon $\Delta\pi_{t-1}$, the most recent change in the inflation rate, $(e_{t-1,t-h-1})^2$, the most recent squared forecast error, $|E_t[\pi_{t+h}] - E_{t-1}[\pi_{t+h-1}]|$ the current absolute change in the forecast and $|\theta_t - \theta_{t-1}|$, the most recent absolute change in oil prices:

$$\sigma_{t,t+h} = c + \alpha|\Delta\pi_{t-1}| + \beta(e_{t-1,t-h-1})^2 + \gamma|E_t[\pi_{t+h}] - E_{t-1}[\pi_{t+h-1}]| + \lambda|\theta_t - \theta_{t-1}| + \epsilon_t \qquad (6.3.14)$$

Tests of (6.3.14) for forecast horizons $h = 0, \dots, 4$ across all four sample periods are presented in Appendix 6.32. It is evident that the response of disagreement is dependent upon the shock, the forecast horizon and the sample period. The specification employed in (6.3.14) can be considered a compromise between the models employed by Andrade and Le Bihan (2010) and Coibion and Gorodnichenko (2012); whilst Coibion and Gorodnichenko (2012) analyse the impact of specific disturbances, Andrade and Le Bihan (2010) analyse key determinants of disagreement to a wide range of shocks. This specification shall look at the response of disagreement to both general and specific shocks.

For the whole and Greenspan-Bernanke sample periods, whilst α is insignificant, β, γ and λ are generally positive and significant. These results are therefore

[204] β_2 is however significant for $h = 1$ in the stable sub-period.

analogous with those presented by Andrade and Le Bihan (2010); although the dispersion of inflation forecasts is generally independent of changes in the inflation rate, disagreement increases in response to all other shocks. Nevertheless, for longer forecast horizons, particularly $h = 4$, the coefficients are less significant. For the whole and Greenspan-Bernanke periods, the response of disagreement across short horizon forecasts is thus most consistent with the predictions of sticky information models as presented by Coibion and Gorodnichenko (2012). Contrastingly, the insignificance of β, γ and λ, most notably for $h = 4$ in the Greenspan-Bernanke sub-period, suggests that noisy information may be a more appropriate hypothesis for longer horizon forecasts in these sample periods[205].

For the stable and volatile sub-periods, the conclusions are more ambiguous. There is some evidence that disagreement responds to shocks; for example, λ is significant for $h = 1, \ldots, 4$ in the stable sub-period and $h = 0,1,2$ in the volatile sub-period. Additionally, γ is significant at the 5% level in the volatile sub-period for $h = 0,3,4$. However, β is generally insignificant for all h across both the stable and volatile sub-periods and α is insignificant in the stable sub-period for longer forecast horizons and for $h = 0,1,3,4$ in the volatile sub-period. Therefore, whilst there is some evidence in favour of a positive response to certain shocks, disagreement is independent of other disturbances.

Nevertheless, excluding oil price shocks from (6.3.14), establishing the model employed by Andrade and Le Bihan (2010), clearer conclusions emerge for the stable sub-period. From Appendix 6.33, there is evidence of a significant response to shocks in accordance with Coibion and Gorodnichenko's (2012) predictions concerning sticky information for $h = 0$ and $h = 1$. In contrast, for longer forecasting horizons, professional disagreement does not respond to shocks, indicating that models of noisy information are most appropriate.

To determine the sensitivity of these results to the selection of shock, (6.3.14) is re-estimated, replacing oil price shocks with news shocks $|\eta_t - \eta_{t-1}|$ with the results presented in Appendix 6.34. The response of disagreement to inflation, forecast errors and forecast fluctuations are unsurprisingly similar to that presented in

[205] Excluding λ and the effect of oil prices, disagreement appears to be an increasing function of non-specific shocks at all horizons for the whole and Greenspan-Bernanke periods. This suggests that professional forecasts at all horizons are most consistent with the sticky information hypothesis.

Appendix 6.33. For the Greenspan-Bernanke and sub-periods, news intensity is generally insignificant. For the volatile sub-period and $h = 2,3$ for the whole period, the response of disagreement to news intensity shocks is positive and significant. Following the predictions of Coibion and Gorodnichenko (2012), this adds to the evidence that professional disagreement is more consistent with sticky information models during periods of increased macroeconomic uncertainty. In contrast, noisy information models appear to better characterise the dispersion of professional inflation forecasts during periods of relative stability. Meanwhile, analysing the effects to professional disagreement of replacing oil price shocks with news shocks for the volatile sub-period is unable to provide precise conclusions regarding the most appropriate model of information rigidity; whilst α and β are not significant for any forecasting horizon, γ is significant for all h. Alternative tests of information rigidity will thus need to be considered in an attempt to determine which model of information rigidity best characterises professional forecasters for the most recent period of macroeconomic uncertainty.

Information rigidities which generate disagreement amongst agents have been of increasing interest for macroeconomic modelling with the sticky information and noisy information hypotheses prominently cited. Whilst Mankiw et al. (2003) argue that the sticky information hypothesis is able to explain the dispersion amongst Livingston Survey expectations, Coibion and Gorodnichenko (2012) do not find any evidence that professional disagreement responds to shocks in accordance with noisy information. Re-examining formal empirical models concerning information rigidities,. the results presented in this section indicate that there is some ambiguity regarding which model of information rigidity is most consistent with disagreement amongst SPF inflation forecasts; instead the relationship is dependent upon the sample period, forecast horizon and the properties of the shock imposed on the economy. Evaluating the predictions of sticky information and noisy information models, Coibion and Gorodnichenko (2012) indicate that a positive response of disagreement to any shock would be consistent with the former. Although there is more evidence in favour of sticky information, any conclusions appear dependent upon the nature of the shock, the sample period and the forecast horizon. Notably, noisy information appears more appropriate for longer forecasting horizons and the most recent period of macroeconomic uncertainty.

6.4. Discussion

A primary objective of this study is to ascertain the manner which agents formulate expectations regarding key macroeconomic variables and whether they conform to previously established models and theories. Exploiting the multi-horizon structure of the SPF, this chapter evaluates the properties of fixed-horizon, fixed-event and the cross-sectional dispersion of professional forecasts. In Chapter 3, empirical testing was unable to confirm that professional inflation forecasts are fully consistent with the properties of rational expectations, nor were they adequately characterised by traditional models with inherent backward-looking rules. Moreover, in the previous chapter, tests of Carroll's (2003) epidemiological model concluded that household forecasts were subject to frictions in the acquisition and processing of information.

In accordance with recent research, including notable contributions by Mankiw et al. (2003), Andrade and Le Bihan (2010) and Coibion and Gorodnichenko (2010, 2012), this chapter has confirmed that professional inflation forecasts are inconsistent with underlying assumptions of full information and has reconsidered the presence of rigidities constraining the acquisition and processing of information. As professionals are generally considered as informed agents, the acknowledgement that their expectations exhibit some degree of informational inattentiveness may have uncomfortable implications for a variety of macroeconomic models and thus be dismissed by some economists. Nevertheless, this study emphasises that not only are professional forecasts subject to some degree of information friction, the most applicable model is dependent upon the forecasting horizon and the macroeconomic conditions characterising the sample period.

Preliminary tests concerning the adding up of quarterly forecasts to the annual forecast akin to Clements (2012) suggested that professional inflation forecasting process is not subject to attentiveness. For periods of relative macroeconomic stability, formal empirical models concerning forecast revisions generally support this view through the rejection of the information rigidity null hypothesis or incompatibility with the predictions of the respective models.

Contrastingly, for periods of increased macroeconomic uncertainty, the prevalence of information rigidities appears stronger although the appropriate model is unclear.

Utilising the Coibion and Gorodnichenko (2010) framework, significant information rigidities were observed across the whole sample period across forecast updates for $h = 1, \ldots, 3$; furthermore, under the sticky information hypothesis, these forecasts were associated with professionals updating their information every four to six months. However, tests of (6.3.9) for the whole sample period deemed forecast revisions at any horizon to be inconsistent with any model of information rigidity. Moreover, for the volatile sub-period the Coibion and Gorodnichenko (2010) model found evidence of information rigidities for shorter forecast horizons only whilst for $h = 1, \ldots, 4$ forecast revisions are consistent with the predictions of both noisy and sticky information models.

The examination of fixed-horizon forecasts suggests that the degree and most appropriate model of information rigidity is ambiguous and may be conditional on the shock imposed on the economy. Conforming to the predictions of information rigidity models, the response of forecast errors to oil price shocks was positive and significant; however, in accordance to the REH, the response of forecast errors to news intensity shocks is insignificant. The results concerning news intensity may however be unreliable, with this class of shock accounting for no more than 5 percent of inflation volatility in the whole, Greenspan-Bernanke and stable sample periods[206]; in comparison, oil price shocks for these three sample periods generally account for over 20 percent of inflation volatility and are thus able to provide stronger and more reliable predictions regarding the prevalence of information rigidities. Moreover, that Coibion and Gorodnichenko (2012) report contrasting results emphasises that the manner which shocks are specified is critical in ascertaining whether professional forecasts conform with the predictions of information rigidity models.

Despite being recognised as some of the most informed agents, 6.2.2, in accordance with Mankiw et al. (2003) and Dovern et al. (2013) identified substantial disagreement amongst professional disagreement. Specifically, whilst disagreement was observed for all forecast horizons, reduced levels of forecast consensus arise for periods of recession and greater macroeconomic volatility. Re-examining formal

[206] Results concerning news intensity shocks for the volatile period may be considered more reliable as the associated variance decomposition attributes up to 30% of the inflation volatility to these shocks.

empirical models, there is some ambiguity regarding the relationship between professional disagreement and information rigidities. From (6.3.10) an invariably positive response in disagreement was observed for both recession and the volatile sub-period; this was deemed to be consistent with Coibion and Gorodnichenko's (2012) predictions for sticky information. Nevertheless, the introduction of more specific shocks in (6.3.11), (6.3.12) and (6.3.9) was unable to provide similarly unambiguous conclusions regarding the most appropriate model of information rigidity. Whilst professional disagreement across short horizon forecasts appears most consistent with Coibion and Gorodnichenko's (2012) predictions for sticky information, particularly for the whole, Greenspan-Bernanke and volatile periods, disagreement across longer horizon forecasts generally conform to the predictions of noisy information. Furthermore, whilst evidence of sticky information is found for short horizon forecasts in the volatile sub-period, noisy information appears more prevalent for periods of increased macroeconomic stability.

Re-examining formal empirical models, there has been no overwhelming evidence to classify professional inflation forecasts as consistent with a single model of information rigidity. Whilst these tests have found mixed evidence, appearing to be most consistent with Coibion and Gorodnichenko's (2012) predictions concerning either sticky information or (baseline) noisy information models, tests concerning absolute shocks were able to dismiss models of heterogeneous agent signals, priors and loss aversion as proposed by Capistrán and Timmermann (2009) and Patton and Timmermann (2010). Moreover, several broad features of information rigidities have emerged. Firstly, information rigidities generally appear to be greater for shorter forecast horizons and during periods of increased macroeconomic uncertainty; for periods of increased stability, formal empirical testing generally dismisses the presence of information frictions. Furthermore, whilst short-horizon forecast are consistent with the predictions of sticky information, particularly for the whole, Greenspan-Bernanke and volatile periods, the properties of longer horizon forecasts are more consistent with noisy information. This appears to refute Mankiw et al.'s (2003) proposal that information rigidities are determined by an exogenously given constant and Dovern et al.'s (2013) analysis that information rigidities are monotonically increasing with the forecast horizon. That noisy information better characterises longer horizon forecasts accords with economic reasoning. As professionals are considered to be well informed, they recognise that updating of information and expectations is required as the forecastable event approaches due to unanticipated news. This is incompatible with sticky information. Instead, it is more economically reasonable that at longer horizons, professionals recognise that information is imperfect but adjust their forecasts to news which corresponds with noisy information.

It is unsurprising that the forecasting behaviour of professionals changes under various macroeconomic circumstances. For example, as the forecast horizon shortens, not only would additional information have been revealed and/or incorporated into forecasts, there is also less scope for the onset of a surprise shock to influence the path of the forecasted variable. Furthermore, it is documented that disagreement and information rigidities are larger during the volatile period and recessions, which can be attributed to an increase in general macroeconomic uncertainty. During periods of relative stability, where inflation volatility is much reduced, not only will the behaviour of macroeconomic variables be more predictable, but information acquisition and processing costs are likely to be reduced. Therefore, that empirical testing revealed that information frictions are less pronounced amongst professional forecasts during the stable period adheres to macroeconomic theory and conventional wisdom.

An unresolved issue beyond the scope of this study concerns determining the most appropriate measure of disagreement for professional forecasts and whether the use of alternative measure has implications for models of information frictions and more general theories of macroeconomic expectations. Whilst both the IQR and standard deviation have limitations, the former was dismissed on the grounds that despite being more robust to outliers, the IQR fails to capture the full extent of belief heterogeneity amongst forecasters.

The empirical analysis in 6.3.2 considered the response of forecast properties to a range of structural shocks and considered whether they conformed to the predictions of information rigidity theory. Whilst Coibion and Gorodnichenko (2012) observe that technology, news, oil price an unidentified shocks result in a significant response in forecast errors, the results in 6.3.2 suggest that forecast errors do not respond to these shocks over certain periods. The conflicting results were attributed to differences in the sample period and sensitivity to the specification and assumptions associated with the various shocks. This suggests that the evidence in favour of information rigidities, or otherwise, is not robust. Future studies may wish to explore the extent which the conclusions concerning the response of professional forecast errors to shocks and the relationship with information rigidities is sensitive to various specification alterations.

Further research may also wish to examine the impact of different measures of disagreement amongst macroeconomic expectations and extend the analysis across forecasts for alternative variables. Besides, as more data is contributed and released over time, further insights into professional forecast behaviour shall be revealed. In the meantime, future studies could consider whether there is substantial heterogeneity between professionals from different sectors and compare FOMC forecasts to those of economists with academic and commercial backgrounds. Moreover, the integration of inattentive professional forecasts and those of households, akin to Maćkowiak and Wiederholt (2010) may provide further insights into information rigidities and interesting implications for wider macroeconomic analysis.

CHAPTER 7: CONCLUSION

Expectations are keystone economic variables, allowing for appropriate decision making in the presence of uncertainty regarding the future. The manner in which economic agents formulate their perceptions of future events has been long debated, with expectations of critical importance for numerous macroeconomic relationships, and to date remains a keen topic of interest for economists. Utilising aggregate data from the SPF and both aggregate and disaggregate data from the Michigan Survey of Consumers, this thesis has empirically analysed and evaluated the manner which agents formulate their inflation expectations, employing a range of methodologies and econometric techniques including OLS, GMM and VAR estimation.

The evaluation of how the expectation formation process evolves over time commences in Chapter 2 with the identification of the properties of survey forecasts. Analysing forecast error statistics from both the SPF and Michigan Survey there is insufficient evidence to declare that the expectations of either professionals or households consistently outperform the other, with conclusions dependent upon the specific measure employed and the sample period under consideration. Specifically, compared to the whole sample period, smaller forecast errors are observed for both agent classes for the stable sub-period yet are much larger for the most recent volatile sub-period; forecast accuracy is thus deemed to be dependent upon macroeconomic conditions. Moreover, empirical tests were generally unable to reject the equality of MFE's and MSFE's between the two agent classes. Nevertheless, the utilisation of consensus forecasts are likely to conceal individual inaccuracies, thus in accordance with Zarnowitz and Braun (1993) and Thomas (1999) as they are considered better informed, the typical professional is likely to report superior expectations in comparison to the typical household.

The analysis of survey forecasts in Chapter 2 identified time-variant properties amongst agent perceptions of the future rate of inflation, however, this was argued to not be particularly informative to economists regarding the expectation formation process undertaken by either agent class. Considering the compatibility of survey forecasts to various model predictions, Chapter 3 extensively investigates whether traditional theories of expectation formation are able to embody the evolution of aggregate professional and household inflation forecasts. Whereas backward-looking theories including the static and adaptive expectations hypotheses are concluded to assume excessive myopia on the part of agent forecasting behaviour, survey forecasts are also not fully consistent with the predictions of the rational expectations hypothesis. Nevertheless, the relevance of traditional theories of expectation formation is concluded to be agent specific and time-dependent. Whereas for the whole, Greenspan-Bernanke and volatile sample periods, household expectations are more consistent with the predictions of the REH, for periods of greater macroeconomic stability, professionals appear to utilise increased levels of backward-looking behaviour in formulating their inflation forecasts. Nevertheless, for the volatile sub-period, expectations reported by both agent classes exhibit significant deviations from the properties required under rationality.

In accordance with the approach adopted by various models, which make assumptions regarding a representative agent, Chapter 2 and Chapter 3 analyse the expectation formation process for aggregate expectations; despite simplifying the complex process of expectation formation and ensuring greater tractability, economists have long recognised that such assumptions bypass the reality of expectational heterogeneity amongst agents. In a similar manner to Bryan and Venkatu (2001a, 2001b), Souleles (2004) and Pfajfar and Santoro (2008), utilising disaggregate inflation forecasts reported by the Michigan Survey, Chapter 4 analyses expectational heterogeneity across demographic groups. In accordance with the results for aggregate expectations presented in Chapter 2, all demographic groups tend to overestimate the future rate of inflation whilst larger forecast errors were again observed for the volatile sub-period. Nevertheless significant differences between demographic groups were established with higher education and income groups and men realising lower forecast errors relative to less advantaged counterparts and women. These households are thus deemed to be sufficiently well informed, and utilise more sophisticated forecasting techniques. Other demographic characteristics, such as region of residence, were found to have a much smaller impact upon the expectations of households as the null hypotheses of equality of both reported forecasts and realised forecast errors generally unable to be rejected at conventional significance levels.

Whereas the majority of studies concerning expectations tend to solely focus upon the reported expectations and forecast errors, measures of central tendency are unable to reveal the full extent of expectational differences of typical agents across demographic groups. Extending the analysis presented by Mankiw, Reis and Wolfers (2003), Chapter 4 further identifies that those groups reporting larger forecast errors, including women and those with lower levels of education or income, exhibit higher levels of forecast dispersion and disagreement relative to men and more advantaged households. These findings were attributed to heterogeneous information acquisition and processing costs across demographics, however, the properties of disagreement were found to be fairly time-insensitive with similar levels of forecast dispersion observed for both the stable and volatile period across demographics. Furthermore, whilst over the sample period a negative trend in disagreement amongst individual demographic groups was observed, a robust negative relationship across all agent classes is observed between the level of forecast dispersion and the output gap; in accordance with Dovern et al. (2012) the level of expectational disagreement amongst agents is thus deemed to increase in response to recessionary macroeconomic conditions.

In accordance with Lamla and Maag (2012) and Menz and Poppitz (2013) the analysis of the determinants of household forecast disagreement in Chapter 4 reveal a significant negative relationship between the perceived level of news and forecast dispersion. This suggests that the volume of news has some role in achieving expectational consensus amongst households, and may further suggest some role for greater communication by policymakers in reducing forecast dispersion. Nevertheless, whilst the impact of favourable news on household disagreement is found to be generally insignificant, greater expectational consensus is observed in response to unfavourable news. This appears to correspond with the argument proposed by Mankiw and Reis (2002) and Pfajfar and Santoro (2010) that agents are more attentive when inflation matters or when the opportunity costs associated with inattentiveness are sufficiently high. Similarly, the analysis in Chapter 6 revealed that professional disagreement is consistent with the predictions of information rigidity models. However, the appropriate model of information rigidity is ambiguous: professional disagreement over longer forecast horizons, and for the whole, Greenspan-Bernanke and volatile sample periods appears most consistent with the sticky information model, whilst the properties of noisy information appear consistent with disagreement over shorter forecast horizons and the stable sub-period.

Various explanations for the occurrence of differences in expectations amongst demographic groups have been proposed by economists. Whereas Hobijn and Lagakos (2005), McGranahan and Paulson (2006), and Hobijn et al. (2009) consider the effect of inflation differentials across demographic groups, Bruine de Bruin et al. (2010c) and Burke and Manz (2010) propose that expectational heterogeneity results from differences in economic and financial literacy amongst groups. Whereas the former may be more relevant for age and regional expectational differences, the latter may be more appropriate for asymmetries between education, income and gender disaggregations. Additionally, there may be further biasing effects embodied in the reported expectations of individual demographic groups arising from specific prices (Bruine de Bruin et al., 2011b), the frequency which various commodities are purchased (Ranyard et al., 2008, Georganas et al., 2014) or by the procedure or wording employed by surveys in collating price or inflation expectations (Bruine de Bruin et al., 2010b, Coibion and Gorodnichenko, 2010). Further research regarding differences in inflation expectations between demographic groups is thus required to fully establish the relative impact of the various underlying influences upon expectation asymmetries across varying macroeconomic conditions.

In response to the failures of traditional expectation theories to fully accommodate the manner which agents formulate their expectations, economists have devoted attention to developing alternate theories which mitigate the limitations of standard approaches. Section 3.3 identifies several alternatives including incomplete information RE, bounded rationality and adaptive learning; whilst not explicitly examined within this study, future research may wish to consider whether survey forecasts are consistent with the predictions of these theories, and the extent to which heterogeneity prevails across demographics and macroeconomic conditions. Instead, Chapter 5 and Chapter 6 consider a prominent alternative, namely models of information rigidities, specifically focusing on theories of sticky information and noisy information in the manner proposed by Mankiw and Reis (2002), and Sims (2003, 2006), Woodford (2003) and Maćkowiak and Wiederholt (2009) respectively.

An interesting application of the sticky information theory concerns the epidemiological, or survey-updating, model presented by Carroll (2003, 2006) which advocates that households update their information upon infrequently encountering and absorbing media reports on inflation which are synonymous with the expectations of professionals. Empirical tests in Chapter 5 re-examine Carroll's epidemiological survey-updating model and two prominent alternatives, namely the naïve sticky information and rational updating models of Lanne et al. (2009) and Nunes (2009) respectively. Whereas the sticky information hypothesis presented by Mankiw and Reis (2002) implicitly proposes that the rate of information updating is constant, the results from the three epidemiological models across the four sample periods evidently show that the frequency that agents update their information is time-variant. Specifically, a higher frequency of information updating is observed for the stable sub-period, deemed to be indicative of agents being unwilling to incur the larger costs associated with the acquisition and processing of information during periods of increased macroeconomic volatility.

Additionally, analysis of the three epidemiological frameworks for disaggregated expectations revealed that household demographics impact upon the frequency of information updates. Specifically, higher rates of updating across the various models were generally observed for men and those households with higher levels of education or income; in contrast, a U-shaped relationship was generally observed between the frequency of information updates and age whilst, in general, no discernible relationship was observed for regionally disaggregated expectations. Whereas higher rates of attentiveness amongst higher education and income groups were again attributed to lower information acquisition and processing costs compared to less advantaged counterparts, lower rates of attentiveness exhibited by the middle-aged were assigned to a greater reliance on both current and historical price experiences in the formation of inflation expectations.

Proposing a model of heterogeneous updating, including elements of the survey updating, naïve sticky information and rational updating theories, Chapter 5 further highlights that agents update their information heterogeneously, utilising a range of news sources. Moreover, it is observed that households are more likely to update in accordance to the forward-looking rational updating framework during periods of greater stability, resorting to more backward looking updating behaviour where macroeconomic conditions are more volatile. The conclusion that households across demographic groups infrequently update their information associated with inflation expectations, whilst the rate of information diffusion is heterogeneous, will likely effect the conduct of policymaking. As previously emphasised by Sims (2009), the optimal communication strategy employed by policymakers may not be homogeneous across agents and instead feature multi-tiered characteristics, accommodating heterogeneity in agent priors and the expectation formation process, the rate of information diffusion, and the degree of attentiveness to individual information sources. Akin to the analysis presented by Brock and Hommes (1997) and Branch (2007), future research may thus wish to consider the rate at which households switch between the various updating behaviours, and whether such differences are dependent upon the sample period and household demographics.

Whereas Chapter 5 investigates whether the inconsistency of household expectations with the properties of traditional theories results from infrequent information updates, Chapter 6 extensively analyse the informational properties of the expectation formation process of professionals. Exploiting the multi-horizon structure of the SPF, professional expectations were established to be subject to significant forecast updates and forecast revisions, violating the underlying assumptions of full information. Moreover, despite being recognised as some of the most informed agents, in accordance with Mankiw et al. (2003) and Dovern et al. (2013), professional expectations are subject to persistent levels of disagreement. Following recent contributions by Andrade and Le Bihan (2010), Coibion and Gorodnichenko (2010, 2012), Clements (2012), and Dovern et al. (2012, 2013) forecast updates, forecast revisions and disagreement from the SPF are found to be be consistent with the predictions of information rigidity models. As for household expectations, information rigidities were found to be stronger for periods of increased macroeconomic volatility. In contrast, for periods of greater macroeconomic stability, where information acquisition and processing costs are lower, the presence of information rigidities is dismissed. Furthermore, whilst long-horizon forecasts were found to be more consistent with the predictions of noisy information, as the event horizon nears professional expectations exhibit greater consistency with sticky information theory.

This study has analysed the manner in which agents form their inflation expectations and their empirical consistency with various theories. Agent expectations regarding future macroeconomic events are however generally considered unobservable with various theories endogenously deriving expectations under specific assumptions. The empirical analysis of expectation theory in this study has instead employed quantitative inflation forecasts available from prominent surveys in the United States. Despite this approach having been widely adopted by expectation formation studies, these direct measures of agent expectations were however noted to suffer from a number of limitations as highlighted in 2.1.3. These include the absence of appropriate incentives as highlighted by Keane and Runkle (1990), Roberts (1998) and Ottaviani and Sørensen (2006), and differential interpretations of survey questions (Bruine de Bruin et al., 2010b, Coibion and Gorodnichenko, 2010). The observation that agent inflation forecasts are not fully consistent with the predictions of traditional expectation theory, and are instead characterised by models of information rigidities may thus be a consequence of inappropriate procedures employed in the collation of inflation or price expectations. As previously highlighted, these issues are evidently more prominent for the Michigan Survey.

An elementary amendment to the Michigan Survey would be to amend the wording of the inflation and prices question to specifically request agents to provide a forecast for some prominent measure of inflation such as CPI or RPI. Some may argue that a proportion of agents will lack the required economic or financial literacy in the manner detailed by Bruine de Bruin et al. (2010c) and Burke and Manz (2010) to be able to provide an informed forecast of these measures. Nevertheless, following the current procedure of the Michigan Survey to estimate price expectations, it would be advised to include a secondary question which clarifies the construction of the respective price indices. To resolve the incentives issue, surveys may wish to impose some rule that future participation is dependent upon past performance. For example, should forecast errors of an individual respondent over a fixed time period exceed some threshold relative to either the forecast variable or the consensus forecast, their future participation may be temporarily suspended or withdrawn indefinitely. A rule akin to this example could be applicable to the SPF, yet cannot be applied to the Michigan Survey where respondents partake in a single re-interview. The imposition of some accuracy rule would however introduce their own issues as the relative uncertainty and unpredictability of the future value of the forecast variable and general macroeconomic conditions would need to be taken into consideration whilst it may also introduce some bias upon the reported forecasts of agents. Furthermore, smaller deviations from the consensus forecast may not necessarily be indicative of greater forecast accuracy, whilst those with extreme views may occasionally be correct. Another alternative to the incentives issue is the provision of monetary rewards; however, these also require appropriate implementation to be effective. The issue of the procedure to collate inflation or price expectations, including appropriate wording of survey questioning and the resulting impact upon the accuracy of expectations across agents, is thus of interest to economists; these issues warrant further research to determine whether the current approaches employed by the SPF, Michigan Survey and other sources of agent expectations are appropriate, or whether they have the capacity to be improved.

In recent years there has been growing interest in deviations from the traditional theories of expectation formation with models across a variety of macroeconomic issues considering the impact of imperfect information. The availability of agent forecasts, as published in prominent surveys has enabled the assessment of the expectation process for several key hypotheses. Specifically, this study has identified that information rigidities are embodied within the forecasts of various agent classes. Incorporating the implications of these findings to policy making and decisions on consumption, wage-setting and price-setting may further assist in the understanding of agent behaviour over time and macroeconomic conditions.

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EXPECTATIONS AND INFORMATION IN THE UNITED STATES 1982-2011:

AN EMPIRICAL EXAMINATION OF INFLATION FORECASTING BETWEEN PROFESSIONALS AND HOUSEHOLDS

by

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APPENDICES FOR CHAPTER 2

Appendix 2.1. Survey Questions

In this section the questions posed by the SPF and Michigan Survey regarding inflation are extensively analysed.

Section 3 of the 2011:Q1 SPF questionnaire, the latest date employed in this study, includes the following table regarding four alternative measures of inflation which respondents are required to complete:

	Quarterly Data (Q/Q)						Annual Data (Q4/Q4)			
	2010:Q4	2011:Q1	2011:Q2	2011:Q3	2011:Q4	2012:Q1	2010	2011	2012	2013
CPI Inflation Rate	2.6						1.2			
Core CPI Inflation Rate	0.4						0.6			
PCE Inflation Rate	1.8						1.2			
Core PCE Inflation Rate	0.4						0.8			

Section 1 of the 2011Q1 SPF questionnaire requests respondents to provide forecasts for the GDP Price Index (Chain) in a similar manner.

The Michigan Survey utilises the following procedure in section A12 to record the inflation forecasts of respondents:

A12. During the next 12 months, do you think that prices in general will go up, or go down, or stay where they are now?

1. Go Up 4. Stay the Same 5. Go Down 8. Don't Know

If a stay the same response is given, the interviewer asks the following question:

A12a. Do you mean that prices will go up at the same rate as now, or that prices in general will not go up during the next 12 months?

2. Go Up   3. Will Not Go Up

Where the participant has responded with "Go Up" (either A12. or A12a.) or "Go Down" the interviewer asks the following to quantify the agents forecast:

A12b. By about what percent do you expect prices to go (up/down) on the average, during the <u>next</u> 12 months (use probe if answer is greater than 5%)

If respondent gives an answer that is greater than 5%, the interviewer is asked to probe the respondent with the following:

"Let me make sure that I have that correct. You said that you expect prices to go (up/down) <u>during the next 12 months</u> by (X) percent. Is that correct?"

In the event that the respondent provides a "don't know" response to question A12b. the interviewer is asked to probe the respondent with the following:

A12c. How many cents on the dollar do you expect prices to go (up/down) on the average, during the next 12 months?

Appendix 2.2. Alternative Surveys of Inflation Expectations

Professional inflation forecasts from the US can be obtained from several reliable sources with empirical studies frequently employing data from the Livingston Survey of Professional Economists, Consensus Economics and the Survey of Professional Forecasters (SPF).

Founded in June 1946 by the columnist Joseph Livingston, and having been conducted semi-annually in June and December since, the Livingston Survey of Professional Economists (Livingston Survey henceforth) is the oldest compilation of US inflation expectations (Thomas, 1999). Upon the death of Livingston, in 1989 the Federal Reserve Bank of Philadelphia has compiled the survey. A number of issues concerning the survey have, however, been identified. Firstly, prior to December 2004 respondents were requested to provide an expectation for the consumer price index rather than inflation per se, thus prior assumptions regarding its current level were required before inflation rates could be derived. Moreover, due to a one month lag between the responses being made and publication, Livingston often made adjustments to account for the arrival of new information (Thomas, 1999). Therefore, some caution is required when analysing Livingston Survey data. An alternative is the Consensus Economics forecast. Established in 1989, Consensus Economics compiles economic forecasts from private sector forecasters for numerous economies around the world.

The SPF was first conducted in 1968Q4 and until 1990Q1 was conducted by the American Statistical Association (ASA) in conjunction with the National Bureau of Economic Research (NBER). Since 1990Q2, the SPF has been conducted by the Federal Reserve Bank of Philadelphia. In 1981Q3, the survey was expanded with new variables added including four-quarter ahead expectations concerning the CPI rate of inflation[207,208]. The scale of the SPF has varied over time. In the early years participant numbers exceeded 50 yet over the 1970's and 1980's the number of participants steadily declined to fewer than ten in 1990 (Croushore, 1993, D'Agostino et al., 2012). Since the survey has been conducted by the Philadelphia Fed, participant numbers have increased, generally ranging between 30 and 50

[207] Longer term forecasts of inflation for horizons of 5 and 10 years were added to the SPF in 2005Q3 and 1991Q4 respectively.
[208] Forecasts for core CPI inflation, PCE inflation and core PCE inflation were added to the SPF in 2007Q1.

(Croushore, 1993, D'Agostino et al., 2012), providing a wider distribution of professional opinion thus increasing the inherent reliability of the survey[209]. The appeal of the SPF is highlighted by Coibion and Gorodnichenko (2012) identifying that predictions of well-defined economic indicators such as CPI and the GDP deflator are available at a quarterly frequency ,allowing researchers to analyse the predictive performance of the survey across time.

An often employed series of consumer sentiment and attitudes by the economic literature for the United States is the Thompson Reuters/University of Michigan Survey of Consumers (Michigan Survey henceforth). The Michigan Survey, founded in 1946 by George Katona, conducts a minimum of 500 telephone interviews a month across 48 US states (excluding Alaska and Hawaii) with procedures designed to provide a representative and independent cross-section of the US population[210]. Respondents are subsequently re-interviewed six months later[211]; therefore, the Michigan Survey is often referred to as a rotating or pseudo-panel with approximately 60% of survey responses from new respondents and 40% from those being re-interviewed. This methodology allows for changes in the aggregate composition of US households whilst retaining the ability to monitor evolutions in the expectations of individual agents (Curtin, 1982). Unlike the SPF, however, it does not permit analysis of the expectations formed by individual agents over an extended period of time and across various macroeconomic environments[212]. This limitation implies that the utilisation of aggregate Michigan Survey data is the most suitable for empirical analysis.

[209] For 1990Q2 due to the Federal Reserve Bank of Philadelphia recently assuming responsibility for the SPF, the survey was distributed late leading to a reduced number of responses. For completeness 1990Q2 expectations remain in the sample period employed throughout this study.
[210] The selection procedure provides every household with an equal chance of being selected.
[211] The Michigan Survey previously conducted a third and fourth interview of respondents yet due to falling response rates for third interviews the rotation of the sample was restricted to a single re-interview (Curtin, 1982).
[212] A single follow-up interview after six-months is also unlikely to be sufficient to establish whether individual agents significantly adjust their 5-year ahead inflation expectations in response to new information and experiences.

Appendix 2.3. Correlation Functions for CPI Inflation – Sub-Sample Periods

Greenspan-Bernanke Sample Period: 1987Q2 – 2011Q1

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.839	0.839	69.792	0.000
		2	0.622	-0.280	108.54	0.000
		3	0.433	-0.004	127.47	0.000
		4	0.272	-0.066	135.02	0.000
		5	0.276	0.464	142.91	0.000
		6	0.281	-0.292	151.15	0.000
		7	0.239	-0.022	157.18	0.000
		8	0.211	0.030	161.93	0.000
		9	0.159	0.172	164.68	0.000
		10	0.107	-0.243	165.94	0.000
		11	0.084	0.050	166.71	0.000
		12	0.055	0.001	167.05	0.000

Stable Sample Period: 1990Q1 – 2006Q2

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.854	0.854	50.398	0.000
		2	0.705	-0.093	85.230	0.000
		3	0.518	-0.226	104.35	0.000
		4	0.292	-0.278	110.52	0.000
		5	0.180	0.307	112.92	0.000
		6	0.085	0.010	113.47	0.000
		7	0.016	-0.111	113.48	0.000
		8	-0.023	-0.136	113.53	0.000
		9	-0.055	0.107	113.76	0.000
		10	-0.058	0.110	114.03	0.000
		11	-0.060	-0.084	114.32	0.000
		12	-0.038	-0.004	114.44	0.000

Volatile Sample Period: 2006Q3 – 2011Q1

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.671	0.671	9.9718	0.002
		2	0.275	-0.318	11.749	0.003
		3	-0.060	-0.182	11.838	0.008
		4	-0.301	-0.181	14.248	0.007
		5	-0.178	0.389	15.152	0.010
		6	-0.128	-0.381	15.652	0.016
		7	-0.115	-0.026	16.095	0.024
		8	-0.061	0.027	16.231	0.039
		9	-0.151	-0.096	17.141	0.047
		10	-0.139	-0.093	18.000	0.055
		11	-0.123	-0.082	18.749	0.066
		12	-0.112	0.086	19.469	0.078

Appendix 2.4. Unit Root and Stationarity Tests for CPI, and SPF and Michigan Survey Inflation Forecasts

	ADF TESTS				PHILLIPS-PERRON				KPSS
	γ	α	α (t-stat)	k	γ	α	α (t-stat)	k	LM-Stat
	WHOLE SAMPLE PERIOD 1982Q3 – 2011Q1								
CPI	0.471***	-0.163***	-3.816***	9	0.530***	-0.188***	-3.796***	16	0.668**
	(0.142)	(0.043)			(0.163)	(0.049)			
SPF	0.109	-0.044**	-2.254	0	0.109	-0.044**	-2.367	12	1.191***
	(0.067)	(0.019)			(0.067)	(0.019)			
MS	1.128***	-0.365***	-5.185***	0	1.128***	-0.365***	-5.066***	4	0.401*
	(0.223)	(0.070)			(0.223)	(0.070)			
	GREENSPAN-BERNANKE SUB SAMPLE PERIOD 1987Q2 – 2011Q1								
CPI	0.469**	-0.160***	-2.650*	5	0.477***	-0.164***	-3.168**	1	0.660**
	(0.187)	(0.060)			(0.181)	(0.057)			
SPF	-0.022	0.044	-1.047	0	-0.022	0.044	-1.047	0	1.092***
	(0.021)	(0.064)			(0.021)	(0.065)			
MS	1.014***	-0.329***	-4.235***	0	1.014***	-0.329***	-4.235***	0	0.326
	(0.241)	(0.077)			(0.241)	(0.077)			
	STABLE SUB-SAMPLE PERIOD 1990Q1 – 2006Q2								
CPI	0.274*	-0.097*	-1.836	4	0.309*	-0.109**	-2.289	3	0.356*
	(0.164)	(0.053)			(0.165)	(0.053)			
SPF	-0.240**	-0.063**	-2.044	1	0.148	-0.061**	-1.968	5	0.970***
	(0.116)	(0.031)			(0.095)	(0.032)			
MS	0.999***	-0.341***	-3.647***	0	0.999***	-0.341***	-3.465**	2	0.431*
	(0.093)	(0.093)			(0.278)	(0.093)			
	VOLATILE SUB-SAMPLE PERIOD 2006Q3 – 2011Q1								
CPI	0.900*	-0.437**	-2.520	1	0.615	-0.328	-2.079	1	0.246
	(0.482)	(0.173)			(0.476)	(0.170)			
SPF	0.509	-0.240	-1.479	0	0.509	-0.240	-1.351	3	0.540**
	(0.355)	(0.162)			(0.355)	(0.162)			
MS	2.107***	-0.653***	-3.152**	1	1.411*	-0.436**	-2.095	3	0.169
	(0.673)	(0.207)			(0.670)	(0.206)			

APPENDICES FOR CHAPTER 3

Appendix 3.1. Static Expectations Hypothesis

PANEL A: Contemporaneous Inflation
Testing Equation: $E_{i,t-h}[\pi_t] = \alpha_0 + \alpha_1\pi_{t-h} + \epsilon_t$

	α_0	α_1	Wald χ^2: $\alpha_0 = 0, \alpha_1 = 1$	R^2	$\bar{R}^2$
Period: Whole 1982Q3 – 2011Q1					
SPF	1.715*** (0.339)	0.511*** (0.109)	27.608***	0.375	0.370
MS	2.144*** (0.202)	0.320*** (0.049)	281.908***	0.507	0.502
Period: Greenspan-Bernanke 1987Q2 – 2011Q1					
SPF	1.677*** (0.283)	0.436*** (0.131)	38.704***	0.434	0.428
MS	2.157*** (0.227)	0.311*** (0.053)	248.021***	0.503	0.498
Period: Stable 1990Q1 – 2006Q2					
SPF	1.730*** (0.250)	0.399*** (0.134)	49.034***	0.404	0.394
MS	1.781*** (0.119)	0.395*** (0.036)	288.892***	0.670	0.665
Period: Volatile 2006Q3 – 2011Q1					
SPF	2.001*** (0.069)	0.079*** (0.015)	3806.720***	0.360	0.320
MS	2.587*** (0.203)	0.301*** (0.102)	218.288***	0.559	0.533

PANEL B: One Period Lagged Inflation
Testing Equation: $E_{i,t-h}[\pi_t] = \alpha_0 + \alpha_1\pi_{t-h-1} + \epsilon_t$

	α_0	α_1	Wald χ^2: $\alpha_0 = 0, \alpha_1 = 1$	R^2	$\bar{R}^2$
Period: Whole 1982Q3 – 2011Q1					
SPF	1.719*** (0.262)	0.506*** (0.094)	45.643***	0.393	0.388
MS	2.332*** (0.184)	0.254*** (0.055)	184.781***	0.341	0.336
Period: Greenspan-Bernanke 1987Q2 – 2011Q1					
SPF	1.715*** (0.224)	0.423*** (0.107)	60.952***	0.408	0.402
MS	2.356*** (0.204)	0.242 (0.057)	177.463***	0.306	0.298
Period: Stable 1990Q1 – 2006Q2					
SPF	1.663*** (0.223)	0.421*** (0.067)	96.580***	0.460	0.451
MS	2.041*** (0.072)	0.305*** (0.022)	1056.458***	0.410	0.401
Period: Volatile 2006Q3 – 2011Q1					
SPF	1.964*** (0.083)	0.093*** (0.018)	2515.204***	0.523	0.495
MS	2.758*** (0.120)	0.208** (0.079)	536.802***	0.285	0.208

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 3.2. Regressive Expectations Models

Testing Equation:

$$E_{i,t}[\pi_{t+h}] = \alpha_0 + \alpha_1\pi_t + \alpha_2[\pi_t - \pi_{t-h}] + \epsilon_t$$

		α_0	α_1	α_2	R^2	$\bar{R}^2$
Period: Whole 1982Q3 – 2011Q1						
SPF	**Unrestricted**	1.118*** (0.304)	0.687*** (0.084)	-0.293*** (0.058)	0.560	0.552
	$\alpha_1 = 1$	0.155 (0.187)		-0.394*** (0.054)	0.446	0.441
MS	**Unrestricted**	2.019*** (0.538)	0.357*** (0.135)	-0.061* (0.034)	0.535	0.526
	$\alpha_1 = 1$	0.043 (0.285)		-0.269*** (0.094)	-1.116	-1.134
Period: Greenspan-Bernanke 1987Q2 – 2011Q1						
SPF	**Unrestricted**	1.204*** (0.243)	0.598*** (0.077)	-0.212*** (0.040)	0.530	0.520
	$\alpha_1 = 1$	0.032 (0.171)		-0.413*** (0.055)	0.304	0.296
MS	**Unrestricted**	2.054*** (0.427)	0.346*** (0.099)	-0.046 (0.031)	0.514	0.503
	$\alpha_1 = 1$	0.145 (0.557)		-0.375*** (0.132)	-0.860	-0.880
Period: Stable 1990Q1 – 2006Q2						
SPF	**Unrestricted**	1.307*** (0.226)	0.538*** (0.069)	-0.321*** (0.089)	0.624	0.613
	$\alpha_1 = 1$	-0.053 (0.560)		-0.514*** (0.179)	0.181	0.168
MS	**Unrestricted**	1.810*** (0.118)	0.386*** (0.036)	0.022 (0.043)	0.672	0.662
	$\alpha_1 = 1$	0.004 (0.211)		-0.234** (0.104)	-0.657	-0.683
Period: Volatile 2006Q3 – 2011Q1						
SPF	**Unrestricted**	1.787*** (0.073)	0.167*** (0.030)	-0.071*** (0.021)	0.661	0.618
	$\alpha_1 = 1$	-0.129 (0.426)		-0.469*** (0.104)	-15.535	-16.507
MS	**Unrestricted**	2.338*** (0.168)	0.402*** (0.105)	-0.082* (0.044)	0.603	0.554
	$\alpha_1 = 1$	0.963** (0.379)		-0.368*** (0.125)	-0.303	-0.379

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 3.3. Cagan Adaptive Expectations

Testing Equation:

$$E_{i,t}[\pi_{t+4}] = \alpha_0 + \alpha_1 E_{i,t-1}[\pi_{t+3}] + \alpha_2[\pi_t] + \epsilon_t$$

		α_0	α_1	α_2	Wald χ^2: $\alpha_1 + \alpha_2 = 1$	R^2	$\bar{R}^2$
Period: Whole 1982Q3 – 2011Q1							
SPF	$j = 1$	0.083** (0.033)	0.930*** (0.016)	0.037*** (0.011)	6.169**	0.957	0.956
	$j = 4$	0.355*** (0.091)	0.706*** (0.029)	0.158*** (0.045)	12.089***	0.892	0.890
MS	$j = 1$	1.463*** (0.145)	0.309*** (0.067)	0.227*** (0.052)	92.243***	0.563	0.555
	$j = 4$	1.539*** (0.155)	0.216*** (0.057)	0.292*** (0.049)	97.645***	0.583	0.575
Period: Greenspan-Bernanke 1987Q2 – 2011Q1							
SPF	$j = 1$	0.043 (0.051)	0.946*** (0.025)	0.033*** (0.012)	1.165	0.960	0.959
	$j = 4$	0.069 (0.154)	0.841*** (0.055)	0.113*** (0.034)	0.556	0.892	0.890
MS	$j = 1$	1.362*** (0.109)	0.356*** (0.067)	0.210*** (0.047)	110.740***	0.575	0.566
	$j = 4$	1.496*** (0.359)	0.224* (0.127)	0.302*** (0.058)	14.573***	0.552	0.543
Period: Stable 1990Q1 – 2006Q2							
SPF	$j = 1$	0.138* (0.079)	0.890*** (0.037)	0.052** (0.024)	4.352**	0.936	0.934
	$j = 4$	0.373*** (0.135)	0.711*** (0.062)	0.126*** (0.043)	15.481***	0.889	0.885
MS	$j = 1$	1.806*** (0.098)	-0.014 (0.096)	0.401*** (0.073)	291.684***	0.670	0.660
	$j = 4$	1.819*** (0.138)	-0.017 (0.045)	0.400*** (0.026)	207.186***	0.671	0.660
Period: Volatile 2006Q3 – 2011Q1							
SPF	$j = 1$	0.749*** (0.217)	0.610*** (0.104)	0.042*** (0.012)	11.809***	0.644	0.600
	$j = 4$	0.765** (0.314)	0.560*** (0.145)	0.068*** (0.011)	6.329**	0.587	0.536
MS	$j = 1$	2.047*** (0.221)	0.198** (0.076)	0.257*** (0.050)	131.197***	0.585	0.533
	$j = 4$	0.730 (0.901)	0.500** (0.234)	0.411*** (0.089)	0.083	0.712	0.676

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 3.4. Adaptive Expectations ($j = 1, j = 4$)

Testing Equation: $E_{i,t}[\pi_{t+h}] = \alpha_0 + \alpha_1 E_{i,t-j}[\pi_{t-j+h}] + \alpha_2 \varepsilon_{i,t} + \epsilon_t$

		α_0	α_1	α_2	Wald χ^2: $\alpha_1 + \alpha_2 = 1$	Wald χ^2: $\alpha_0 = 0$, $\alpha_1 + \alpha_2 = 1$	R^2	$\bar{R}^2$
Period: Whole 1982Q3 – 2011Q1								
SPF	$j = 1$	0.093*** (0.034)	0.963*** (0.013)	0.018** (0.008)	0.970	17.782***	0.956	0.955
	$j = 4$	0.355*** (0.091)	0.864*** (0.039)	0.158*** (0.045)	0.072	37.882***	0.892	0.890
MS	$j = 1$	1.414*** (0.119)	0.549*** (0.033)	0.102*** (0.028)	118.190***	141.222***	0.468	0.458
	$j = 4$	1.539*** (0.155)	0.508*** (0.050)	0.292*** (0.049)	6.182**	150.086***	0.583	0.575
Period: Greenspan-Bernanke 1987Q2 – 2011Q1								
SPF	$j = 1$	0.049 (0.048)	0.977*** (0.018)	0.027*** (0.009)	0.056	5.785*	0.960	0.959
	$j = 4$	0.069 (0.154)	0.955*** (0.061)	0.113*** (0.034)	0.701	9.109**	0.892	0.890
MS	$j = 1$	1.486*** (0.106)	0.522*** (0.035)	0.131** (0.050)	179.927***	198.081***	0.520	0.510
	$j = 4$	1.496*** (0.359)	0.527*** (0.124)	0.302*** (0.058)	1.365	47.847***	0.552	0.543
Period: Stable 1990Q1 – 2006Q2								
SPF	$j = 1$	0.140** (0.056)	0.943*** (0.019)	0.033** (0.018)	1.170	6.941**	0.934	0.932
	$j = 4$	0.373*** (0.135)	0.837*** (0.041)	0.126*** (0.043)	0.401	10.728***	0.890	0.885
MS	$j = 1$	1.907*** (0.300)	0.354*** (0.102)	0.266*** (0.046)	40.109***	40.404***	0.573	0.560
	$j = 4$	1.819*** (0.138)	0.383*** (0.043)	0.400*** (0.026)	15.696***	739.684***	0.671	0.660
Period: Volatile 2006Q3 – 2011Q1								
SPF	$j = 1$	0.767*** (0.229)	0.645*** (0.105)	0.039*** (0.012)	9.462***	12.694***	0.637	0.591
	$j = 4$	0.765** (0.314)	0.628*** (0.148)	0.068*** (0.011)	4.013**	15.348***	0.587	0.536
MS	$j = 1$	2.319*** (0.389)	0.335*** (0.087)	0.149** (0.051)	29.150***	64.105***	0.476	0.411
	$j = 4$	0.730 (0.901)	0.912*** (0.308)	0.411*** (0.089)	0.694	43.883***	0.712	0.676

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 3.5. Distributed Lag Model - SPF ($n = 3, n = 7$)

Testing Equation: $E_{i,t}[\pi_{t+h}] = \alpha_0 + \alpha_1\pi_t + \sum_{j=1}^{n}\alpha_{j+1}\pi_{t-j} + \epsilon_t$

	α_0	α_1	α_2	α_3	α_4	α_5	α_6	α_7	α_8	Wald χ^2: $\sum_{j=1}^{n}\alpha_j = 1$	R^2	$\bar{R}^2$
Period: Whole 1982Q3 – 2011Q1												
$n = 3$	1.257*** (0.333)	0.353*** (0.103)	0.054* (0.032)	-0.096*** (0.026)	0.337*** (0.057)					10.414***	0.508	0.490
$n = 7$	1.032*** (0.326)	0.352** (0.141)	0.019 (0.047)	-0.038 (0.058)	0.098 (0.095)	0.118* (0.062)	0.009 (0.049)	-0.092 (0.071)	0.230** (0.102)	16.176***	0.610	0.580
Period: Greenspan-Bernanke 1987Q2 – 2011Q1												
$n = 3$	1.344*** (0.202)	0.324*** (0.105)	0.088 (0.054)	-0.083*** (0.023)	0.223*** (0.036)					20.744***	0.506	0.484
$n = 7$	1.015*** (0.243)	0.347*** (0.096)	0.041 (0.049)	-0.060 (0.059)	0.106 (0.084)	0.153** (0.064)	-0.028 (0.045)	-0.050 (0.069)	0.150 (0.114)	25.501***	0.546	0.506
Period: Stable 1990Q1 – 2006Q2												
$n = 3$	1.444*** (0.266)	0.159 (0.173)	0.102* (0.058)	-0.167*** (0.053)	0.398*** (0.066)					16.142***	0.572	0.543
$n = 7$	1.091*** (0.402)	0.224*** (0.055)	0.049 (0.048)	-0.190** (0.072)	0.216*** (0.066)	0.132 (0.128)	-0.016 (0.068)	-0.142*** (0.044)	0.334*** (0.056)	34.228***	0.712	0.672
Period: Volatile 2006Q3 – 2011Q1												
$n = 3$	1.875*** (0.057)	0.035** (0.013)	0.083** (0.033)	-0.047** (0.018)	0.060** (0.024)					886.985***	0.636	0.532
$n = 7$	1.596*** (0.085)	0.045 (0.035)	0.088* (0.045)	-0.072* (0.034)	0.071* (0.038)	0.034 (0.047)	0.027 (0.053)	-0.064 (0.050)	0.100* (0.049)	558.595***	0.845	0.721

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 3.6. Distributed Lag Model – Michigan Survey ($n = 3, n = 7$)

Testing Equation: $E_{i,t}[\pi_{t+h}] = \alpha_0 + \alpha_1\pi_t + \sum_{j=1}^{n} \alpha_{j+1}\pi_{t-j} + \epsilon_t$

	α_0	α_1	α_2	α_3	α_4	α_5	α_6	α_7	α_8	Wald χ^2: $\sum_{j=1}^{n} \alpha_j = 1$	R^2	$\bar{R}^2$
Period: Whole 1982Q3 – 2011Q1												
$n = 3$	2.063*** (0.248)	0.357*** (0.099)	-0.034 (0.054)	-0.119** (0.053)	0.139*** (0.052)					107.673***	0.541	0.524
$n = 7$	2.032*** (0.299)	0.409*** (0.134)	-0.024 (0.090)	-0.238*** (0.058)	0.125 (0.077)	0.168*** (0.060)	0.033 (0.041)	-0.291*** (0.061)	0.169*** (0.057)	78.901***	0.613	0.583
Period: Greenspan-Bernanke 1987Q2 – 2011Q1												
$n = 3$	2.092*** (0.260)	0.368*** (0.120)	-0.050 (0.064)	-0.106*** (0.037)	0.121*** (0.042)					91.836***	0.531	0.510
$n = 7$	2.103*** (0.477)	0.419** (0.182)	-0.033 (0.119)	-0.219** (0.091)	0.119 (0.102)	0.151** (0.063)	0.021 (0.051)	-0.238* (0.136)	0.107 (0.136)	32.018***	0.583	0.545
Period: Stable 1990Q1 – 2006Q2												
$n = 3$	1.820*** (0.098)	0.626*** (0.108)	-0.167** (0.068)	-0.237** (0.097)	0.160** (0.063)					438.035***	0.746	0.730
$n = 7$	1.821*** (0.183)	0.720*** (0.092)	-0.280*** (0.075)	-0.214*** (0.076)	0.037 (0.047)	0.293*** (0.083)	-0.151 (0.115)	-0.032 (0.114)	0.011 (0.043)	236.801***	0.773	0.741
Period: Volatile 2006Q3 – 2011Q1												
$n = 3$	2.442*** (0.054)	0.316*** (0.062)	0.001 (0.020)	-0.050 (0.043)	0.092* (0.051)					144.567	0.588	0.470
$n = 7$	2.327*** (0.288)	0.340** (0.140)	0.078 (0.107)	-0.237 (0.220)	0.159 (0.227)	0.093 (0.133)	0.105 (0.123)	-0.342** (0.132)	0.194 (0.151)	15.811***	0.715	0.487

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 3.7. REH Properties – Unbiasedness of Survey Forecasts

Testing Equation: $\pi_{t,t+h} = \alpha_0 + \alpha_1 E_t[\pi_{t,t+h}] + \epsilon_t$

	α_0	α_1	Wald χ^2: $\alpha_0 = 0, \alpha_1 = 1$	R^2	$\bar{R}^2$
Period: Whole 1982Q3 – 2011Q1					
SPF	1.231*** (0.402)	0.514*** (0.109)	25.448***	0.258	0.251
MS	1.809* (0.917)	0.372 (0.313)	4.036	0.048	0.039
Period: Greenspan-Bernanke 1987Q2 – 2011Q1					
SPF	0.218 (0.779)	0.890*** (0.225)	0.847	0.342	0.335
MS	2.324 (1.938)	0.194 (0.701)	1.647	0.007	-0.004
Period: Stable 1990Q1 – 2006Q2					
SPF	0.709 (0.740)	0.728*** (0.191)	8.378**	0.280	0.269
MS	0.096 (1.099)	0.951** (0.417)	0.039	0.248	0.236
Period: Volatile 2006Q3 – 2011Q1					
SPF	-1.448 (3.764)	1.565 (1.933)	20.041***	0.032	-0.025
MS	6.952** (2.425)	-1.499** (0.659)	19.771***	0.332	0.293

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 3.8. REH Properties – Orthogonality of Survey Forecasts

Testing Equation: $\pi_{t+h} - E_{i,t}[\pi_{t+h}] = \alpha_0 + \alpha_1(\pi_t - E_{i,t-h}[\pi_t]) + \epsilon_t$

	α_0	α_1	Wald χ^2: $\alpha_0 = 0, \alpha_1 = 0$	R^2	$\bar{R}^2$
Period: Whole 1982Q3 – 2011Q1†					
SPF	-0.301 (0.236)	0.106 (0.199)	4.365	0.013	0.004
MS	-0.169 (0.193)	-0.073 (0.102)	0.774	0.005	-0.004
Period: Greenspan-Bernanke 1987Q2 – 2011Q1					
SPF	-0.138 (0.180)	-0.107 (0.128)	0.868	0.014	0.004
MS	-0.150 (0.208)	-0.075 (0.100)	0.615	0.006	-0.005
Period: Stable 1990Q1 – 2006Q2					
SPF	-0.073 (0.489)	0.201 (0.396)	1.386	0.032	0.017
MS	-0.050 (0.217)	-0.005 (0.169)	0.059	0.000	-0.016
Period: Volatile 2006Q3 – 2011Q1					
SPF	-0.114 (0.960)	-0.284 (0.432)	0.464	0.092	0.038
MS	-1.401 (1.452)	-0.291 (0.430)	0.939	0.096	0.043

***,**,* indicate significance at 1, 5 and 10 percent levels.

†Due to the lack of availability of four period ahead forecast errors from the SPF, the whole sample period for both agent classes is modified to 1983Q3 – 2011Q1 to ensure comparability. Utilising the initial whole sample period for the Michigan Survey does not significantly change the results.

Appendix 3.9. Comparison of Backward-Looking and Forward-Looking Behaviour – Forecast Errors

Testing Equation:

$$\pi_{t+h} - E_{i,t}[\pi_{t+h}] = \alpha_0 + \alpha_1 \sum_{j=1}^{4} \pi_{t+j} + \alpha_2 \pi_t + \alpha_3 \sum_{j=1}^{4} \pi_{t-j} + \alpha_4 \sum_{j=1}^{4} (\pi_{t-j} - E_{i,t-j}[\pi_{t-j+h}]) + \epsilon_{i,t}$$

	α_0	α_1	α_2	α_3	α_4	R^2	$\bar{R}^2$
Period: Whole 1982Q3 – 2011Q1							
SPF†	-0.021	-0.017	1.013***	-0.232***	0.199***	0.957	0.956
	(0.090)	(0.011)	(0.012)	(0.007)	(0.006)		
MS	-1.317***	-0.019**	1.214***	-0.178***	0.084***	0.927	0.924
	(0.150)	(0.008)	(0.047)	(0.007)	(0.015)		
Period: Greenspan-Bernanke 1987Q2 – 2011Q1							
SPF	0.066	-0.019*	1.021***	-0.239***	0.215***	0.967	0.965
	(0.156)	(0.010)	(0.020)	(0.012)	(0.011)		
MS	-0.942***	-0.021***	1.232***	-0.212***	0.118***	0.942	0.939
	(0.251)	(0.008)	(0.044)	(0.032)	(0.036)		
Period: Stable 1990Q1 – 2006Q2							
SPF	-0.224***	0.004	1.009***	-0.232***	0.204***	0.964	0.961
	(0.081)	(0.011)	(0.041)	(0.008)	(0.010)		
MS	-1.586***	-0.038***	1.292***	-0.153***	-0.003	0.923	0.918
	(0.160)	(0.011)	(0.045)	(0.011)	(0.021)		
Period: Volatile 2006Q3 – 2011Q1							
SPF	0.219	-0.011**	1.015***	-0.260***	0.245***	0.995	0.994
	(0.571)	(0.005)	(0.016)	(0.061)	(0.062)		
MS	-0.810*	-0.008	1.259***	-0.246***	0.157	0.968	0.959
	(0.428)	(0.013)	(0.092)	(0.033)	(0.022)		

***,**,* indicate significance at 1, 5 and 10 percent levels.

APPENDICES FOR CHAPTER 4

Appendix 4.1. Disaggregate Household Inflation Forecasts – Elementary Statistics – Whole and Greenspan-Bernanke Sample Periods

	Whole Sample Period 1982q3 – 2011q1				Greenspan-Bernanke Sample Period 1987q2 – 2011q1			
	Mean Forecast	Max.	Min.	St.Dev.	Mean Forecast	Max.	Min.	St.Dev.
SPF	3.246	6.000	1.800	1.072	2.949	5.000	1.800	0.863
A1834	3.172	5.100	0.800	0.692	3.067	5.100	0.800	0.640
A3544	3.162	5.000	0.700	0.678	3.067	5.000	0.700	0.630
A4554	3.096	5.100	1.400	0.577	3.079	5.100	1.400	0.586
A5564	2.938	4.900	1.000	0.574	2.963	4.900	1.000	0.587
A6597	2.968	5.000	0.900	0.655	3.070	5.000	0.900	0.606
ELHS	3.483	5.900	2.300	0.740	3.546	5.900	2.300	0.754
EHSD	3.203	5.300	1.300	0.551	3.209	5.300	1.300	0.550
ESC	3.098	5.200	1.100	0.606	3.081	5.200	1.100	0.589
ECD	2.990	4.900	0.400	0.739	2.886	4.800	0.400	0.690
EGS	3.149	5.000	0.300	0.870	2.988	4.800	0.300	0.805
MALE	2.918	4.900	0.800	0.575	2.875	4.900	0.800	0.580
FEMALE	3.326	5.100	1.100	0.636	3.290	5.100	1.100	0.626
Y14	3.555	5.400	2.000	0.673	3.573	5.400	2.000	0.692
Y24	3.221	5.200	1.600	0.619	3.196	5.200	1.600	0.610
Y34	2.985	5.000	0.600	0.594	2.938	5.000	0.600	0.570
Y44	2.856	4.800	0.200	0.721	2.771	4.700	0.200	0.719
NC	3.077	5.000	0.700	0.564	3.060	5.000	0.700	0.577
NE	3.134	5.100	0.300	0.749	3.051	5.100	0.300	0.736
S	3.115	5.100	1.700	0.549	3.089	5.100	1.700	0.537
W	3.116	5.000	1.100	0.633	3.056	5.000	1.100	0.599

Appendix 4.2. Disaggregate Household Inflation Forecasts – Elementary Statistics – Stable and Volatile Sample Periods

	Stable Sample Period 1990q1 – 2006q2				Volatile Sample Period 2006q3 -2011q1			
	Mean Forecast	**Max.**	**Min.**	**St.Dev.**	**Mean Forecast**	**Max.**	**Min.**	**St.Dev.**
SPF	2.894	4.500	1.800	0.635	2.166	2.500	1.800	0.234
A1834	2.945	4.800	0.800	0.569	3.079	5.100	2.200	0.717
A3544	2.976	5.000	0.700	0.559	3.074	5.000	1.900	0.816
A4554	2.947	4.600	1.400	0.450	3.221	5.100	1.600	0.811
A5564	2.836	4.300	1.000	0.506	3.211	4.900	1.500	0.761
A6597	2.903	4.600	0.900	0.500	3.379	5.000	2.600	0.692
ELHS	3.426	5.000	2.300	0.714	3.874	5.900	2.800	0.847
EHSD	3.062	4.700	1.300	0.451	3.537	5.300	2.800	0.676
ESC	2.932	4.600	1.100	0.522	3.358	5.200	2.700	0.695
ECD	2.779	4.800	0.500	0.572	2.889	4.800	0.400	0.969
EGS	2.852	4.800	0.300	0.636	2.821	4.800	0.300	0.995
MALE	2.774	4.600	0.900	0.479	2.953	4.900	0.800	0.851
FEMALE	3.136	4.800	1.100	0.522	3.479	5.100	2.600	0.741
Y14	3.380	5.000	2.000	0.577	4.026	5.400	2.900	0.779
Y24	3.0454	4.900	1.600	0.479	3.447	5.200	2.400	0.823
Y34	2.835	4.600	0.600	0.521	3.074	5.000	1.800	0.739
Y44	2.694	4.700	0.300	0.559	2.605	4.700	0.200	1.077
NC	2.932	4.700	0.700	0.501	3.268	5.000	2.400	0.707
NE	2.867	4.700	0.300	0.623	3.200	5.100	1.100	0.869
S	2.971	4.900	1.700	0.452	3.258	5.100	2.000	0.703
W	2.947	4.500	1.100	0.505	3.074	5.000	1.900	0.758

Appendix 4.3. ANOVA F-Test Equality of Mean Forecasts – Age Disaggregated Expectations

		A1834	A3544	A4554	A5564	A6597
A3544	W	0.011				
	G-B	0.000				
	S	0.095				
	V	0.000				
A4554	W	0.830	0.651			
	G-B	0.020	0.020			
	S	0.000	0.106			
	V	0.328	0.312			
A5564	W	7.783***	7.337***	4.300**		
	G-B	1.381	1.404	1.899		
	S	1.354	2.253	1.760		
	V	0.301	0.286	0.002		
A6597	W	5.286**	4.908**	2.464	0.132	
	G-B	0.001	0.001	0.012	1.552	
	S	0.207	0.620	0.282	0.579	
	V	1.721	1.546	0.417	0.509	
SPF	W	0.385	0.497	1.753	7.361***	5.634**
	G-B	1.143	1.156	1.486	0.015	1.251
	S	0.242	0.618	0.308	0.330	0.009
	V	27.855***	21.747***	29.712***	32.731***	52.330***

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 4.4. ANOVA F-Test Equality of Mean Forecasts – Education Disaggregated Expectations

		ELHS	EHSD	ESC	ECD	EGS
EHSD	W	10.521***				
	G-B	12.460***				
	S	12.241***				
	V	1.835				
ESC	W	18.560***	1.897			
	G-B	22.604***	2.423			
	S	20.575***	2.353			
	V	4.208**	0.647			
ECD	W	25.546***	6.191**	1.487		
	G-B	39.903***	12.838***	4.420**		
	S	33.023***	9.992***	2.576		
	V	11.104***	5.701**	2.929*		
EGS	W	9.827***	0.325	0.260	2.234	
	G-B	24.593***	4.972**	0.848	0.872	
	S	23.795***	4.812**	0.628	0.477	
	V	12.332***	6.730**	3.717*	0.046	
SPF	W	3.791*	0.143	1.654	4.458**	0.571
	G-B	25.982***	6.191**	1.528	0.311	0.100
	S	20.445***	3.079*	0.141	1.196	0.146
	V	71.749***	69.794***	50.140***	10.005***	7.813***

***,**,* indicate significance at 1, 5 and 10 peircent levels.

Appendix 4.5. ANOVA F-Test Equality of Mean Forecasts – Gender Disaggregated Expectations

		MALE	FEMALE
FEMALE	W	26.022***	
	G-B	22.662***	
	S	17.246***	
	V	4.134**	
SPF	W	8.342***	0.474
	G-B	0.491	9.773***
	S	1.492	5.738**
	V	15.110***	5.738**

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 4.6. ANOVA F-Test Equality of Mean Forecasts – Income Disaggregated Expectations

		Y14	Y24	Y34	Y44
Y24	W	15.336***			
	G-B	16.032***			
	S	13.154***			
	V	4.957**			
Y34	W	46.293***	8.670***		
	G-B	48.238***	9.193***		
	S	32.482***	5.834**		
	V	14.940***	2.168		
Y44	W	57.787***	16.978***	2.211	
	G-B	61.977***	19.486***	3.167*	
	S	48.163***	15.025***	2.241	
	V	21.700***	7.332**	2.442	
SPF	W	6.840***	0.047	5.203**	10.493***
	G-B	30.488***	5.217**	0.013	2.424
	S	21.209***	2.395	0.340	3.680*
	V	99.284***	42.638***	26.046***	3.020*

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 4.7. ANOVA F-Test Equality of Mean Forecasts – Regionally Disaggregated Expectations

		NC	NE	S	W
NE	**W**	0.418			
	G-B	0.010			
	S	0.438			
	V	0.071			
S	**W**	0.260	0.049		
	G-B	0.122	0.163		
	S	0.225	1.218		
	V	0.002	0.051		
W	**W**	0.234	0.040	0.000	
	G-B	0.002	0.003	0.154	
	S	0.030	0.661	0.084	
	V	0.671	0.228	0.603	
SPF	**W**	2.227	0.845	1.365	1.260
	G-B	1.098	0.771	1.798	0.993
	S	0.145	0.061	0.650	0.283
	V	41.631***	25.113***	41.231***	24.896***

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 4.8. Mean Forecast Error and Mean Square Forecast Error Statistics – Disaggregate Forecasts

	MEAN FORECAST ERROR (MFE)				MEAN SQUARE FORECAST ERROR (MSFE)			
	WHOLE	**G-B**	**STABLE**	**VOLATILE**	**WHOLE**	**G-B**	**STABLE**	**VOLATILE**
SPF	-0.433***	-0.115	-0.114	-0.175	1.778	1.128	0.777	2.913
MS	-0.194	-0.140	-0.050	-1.177**	1.820	1.893	0.760	6.103
A1834	-0.292**	-0.154	-0.087	-1.051*	1.841	1.780	0.752	5.764
A3544	-0.292**	-0.153	-0.094	-1.135**	1.950	1.932	0.795	6.198
A4554	-0.178	-0.147	-0.070	-1.203**	1.883	1.953	0.766	6.350
A5564	0.040	-0.017	0.074	-1.203**	1.993	2.083	0.847	6.312
A6597	0.047	-0.115	-0.006	-1.329**	2.104	2.013	0.766	6.333
ELHS	-0.509***	-0.593***	-0.478***	-2.003***	2.528	2.761	1.177	8.948
EHSD	-0.258**	-0.265*	-0.143	-1.466***	1.930	2.065	0.868	6.588
ESC	-0.186	-0.148	-0.043	-1.312**	1.948	2.023	0.749	6.638
ECD	-0.105	0.026	0.085	-0.872	1.912	1.863	0.770	5.790
EGS	-0.292**	-0.103	0.018	-0.929*	1.877	1.768	0.775	5.851
MALE	-0.007	0.041	0.125	-0.956*	1.809	1.913	0.821	5.817
FEMALE	-0.403***	-0.358**	-0.268**	-1.419**	1.936	1.989	0.769	6.749
Y14	-0.605***	-0.624***	-0.481***	-2.035***	2.281	2.473	0.920	8.619
Y24	-0.285**	-0.266*	-0.153	-1.440**	1.945	2.042	0.836	6.598
Y34	-0.088	-0.021	0.068	-1.061*	1.917	1.970	0.835	6.051
Y44	0.033	0.128	0.179	-0.651	1.778	1.825	0.803	5.557
NC	-0.153	-0.133	-0.035	-1.219**	1.878	1.976	0.833	6.173
NE	-0.219*	-0.138	-0.008	-1.182**	1.768	1.826	0.675	6.313
S	-0.184	-0.158	-0.079	-1.214**	1.856	1.968	0.795	6.256
W	-0.230*	-0.141	-0.070	-1.093**	1.837	1.826	0.753	5.808

***,**,* indicate significance of t-tests of the null hypothesis that $MFE_i = 0$ at 1, 5 and percent levels.

Appendix 4.9. Mean Forecast Error Statistics – Disaggregate Forecasts

	WHOLE 1982Q3 – 2011Q1	G-B 1987Q2 – 2011Q1	STABLE 1990Q1 – 2006Q2	VOLATILE 2006Q3 – 2011Q1
AGE	1.669	0.170	0.397	0.039
EDUCATION	1.224	2.360*	3.520***	0.732
GENDER	4.981**	4.008**	6.716**	0.401
INCOME	4.697***	5.151***	7.463***	1.268
REGION	0.076	0.006	0.095	0.013

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 4.10. Mean Square Forecast Error Statistics – Disaggregate Forecasts

	WHOLE 1982Q3 – 2011Q1	G-B 1987Q2 – 2011Q1	STABLE 1990Q1 – 2006Q2	VOLATILE 2006Q3 – 2011Q1
AGE	0.040	0.037	0.057	0.008
EDUCATION	0.204	0.309	0.721	0.153
GENDER	0.032	0.008	0.061	0.056
INCOME	0.153	0.183	0.113	0.194
REGION	0.009	0.020	0.229	0.007

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 4.11. ANOVA F-Test Equality of MFE's – Age Disaggregated Expectations

		A1834	A3544	A4554	A5564	A6597
A3544	W	0.000				
	G-B	0.000				
	S	0.002				
	V	0.013				
A4554	W	0.404	0.392			
	G-B	0.004	0.002			
	S	0.012	0.025			
	V	0.044	0.009			
A5564	W	3.340*	3.245*	1.413		
	G-B	0.512	0.471	0.408		
	S	1.057	1.129	0.840		
	V	0.044	0.009	0.000		
A6597	W	3.382*	3.288*	1.463	0.001	
	G-B	0.056	0.047	0.029	0.218	
	S	0.277	0.323	0.172	0.261	
	V	0.152	0.072	0.030	0.030	
SPF	W	0.681	0.659	2.144	7.111***	7.102***
	G-B	0.084	0.070	0.045	0.259	0.000
	S	0.032	0.016	0.082	1.428	0.491
	V	1.829	2.127	2.444	2.456	3.221*

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 4.12. ANOVA F-Test Equality of MSFE's – Age Disaggregated Expectations

		A1834	A3544	A4554	A5564	A6597
A3544	W	0.024				
	G-B	0.034				
	S	0.045				
	V	0.012				
A4554	W	0.004	0.009			
	G-B	0.043	0.001			
	S	0.005	0.021			
	V	0.022	0.001			
A5564	W	0.020	0.004	0.024		
	G-B	0.136	0.032	0.023		
	S	0.195	0.053	0.143		
	V	0.020	0.001	0.000		
A6597	W	0.135	0.045	0.091	0.024	
	G-B	0.078	0.009	0.005	0.007	
	S	0.005	0.018	0.000	0.126	
	V	0.021	0.001	0.000	0.000	
SPF	W	0.012	0.089	0.032	0.141	0.303
	G-B	1.101	1.566	1.584	2.270	1.858
	S	0.021	0.011	0.004	0.133	0.003
	V	0.949	1.190	1.244	1.330	1.275

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 4.13. ANOVA F-Test Equality of MFE's – Education Disaggregated Expectations

		ELHS	EHSD	ESC	ECD	EGS
EHSD	W	1.730				
	G-B	2.322				
	S	4.056**				
	V	0.553				
ESC	W	2.837*	0.157			
	G-B	4.261**	0.324			
	S	7.244***	0.407			
	V	0.857	0.042			
ECD	W	4.451**	0.709	0.195		
	G-B	8.515***	2.080	0.744		
	S	12.000***	2.085	0.697		
	V	2.313	0.672	0.363		
EGS	W	1.327	0.034	0.341	1.069	
	G-B	5.464**	0.660	0.051	0.438	
	S	9.258***	1.034	0.157	0.188	
	V	2.091	0.550	0.276	0.006	
SPF	W	0.171	1.004	1.978	3.501*	0.673
	G-B	6.146**	0.682	0.033	0.637	0.005
	S	5.021**	0.034	0.217	1.676	0.733
	V	7.695***	4.100*	3.027*	1.104	1.302

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 4.14. ANOVA F-Test Equality of MSFE's – Education Disaggregated Expectations

		ELHS	EHSD	ESC	ECD	EGS
EHSD	W	0.538				
	G-B	0.515				
	S	1.142				
	V	0.280				
ESC	W	0.495	0.001			
	G-B	0.569	0.002			
	S	2.526	0.295			
	V	0.262	0.000			
ECD	W	0.602	0.001	0.003		
	G-B	0.912	0.060	0.036		
	S	2.181	0.189	0.010		
	V	0.529	0.042	0.046		
EGS	W	0.666	0.006	0.010	0.003	
	G-B	1.112	0.127	0.091	0.014	
	S	2.160	0.174	0.016	0.001	
	V	0.510	0.036	0.039	0.000	
SPF	W	1.176	0.068	0.081	0.058	0.032
	G-B	4.287**	2.051	1.796	1.444	1.094
	S	2.527	0.216	0.027	0.002	0.000
	V	2.832	1.463	1.420	1.008	1.053

***,**,* indicate significance at 1, 5 and 10 percent levels

Appendix 4.15. ANOVA F-Test Equality of MFE's – Gender Disaggregated Expectations

		MALE	FEMALE
FEMALE	**W**	4.981**	
	G-B	4.008**	
	S	6.716**	
	V	0.401	
SPF	**W**	6.077**	0.031
	G-B	0.762	1.887
	S	2.372	1.065
	V	1.409	3.656*

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 4.16. ANOVA F-Test Equality of MSFE's – Gender Disaggregated Expectations

		MALE	FEMALE
FEMALE	**W**	0.032	
	G-B	0.008	
	S	0.061	
	V	0.056	
SPF	**W**	0.003	0.070
	G-B	1.660	1.655
	S	0.055	0.002
	V	1.040	1.506

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 4.17. ANOVA F-Test Equality of MFE's – Income Disaggregated Expectations

		Y14	Y24	Y34	Y44
Y24	**W**	3.088*			
	G-B	3.008*			
	S	4.636**			
	V	0.707			
Y34	**W**	7.952***	1.167		
	G-B	8.527***	1.444		
	S	12.864***	1.936		
	V	1.815	0.274		
Y44	**W**	12.543***	3.154*	0.452	
	G-B	13.807***	3.896**	0.558	
	S	19.338***	4.520**	0.496	
	V	3.588*	1.162	0.302	
SPF	**W**	0.958	0.726	3.873*	7.342***
	G-B	7.688***	0.696	0.274	1.924
	S	6.019**	0.064	1.346	3.619*
	V	8.457***	3.887*	1.810	0.508

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 4.18. ANOVA F-Test Equality of MSFE's – Income Disaggregated Expectations

		Y14	Y24	Y34	Y44
Y24	**W**	0.178			
	G-B	0.207			
	S	0.138			
	V	0.214			
Y34	**W**	0.221	0.002		
	G-B	0.300	0.007		
	S	0.142	0.000		
	V	0.366	0.018		
Y44	**W**	0.458	0.059	0.044	
	G-B	0.539	0.071	0.034	
	S	0.326	0.024	0.023	
	V	0.565	0.073	0.018	
SPF	**W**	0.585	0.078	0.060	0.000
	G-B	3.246*	1.863	1.785	1.459
	S	0.429	0.095	0.096	0.024
	V	2.815	1.388	1.135	0.961

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 4.19. ANOVA F-Test Equality of MFE's – Regionally Disaggregated Expectations

		NC	NE	S	W
NE	W	0.139			
	G-B	0.000			
	S	0.032			
	V	0.003			
S	W	0.029	0.041		
	G-B	0.015	0.011		
	S	0.077	0.225		
	V	0.000	0.002		
W	W	0.183	0.004	0.067	
	G-B	0.001	0.000	0.008	
	S	0.050	0.176	0.003	
	V	0.031	0.015	0.028	
SPF	W	2.857	1.570	2.074	1.393
	G-B	0.010	0.016	0.058	0.021
	S	0.252	0.507	0.051	0.083
	V	2.591	2.341	2.533	2.022

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 4.20. ANOVA F-Test Equality of MSFE's – Regionally Disaggregated Expectations

		NC	NE	S	W
NE	W	0.024			
	G-B	0.031			
	S	0.561			
	V	0.001			
S	W	0.001	0.015		
	G-B	0.000	0.029		
	S	0.029	0.406		
	V	0.000	0.000		
W	W	0.003	0.010	0.001	
	G-B	0.032	0.000	0.029	
	S	0.133	0.170	0.046	
	V	0.009	0.017	0.013	
SPF	W	0.030	0.000	0.018	0.011
	G-B	1.742	1.186	1.720	1.246
	S	0.084	0.404	0.012	0.019
	V	1.179	1.287	1.239	0.965

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 4.21. REH Properties - Unbiasedness – Age Disaggregated Michigan Survey Inflation Forecasts

Testing Equation: $\pi_{t,t+h} = \alpha_0 + \alpha_1 E_t[\pi_{t,t+h}] + \epsilon_t$

	α_0	α_1	Wald χ^2: $\alpha_0 = 0, \alpha_1 = 1$	R^2	$\bar{R}^2$
			Period: Whole 1982Q3 – 2011Q1		
A1834	1.598*** (0.574)	0.425** (0.196)	8.585**	0.087	0.078
A3544	1.829*** (0.611)	0.355 (0.216)	9.266***	0.060	0.052
A4554	1.990* (1.186)	0.317 (0.457)	3.419	0.036	0.027
A5564	2.767** (1.153)	0.077 (0.443)	7.210**	0.002	-0.007
A6597	2.761** (1.382)	0.079 (0.560)	7.092**	0.002	-0.008
			Period: Greenspan-Bernanke 1987Q2 – 2011Q1		
A1834	1.656 (1.612)	0.409 (0.577)	1.057	0.039	0.029
A3544	2.287 (1.759)	0.204 (0.620)	1.691	0.009	-0.001
A4554	2.521 (3.179)	0.129 (1.176)	1.100	0.003	-0.007
A5564	3.190* (1.670)	-0.093 (0.617)	3.899	0.002	-0.009
A6597	2.732 (1.798)	0.060 (0.649)	2.404	0.001	-0.010
			Period: Stable 1990Q1 – 2006Q2		
A1834	0.399 (0.966)	0.838** (0.377)	0.184	0.270	0.258
A3544	0.470 (0.964)	0.812** (0.368)	0.262	0.231	0.219
A4554	0.030 (1.132)	0.967** (0.433)	0.095	0.244	0.232
A5564	0.602 (1.042)	0.814* (0.423)	0.932	0.172	0.159
A6597	0.221 (0.886)	0.922*** (0.330)	0.064	0.240	0.228
			Period: Volatile 2006Q3 – 2011Q1		
A1834	6.792*** (1.637)	-1.509*** (0.470)	39.532***	0.324	0.284
A3544	6.209** (2.207)	-1.287* (0.615)	15.678***	0.304	0.263
A4554	5.751** (2.361)	-1.121 (0.714)	9.650***	0.253	0.209
A5564	5.908** (2.491)	-1.169 (0.776)	8.563**	0.262	0.219
A6597	7.416*** (2.495)	-1.568** (0.686)	18.082***	0.321	0.281

***,**,* indicate significance at 1, 5 and 10 percent levels

Appendix 4.22. REH Properties - Unbiasedness – Education Disaggregated Michigan Survey Inflation Forecasts

Testing Equation: $\pi_{t,t+h} = \alpha_0 + \alpha_1 E_t[\pi_{t,t+h}] + \epsilon_t$

	α_0	α_1	Wald χ^2: $\alpha_0 = 0, \alpha_1 = 1$	R^2	$\bar{R}^2$
Period: Whole 1982Q3 – 2011Q1					
ELHS	3.095*** (1.107)	-0.029 (0.346)	9.516***	0.000	-0.009
EHSD	2.211* (1.140)	0.241 (0.364)	4.499	0.015	0.007
ESC	2.124** (0.899)	0.274 (0.309)	5.651*	0.028	0.019
ECD	1.913*** (0.535)	0.349* (0.196)	12.766***	0.065	0.056
EGS	1.571*** (0.441)	0.433** (0.165)	12.746***	0.133	0.126
Period: Greenspan-Bernanke 1987Q2 – 2011Q1					
ELHS	3.400*** (1.195)	-0.138 (0.375)	10.055***	0.006	-0.004
EHSD	3.113 (1.957)	-0.062 (0.657)	2.616	0.001	-0.010
ESC	2.821 (2.029)	0.031 (0.709)	1.936	0.000	-0.010
ECD	2.045 (1.260)	0.301 (0.506)	5.919*	0.025	0.014
EGS	1.593 (1.119)	0.438 (0.431)	2.657	0.071	0.062
Period: Stable 1990Q1 – 2006Q2					
ELHS	0.998 (0.917)	0.565* (0.307)	6.048**	0.139	0.125
EHSD	0.134 (1.301)	0.909* (0.478)	0.387	0.159	0.146
ESC	0.153 (1.066)	0.934** (0.401)	0.037	0.258	0.246
ECD	0.644 (0.741)	0.803** (0.304)	1.173	0.258	0.246
EGS	0.775 (0.728)	0.739** (0.293)	1.330	0.263	0.252
Period: Volatile 2006Q3 – 2011Q1					
ELHS	5.282** (1.952)	-0.786 (0.523)	17.197***	0.160	0.110
EHSD	7.218** (2.990)	-1.452* (0.790)	15.271***	0.268	0.225
ESC	7.773*** (2.022)	-1.678*** (0.468)	68.791***	0.421	0.387
ECD	4.326* (2.094)	-0.764 (0.828)	4.595	0.161	0.111
EGS	3.954* (1.928)	-0.625 (0.801)	4.340	0.118	0.066

***,**,* indicate significance at 1, 5 and 10 percent levels

Appendix 4.23. REH Properties - Unbiasedness – Gender Disaggregated Michigan Survey Inflation Forecasts

Testing Equation: $\pi_{t,t+h} = \alpha_0 + \alpha_1 E_t[\pi_{t,t+h}] + \epsilon_t$

	α_0	α_1	Wald χ^2: $\alpha_0 = 0, \alpha_1 = 1$	R^2	$\bar{R}^2$
Period: Whole 1982Q3 – 2011Q1					
MALE	1.945** (0.826)	0.349 (0.296)	5.606*	0.043	0.034
FEMALE	1.708 (1.046)	0.378 (0.338)	4.246	0.049	0.041
Period: Greenspan-Bernanke 1987Q2 – 2011Q1					
MALE	2.496 (1.569)	0.146 (0.612)	4.580	0.004	-0.006
FEMALE	2.076 (2.080)	0.256 (0.700)	1.641	0.014	0.004
Period: Stable 1990Q1 – 2006Q2					
MALE	0.360 (1.132)	0.916* (0.461)	0.657	0.201	0.189
FEMALE	-0.129 (1.148)	0.956** (0.405)	1.489	0.308	0.297
Period: Volatile 2006Q3 – 2011Q1					
MALE	5.039** (2.033)	-0.977 (0.738)	7.188**	0.211	0.165
FEMALE	7.504** (2.975)	-1.553* (0.774)	19.203***	0.351	0.313

***,**,* indicate significance at 1, 5 and 10 percent levels

Appendix 4.24. REH Properties - Unbiasedness – Income Disaggregated Michigan Survey Inflation Forecasts

Testing Equation: $\pi_{t,t+h} = \alpha_0 + \alpha_1 E_t[\pi_{t,t+h}] + \epsilon_t$

	α_0	α_1	Wald χ^2: $\alpha_0 = 0, \alpha_1 = 1$	R^2	$\bar{R}^2$
Period: Whole 1982Q3 – 2011Q1					
Y14	2.121 (1.327)	0.242 (0.399)	6.307**	0.019	0.011
Y24	2.140** (1.065)	0.260 (0.348)	4.604	0.020	0.011
Y34	2.117*** (0.765)	0.285 (0.266)	7.688**	0.031	0.023
Y44	1.764*** (0.566)	0.415* (0.223)	10.838***	0.087	0.079
Period: Greenspan-Bernanke 1987Q2 – 2011Q1					
Y14	2.670 (1.779)	0.069 (0.559)	3.694	0.001	-0.009
Y24	2.622* (1.541)	0.092 (0.549)	2.957	0.002	-0.009
Y34	2.785 (1.739)	0.045 (0.654)	3.548	0.000	-0.010
Y44	1.880 (1.186)	0.372 (0.487)	5.499*	0.041	0.031
Period: Stable 1990Q1 – 2006Q2					
Y14	-0.378 (1.180)	0.970*** (0.358)	5.923*	0.315	0.304
Y24	0.249 (0.960)	0.869** (0.357)	0.291	0.197	0.184
Y34	0.600 (1.100)	0.813* (0.455)	0.826	0.184	0.171
Y44	0.672 (0.884)	0.820** (0.367)	1.730	0.245	0.234
Period: Volatile 2006Q3 – 2011Q1					
Y14	5.423 (3.856)	-0.814 (1.021)	6.640**	0.129	0.077
Y24	5.200* (2.917)	-0.889 (0.937)	4.437	0.149	0.099
Y34	6.838*** (2.222)	-1.518** (0.578)	33.697***	0.377	0.341
Y44	3.455*** (1.029)	-0.506 (0.521)	12.151***	0.093	0.040

***,**,* indicate significance at 1, 5 and 10 percent levels

Appendix 4.25. REH Properties - Unbiasedness – Regionally Disaggregated Michigan Survey Inflation Forecasts

Testing Equation: $\pi_{t,t+h} = \alpha_0 + \alpha_1 E_t[\pi_{t,t+h}] + \epsilon_t$

	α_0	α_1	Wald χ^2: $\alpha_0 = 0, \alpha_1 = 1$	R^2	$\bar{R}^2$
Period: Whole 1982Q3 – 2011Q1					
NC	2.031** (0.881)	0.306 (0.305)	5.345*	0.032	0.024
NE	1.567** (0.782)	0.444 (0.278)	4.055	0.089	0.081
S	2.087* (1.239)	0.285 (0.411)	3.038	0.021	0.013
W	1.717** (0.702)	0.396 (0.242)	6.275**	0.068	0.060
Period: Greenspan-Bernanke 1987Q2 – 2011Q1					
NC	2.721 (1.869)	0.064 (0.679)	2.469	0.001	-0.010
NE	1.758 (1.388)	0.379 (0.523)	2.175	0.045	0.035
S	2.814 (2.085)	0.033 (0.743)	1.970	0.000	-0.010
W	1.935 (1.718)	0.321 (0.628)	1.431	0.022	0.011
Period: Stable 1990Q1 – 2006Q2					
NC	0.472 (0.963)	0.828** (0.387)	0.266	0.181	0.168
NE	0.471 (0.736)	0.836*** (0.290)	0.466	0.342	0.332
S	-0.003 (1.242)	0.974** (0.432)	0.096	0.216	0.203
W	0.166 (1.065)	0.921** (0.398)	0.073	0.258	0.247
Period: Volatile 2006Q3 – 2011Q1					
NC	7.400*** (2.404)	-1.616** (0.640)	24.227***	0.358	0.320
NE	5.441** (1.963)	-1.033** (0.395)	51.545***	0.229	0.183
S	7.195*** (2.077)	-1.556** (0.547)	33.505***	0.361	0.323
W	5.503** (2.448)	-1.082 (0.808)	6.879**	0.206	0.159

***,**,* indicate significance at 1, 5 and 10 percent levels

Appendix 4.26. Disagreement across Household Inflation Forecasts – Elementary Statistics – Whole and Greenspan-Bernanke Sample Periods

	Whole Sample Period 1982q3 – 2011q1				Greenspan-Bernanke Sample Period 1987q2 – 2011q1			
	Mean σ_t	Max.	Min.	St.Dev.	Mean Forecast	Max.	Min.	St.Dev.
MS	5.182	8.500	3.100	1.434	4.874	8.100	3.100	1.321
A1834	5.215	8.500	3.100	1.550	4.872	8.100	3.100	1.411
A3544	5.094	9.000	2.700	1.570	4.784	8.900	2.700	1.446
A4554	4.995	11.100	2.600	1.564	4.795	11.100	2.600	1.557
A5564	4.909	9.000	2.500	1.455	4.638	7.700	2.500	1.334
A6597	5.342	9.900	2.900	1.634	5.024	9.900	2.900	1.538
ELHS	6.790	12.700	3.200	2.393	6.418	12.700	3.200	2.392
EHSD	5.543	9.100	3.200	1.556	5.240	9.000	3.200	1.462
ESC	4.810	8.100	2.700	1.224	4.561	8.100	2.700	1.131
ECD	4.197	8.400	2.500	1.162	3.999	6.800	2.500	1.030
EGS	3.594	6.400	2.100	0.929	3.492	6.400	2.100	0.907
MALE	4.171	4.100	2.700	0.998	3.970	6.800	2.700	0.898
FEMALE	5.827	5.800	3.300	1.781	5.458	9.400	3.300	1.670
Y14	6.439	11.400	3.200	2.141	6.027	11.400	3.200	2.041
Y24	5.353	9.400	3.000	1.634	5.042	8.200	3.000	1.493
Y34	4.578	7.800	2.600	1.242	4.313	7.600	2.600	1.093
Y44	3.753	7.300	2.200	0.940	3.553	6.000	2.200	0.818
NC	5.046	9.200	2.800	1.553	4.755	9.200	2.800	1.478
NE	5.160	8.900	2.700	1.535	4.841	8.900	2.700	1.416
S	5.398	9.100	3.100	1.582	5.068	8.000	3.100	1.448
W	4.871	9.200	2.500	1.366	4.604	7.900	2.500	1.242

Appendix 4.27. Disagreement across Household Inflation Forecasts – Elementary Statistics – Stable and Volatile Sample Periods

	Stable Sample Period 1990q1 – 2006q2				Volatile Sample Period 2006q3 -2011q1			
	Mean σ_t	Max.	Min.	St.Dev.	Mean σ_t	Max.	Min.	St.Dev.
MS	4.770	8.100	3.100	1.419	4.489	6.000	3.300	0.757
A1834	4.730	8.100	3.100	1.438	4.474	6.300	3.200	0.963
A3544	4.785	8.900	2.700	1.617	4.426	6.100	3.000	0.937
A4554	4.683	11.100	2.600	1.660	4.395	6.100	3.000	0.802
A5564	4.559	7.700	2.500	1.456	4.484	5.600	3.200	0.662
A6597	4.853	9.900	2.900	1.631	4.637	6.100	3.600	0.668
ELHS	6.270	12.700	3.200	2.497	5.347	7.500	3.900	0.892
EHSD	5.182	9.00	3.200	1.621	4.789	5.900	3.700	0.597
ESC	4.495	8.100	2.700	1.238	4.616	6.100	3.000	0.891
ECD	3.862	6.500	2.500	1.022	4.042	5.800	2.800	0.947
EGS	3.432	6.400	2.100	0.979	3.747	5.600	2.300	0.845
MALE	3.778	3.550	6.800	0.879	4.153	5.600	2.800	0.793
FEMALE	5.040	4.800	9.400	1.812	4.758	6.300	3.700	0.743
Y14	6.005	11.400	3.200	2.257	5.095	6.600	4.000	0.636
Y24	4.911	8.200	3.000	1.558	4.532	5.600	3.300	0.712
Y34	4.164	7.600	2.600	1.130	4.289	6.500	2.900	0.933
Y44	3.408	6.000	2.200	0.815	3.837	5.400	2.700	0.853
NC	4.611	9.200	2.800	1.507	4.342	5.900	3.000	0.802
NE	4.753	8.900	2.7800	1.517	4.495	6.500	3.500	0.821
S	4.978	8.000	3.100	1.567	4.605	6.000	3.500	0.718
W	4.521	7.900	2.500	1.341	4.495	5.900	3.100	0.815

Appendix 4.28. Welch F-Test Equality of Cross-Sectional Mean Disagreement

	WHOLE 1982Q3 – 2011Q1	G-B 1987Q2 – 2011Q1	STABLE 1990Q1 – 2006Q2	VOLATILE 2006Q3 – 2011Q1
AGE	1.405	0.915	0.342	0.303
EDUCATION	69.376***	50.271***	29.655***	9.797***
GENDER	75.615***	59.157***	42.977***	5.901**
INCOME	65.883***	55.769***	36.602***	9.251***
REGION	2.528*	1.934	1.165	0.367

***,**,* indicate significance at 1, 5 and 10 percent levels

Appendix 4.29. ANOVA F-Test on Equality of Mean Disagreement – Age Disaggregated Michigan Survey Expectations

		A1834	A3544	A4554	A5564	A6597
A3544	W	0.345				
	G-B	0.184				
	S	0.042				
	V	0.024				
A4554	W	1.148	0.230			
	G-B	0.133	0.002			
	S	0.030	0.127			
	V	0.075	0.012			
A5564	W	2.384	0.861	0.187		
	G-B	1.411	0.535	0.565		
	S	0.462	0.711	0.209		
	V	0.002	0.048	0.141		
A6597	W	0.365	1.376	2.707	4.506**	
	G-B	0.503	1.236	1.052	3.458*	
	S	0.210	0.058	0.351	1.193	
	V	0.369	0.636	1.023	0.501	
SPF	W	912.559***	843.459***	811.318***	894.075***	872.678***
	G-B	829.966***	757.665***	659.591***	824.957***	752.232***
	S	543.443***	442.441***	399.787***	487.339***	448.896***
	V	250.584***	256.921***	338.474***	506.713***	542.052***

***,**,* indicate significance at 1, 5 and 10 percent levels

Appendix 4.30. ANOVA F-Test on Equality of Mean Disagreement – Education Disaggregated Michigan Survey Expectations

		ELHS	EHSD	ESC	ECD	EGS
EHSD	W	21.983***				
	G-B	16.956***				
	S	8.813***				
	V	5.131**				
ESC	W	62.470***	15.776***			
	G-B	47.257***	12.915***			
	S	26.745***	7.472***			
	V	6.397**	0.498			
ECD	W	109.335***	55.261***	15.173***		
	G-B	82.836***	46.196***	12.982***		
	S	52.555***	31.304***	10.273***		
	V	19.133***	8.473***	3.701*		
EGS	W	178.310***	132.996***	71.973***	18.854***	
	G-B	125.634***	99.066***	52.271***	13.125***	
	S	73.890***	56.362***	29.972***	6.104**	
	V	32.218***	19.279***	9.506***	1.025	
SPF	W	718.698***	1044.925***	1181.301***	936.741***	958.496***
	G-B	549.383***	914.920***	1091.272***	956.180***	873.768***
	S	341.577***	527.033***	649.240***	664.495***	545.462***
	V	447.974***	717.523***	313.767***	200.109***	203.848***

***,**,* indicate significance at 1, 5 and 10 percent levels

Appendix 4.31. ANOVA F-Test on Equality of Mean Disagreement – Gender Disaggregated Michigan Survey Expectations

		MALE	FEMALE
FEMALE	W	75.615***	
	G-B	59.157***	
	S	42.977***	
	V	5.901**	
SPF	W	1221.868***	902.913***
	G-B	1217.129***	774.483***
	S	843.244***	464.022***
	V	299.623***	475.397***

***,**,* indicate significance at 1, 5 and 10 percent levels

Appendix 4.32. ANOVA F-Test on Equality of Mean Disagreement – Income Disaggregated Michigan Survey Expectations

		Y14	Y24	Y34	Y44
Y24	W	18.707***			
	G-B	14.577***			
	S	10.501***			
	V	6.609**			
Y34	W	65.024***	16.391***		
	G-B	52.641***	14.908***		
	S	35.104***	9.940***		
	V	9.664***	0.809		
Y44	W	151.839***	82.881***	32.290***	
	G-B	121.522***	73.410***	29.701***	
	S	77.304***	48.234***	19.429***	
	V	26.535***	7.427***	2.436	
SPF	W	793.137***	877.077***	1021.617***	1048.404***
	G-B	653.022***	804.211***	1020.991***	1106.296***
	S	379.689***	504.971***	650.279***	763.895***
	V	744.659***	455.486***	239.405***	212.830***

***,**,* indicate significance at 1, 5 and 10 percent levels

Appendix 4.33. ANOVA F-Test on Equality of Mean Disagreement – Regionally Disaggregated Michigan Survey Expectations

		NC	NE	S	W
NE	W	0.821			
	G-B	0.587			
	S	0.130			
	V	0.338			
S	W	2.901*	1.343		
	G-B	2.190	1.207		
	S	1.862	0.688		
	V	1.136	0.195		
W	W	0.821	2.271	7.309***	
	G-B	0.589	1.513	5.670**	
	S	0.130	0.865	3.205*	
	V	0.338	0.000	0.197	
SPF	W	841.766***	907.519***	950.999***	990.196***
	G-B	716.402***	811.566***	864.074***	932.030***
	S	467.294***	494.377***	514.213***	562.107***
	V	327.929***	342.596***	467.147***	346.883***

***,**,* indicate significance at 1, 5 and 10 percent levels

Appendix 4.34. Aggregate Michigan Survey Disagreement

Testing Equation: $\sigma_{i,t} = \alpha_0 + \alpha_1\sigma_{i,t-1} + \alpha_2\pi_t + \alpha_3|\pi_t - \pi_{t-4}| + \alpha_4 Gap_t + \epsilon_t$

	α_0	α_1	α_2	α_3	α_4	R^2	$\bar{R}^2$	D.W. Stat
Period: Whole 1982Q3 – 2011Q1								
MS	0.357** (0.162)	0.781*** (0.046)	0.224*** (0.042)	0.010 (0.044)	-0.046** (0.022)	0.834	0.828	2.602
Period: Greenspan-Bernanke 1987Q2 – 2011Q1								
MS	0.394** (0.188)	0.759*** (0.059)	0.235*** (0.053)	0.017 (0.055)	-0.049** (0.025)	0.784	0.774	2.544
Period: Stable 1990Q1 – 2006Q2								
MS	0.571 (0.378)	0.646*** (0.108)	0.352*** (0.059)	0.006 (0.126)	-0.127* (0.065)	0.787	0.773	2.357
Period: Volatile 2006Q3 – 2011Q1								
MS	0.588* (0.326)	0.788*** (0.118)	0.096** (0.037)	0.028 (0.052)	-0.019 (0.029)	0.687	0.597	2.167

***,**,* indicate significance at 1, 5 and 10 percent levels

Appendix 4.35. Age Disaggregated Michigan Survey Disagreement

Testing Equation: $\sigma_{i,t} = \alpha_0 + \alpha_1\sigma_{i,t-1} + \alpha_2\pi_t + \alpha_3|\Delta\pi_t| + \alpha_4 Gap_t + \epsilon_t$

	α_0	α_1	α_2	α_3	α_4	R^2	$\bar{R}^2$	D.W. Stat
				Period: Whole 1982Q3 – 2011Q1				
A1834	0.716*** (0.241)	0.688*** (0.051)	0.257*** (0.073)	0.009 (0.069)	-0.064* (0.035)	0.699	0.688	2.543
A3544	0.552** (0.233)	0.670*** (0.067)	0.329*** (0.058)	0.004 (0.070)	-0.080* (0.041)	0.695	0.684	2.436
A4554	1.076*** (0.280)	0.492*** (0.079)	0.402*** (0.097)	0.072 (0.089)	-0.098** (0.046)	0.517	0.499	2.506
A5564	1.214*** (0.397)	0.475*** (0.111)	0.377*** (0.089)	0.053 (0.104)	-0.099** (0.048)	0.491	0.472	2.275
A6597	1.206*** (0.408)	0.509*** (0.086)	0.391*** (0.090)	0.098 (0.080)	-0.070 (0.056)	0.505	0.486	2.508
				Period: Greenspan-Bernanke 1987Q2 – 2011Q1				
A1834	0.763** (0.301)	0.653*** (0.063)	0.276*** (0.092)	0.013 (0.085)	-0.070* (0.035)	0.635	0.619	2.377
A3544	0.651** (0.265)	0.674*** (0.085)	0.283*** (0.065)	-0.031 (0.077)	-0.077** (0.035)	0.657	0.642	2.362
A4554	0.815*** (0.263)	0.514*** (0.085)	0.437*** (0.121)	0.081 (0.119)	-0.102** (0.042)	0.536	0.516	2.556
A5564	1.562*** (0.445)	0.420*** (0.140)	0.346*** (0.096)	-0.049 (0.121)	-0.114** (0.052)	0.402	0.376	2.198
A6597	1.239*** (0.416)	0.482*** (0.095)	0.396*** (0.107)	0.081 (0.107)	-0.077* (0.046)	0.457	0.433	2.455
				Period: Stable 1990Q1 – 2006Q2				
A1834	0.865** (0.403)	0.555*** (0.106)	0.399*** (0.101)	-0.034 (0.135)	-0.169** (0.064)	0.719	0.701	2.137
A3544	0.704 (0.511)	0.619*** (0.111)	0.383*** (0.056)	-0.116 (0.082)	-0.153 (0.105)	0.734	0.717	2.091
A4554	1.003** (0.450)	0.362** (0.171)	0.560*** (0.142)	0.238 (0.396)	-0.279** (0.132)	0.590	0.563	2.288
A5564	1.821*** (0.642)	0.299** (0.140)	0.481*** (0.077)	-0.192 (0.187)	-0.233** (0.097)	0.458	0.422	2.055
A6597	1.514 (1.080)	0.386* (0.199)	0.443*** (0.101)	0.072 (0.233)	-0.192 (0.174)	0.440	0.403	2.240
				Period: Volatile 2006Q3 – 2011Q1				
A1834	3.334*** (0.391)	-0.008 (0.126)	0.079 (0.052)	0.290*** (0.072)	-0.064** (0.023)	0.408	0.239	2.040
A3544	0.356 (0.452)	0.755*** (0.118)	0.182*** (0.040)	0.082*** (0.027)	-0.032 (0.039)	0.668	0.573	1.896
A4554	1.249*** (0.277)	0.577*** (0.141)	0.106 (0.072)	0.062 (0.041)	-0.044 (0.042)	0.596	0.481	2.130
A5564	0.558 (0.509)	0.855*** (0.151)	0.048 (0.073)	0.029 (0.041)	0.006 (0.032)	0.730	0.653	2.328
A6597	0.891 (0.888)	0.733** (0.274)	0.106 (0.080)	-0.014 (0.095)	-0.029 (0.027)	0.573	0.451	2.164

***,**,* indicate significance at 1, 5 and 10 percent levels

Appendix 4.36. Education Disaggregated Michigan Survey Disagreement

Testing Equation: $\sigma_{i,t} = \alpha_0 + \alpha_1\sigma_{i,t-1} + \alpha_2\pi_t + \alpha_3|\Delta\pi_t| + \alpha_4 Gap_t + \epsilon_t$

	α_0	α_1	α_2	α_3	α_4	R^2	$\bar{R}^2$	D.W. Stat
Period: Whole 1982Q3 – 2011Q1								
ELHS	1.034** (0.418)	0.610*** (0.068)	0.487*** (0.114)	-0.011 (0.102)	-0.097* (0.051)	0.571	0.555	2.701
EHSD	0.733*** (0.226)	0.684*** (0.060)	0.289*** (0.061)	0.014 (0.068)	-0.070** (0.032)	0.717	0.707	2.581
ESC	1.160*** (0.253)	0.581*** (0.071)	0.234*** (0.069)	0.018 (0.055)	-0.073** (0.033)	0.579	0.564	2.154
ECD	1.116*** (0.266)	0.419*** (0.095)	0.343*** (0.079)	0.117*** (0.043)	-0.091** (0.044)	0.544	0.527	2.457
EGS	1.334*** (0.339)	0.307** (0.124)	0.456*** (0.112)	0.172*** (0.063)	-0.106 (0.046)	0.477	0.458	1.616
Period: Greenspan-Bernanke 1987Q2 – 2011Q1								
ELHS	1.148** (0.457)	0.594*** (0.071)	0.470*** (0.144)	-0.059 (0.142)	-0.101* (0.053)	0.531	0.510	2.661
EHSD	0.763*** (0.279)	0.663*** (0.070)	0.303*** (0.073)	0.007 (0.095)	-0.076 (0.032)	0.664	0.650	2.502
ESC	1.120*** (0.314)	0.575*** (0.085)	0.241*** (0.083)	-0.009 (0.071)	-0.083** (0.033)	0.568	0.549	1.967
ECD	1.149*** (0.260)	0.447*** (0.103)	0.291*** (0.089)	0.093* (0.048)	-0.078** (0.035)	0.496	0.474	2.483
EGS	1.172*** (0.400)	0.374** (0.165)	0.418** (0.175)	0.149** (0.072)	-0.090* (0.052)	0.442	0.418	1.560
Period: Stable 1990Q1 – 2006Q2								
ELHS	1.529 (0.952)	0.455*** (0.117)	0.640*** (0.087)	-0.212 (0.228)	-0.289 (0.160)	0.508	0.476	2.514
EHSD	1.032 (0.629)	0.536*** (0.134)	0.435*** (0.059)	-0.024 (0.186)	-0.210* (0.106)	0.702	0.683	2.394
ESC	1.013 (0.689)	0.544*** (0.136)	0.339*** (0.040)	-0.022 (0.116)	-0.127 (0.087)	0.656	0.633	1.831
ECD	1.155*** (0.400)	0.398*** (0.128)	0.376*** (0.059)	0.005 (0.093)	-0.122* (0.063)	0.581	0.554	2.310
EGS	1.299 (0.808)	0.272 (0.183)	0.515*** (0.065)	0.054 (0.117)	-0.156 (0.115)	0.544	0.514	2.297
Period: Volatile 2006Q3 – 2011Q1								
ELHS	3.066*** (0.967)	0.412** (0.144)	-0.016 (0.119)	0.014 (0.091)	-0.019 (0.060)	0.256	0.044	2.828
EHSD	3.066*** (0.799)	0.114 (0.222)	0.189** (0.083)	0.193** (0.068)	-0.063** (0.028)	0.517	0.378	2.080
ESC	1.171 (0.821)	0.575** (0.257)	0.152 (0.107)	0.069 (0.083)	-0.055 (0.045)	0.567	0.444	2.084
ECD	1.184*** (0.381)	0.651*** (0.140)	0.024 (0.078)	0.039 (0.014)	-0.021 (0.060)	0.575	0.454	1.956
EGS	0.750 (0.476)	0.967*** (0.139)	-0.062 (0.066)	0.004 (0.027)	0.031 (0.021)	0.692	0.605	1.607

***,**,* indicate significance at 1, 5 and 10 percent levels

Appendix 4.37. Gender Disaggregated Michigan Survey Disagreement

Testing Equation: $\sigma_{i,t} = \alpha_0 + \alpha_1\sigma_{i,t-1} + \alpha_2\pi_t + \alpha_3|\Delta\pi_t| + \alpha_4 Gap_t + \epsilon_t$

	α_0	α_1	α_2	α_3	α_4	R^2	$\bar{R}^2$	D.W. Stat
Period: Whole 1982Q3 – 2011Q1								
MALE	1.017***	0.462***	0.310***	0.143***	-0.072**	0.674	0.662	2.338
	(0.264)	(0.116)	(0.069)	(0.053)	(0.030)			
FEMALE	0.429**	0.786***	0.246***	-0.032	-0.057*	0.803	0.796	2.647
	(0.195)	(0.043)	(0.056)	(0.047)	(0.030)			
Period: Greenspan-Bernanke 1987Q2 – 2011Q1								
MALE	1.164***	0.394***	0.334***	0.126*	-0.087**	0.590	0.572	2.282
	(0.266)	(0.126)	(0.082)	(0.065)	(0.033)			
FEMALE	0.469**	0.768***	0.250***	-0.022	-0.058*	0.756	0.746	2.606
	(0.230)	(0.053)	(0.066)	(0.063)	(0.031)			
Period: Stable 1990Q1 – 2006Q2								
MALE	1.519***	0.200	0.435***	0.181	-0.160***	0.612	0.587	1.951
	(0.372)	(0.157)	(0.080)	(0.110)	(0.059)			
FEMALE	0.567	0.674***	0.396***	-0.071	-0.152**	0.776	0.762	2.303
	(0.447)	(0.091)	(0.083)	(0.185)	(0.072)			
Period: Volatile 2006Q3 – 2011Q1								
MALE	-0.022	0.916***	0.144**	0.023	-0.009	0.792	0.732	2.680
	(0.371)	(0.173)	(0.054)	(0.060)	(0.026)			
FEMALE	1.669**	0.554**	0.062	0.050	-0.037	0.551	0.422	2.003
	(0.741)	(0.237)	(0.107)	(0.079)	(0.044)			

***,**,* indicate significance at 1, 5 and 10 percent levels

Appendix 4.38. Income Disaggregated Michigan Survey Disagreement

Testing Equation: $\sigma_{i,t} = \alpha_0 + \alpha_1\sigma_{i,t-1} + \alpha_2\pi_t + \alpha_3|\Delta\pi_t| + \alpha_4 Gap_t + \epsilon_t$

	α_0	α_1	α_2	α_3	α_4	R^2	$\bar{R}^2$	D.W. Stat
Period: Whole 1982Q3 – 2011Q1								
Y14	0.780**	0.689***	0.371***	-0.042	-0.083**	0.674	0.663	2.707
	(0.323)	(0.064)	(0.088)	(0.093)	(0.041)			
Y24	0.778***	0.628***	0.325***	0.096	-0.059	0.656	0.643	2.637
	(0.263)	(0.071)	(0.072)	(0.079)	(0.036)			
Y34	0.922***	0.525***	0.343***	0.054	-0.091**	0.649	0.636	2.499
	(0.249)	(0.081)	(0.074)	(0.057)	(0.042)			
Y44	0.933***	0.474***	0.252***	0.139***	-0.068**	0.639	0.625	2.214
	(0.198)	(0.091)	(0.058)	(0.049)	(0.030)			
Period: Greenspan-Bernanke 1987Q2 – 2011Q1								
Y14	0.762**	0.680***	0.360***	-0.013	-0.079**	0.642	0.626	2.624
	(0.326)	(0.066)	(0.105)	(0.120)	(0.039)			
Y24	0.807**	0.629***	0.317***	0.040	-0.064	0.611	0.594	2.529
	(0.312)	(0.101)	(0.101)	(0.104)	(0.043)			
Y34	1.088***	0.470***	0.348***	0.026	-0.102	0.577	0.558	2.327
	(0.390)	(0.130)	(0.103)	(0.074)	(0.064)			
Y44	1.121***	0.404***	0.263***	0.095*	-0.085***	0.547	0.527	2.053
	(0.249)	(0.105)	(0.068)	(0.049)	(0.032)			
Period: Stable 1990Q1 – 2006Q2								
Y14	1.062*	0.551***	0.535***	-0.102	-0.247**	0.638	0.614	2.467
	(0.592)	(0.113)	(0.105)	(0.306)	(0.119)			
Y24	0.913*	0.548***	0.404***	0.030	-0.173**	0.665	0.643	2.415
	(0.539)	(0.127)	(0.077)	(0.149)	(0.081)			
Y34	1.607***	0.254	0.496***	-0.088	-0.215**	0.616	0.591	2.106
	(0.509)	(0.153)	(0.091)	(0.132)	(0.087)			
Y44	1.346***	0.225*	0.376***	0.156*	-0.143***	0.560	0.531	1.931
	(0.337)	(0.120)	(0.079)	(0.086)	(0.043)			
Period: Volatile 2006Q3 – 2011Q1								
Y14	2.309***	0.440***	0.084**	0.067***	-0.040	0.463	0.309	2.163
	(0.360)	(0.075)	(0.036)	(0.021)	(0.024)			
Y24	1.397**	0.517***	0.136	0.127*	-0.038	0.597	0.482	2.254
	(0.495)	(0.156)	(0.103)	(0.064)	(0.043)			
Y34	1.004*	0.584***	0.151	0.088	-0.050*	0.586	0.467	2.102
	(0.563)	(0.168)	(0.096)	(0.080)	(0.028)			
Y44	0.271***	0.856***	0.102	0.013	-0.011	0.720	0.640	2.120
	(0.056)	(0.156)	(0.136)	(0.031)	(0.083)			

***,**,* indicate significance at 1, 5 and 10 percent levels

Appendix 4.39. Regionally Disaggregated Michigan Survey Disagreement

Testing Equation: $\sigma_{i,t} = \alpha_0 + \alpha_1\sigma_{i,t-1} + \alpha_2\pi_t + \alpha_3|\Delta\pi_t| + \alpha_4 Gap_t + \epsilon_t$

	α_0	α_1	α_2	α_3	α_4	R^2	$\bar{R}^2$	D.W. Stat
				Period: Whole 1982Q3 – 2011Q1				
NC	0.860***	0.596***	0.341***	0.011	-0.080**	0.620	0.606	2.530
	(0.315)	(0.102)	(0.094)	(0.087)	(0.040)			
NE	0.906***	0.564***	0.362***	0.095	-0.077*	0.593	0.578	2.541
	(0.302)	(0.093)	(0.093)	(0.068)	(0.045)			
S	0.450**	0.727***	0.291***	0.027	0.027	0.775	0.767	2.399
	(0.181)	(0.045)	(0.056)	(0.056)	(0.056)			
W	1.407***	0.471***	0.322***	0.031	-0.097*	0.483	0.464	2.427
	(0.428)	(0.104)	(0.083)	(0.068)	(0.057)			
				Period: Greenspan-Bernanke 1987Q2 – 2011Q1				
NC	0.986***	0.560***	0.344***	-0.024	-0.089**	0.560	0.540	2.463
	(0.348)	(0.118)	(0.112)	(0.107)	(0.043)			
NE	1.018***	0.479***	0.441***	0.055	-0.104*	0.522	0.501	2.451
	(0.261)	(0.095)	(0.099)	(0.088)	(0.053)			
S	0.478**	0.718***	0.279***	0.042	-0.059**	0.727	0.715	2.307
	(0.222)	(0.053)	(0.066)	(0.068)	(0.025)			
W	1.518***	0.458***	0.289***	-0.022	-0.100	0.433	0.409	2.291
	(0.540)	(0.145)	(0.108)	(0.101)	(0.063)			
				Period: Stable 1990Q1 – 2006Q2				
NC	1.133	0.403	0.496**	0.053	-0.219	0.601	0.574	2.274
	(1.039)	(0.322)	(0.209)	(0.137)	(0.175)			
NE	1.474**	0.314**	0.585***	-0.084	-0.269**	0.588	0.561	2.057
	(0.592)	(0.141)	(0.083)	(0.207)	(0.121)			
S	0.656	0.617***	0.402***	-0.013	-0.154*	0.747	0.731	2.159
	(0.484)	(0.098)	(0.039)	(0.145)	(0.078)			
W	1.646*	0.360*	0.397***	-0.043	-0.209*	0.514	0.482	2.273
	(0.887)	(0.185)	(0.078)	(0.112)	(0.125)			
				Period: Volatile 2006Q3 – 2011Q1				
NC	1.167**	0.652***	0.070	0.015	-0.032	0.567	0.444	2.333
	(0.449)	(0.131)	(0.043)	(0.021)	(0.040)			
NE	0.224	0.848***	0.160**	0.006	-0.023	0.664	0.568	2.141
	(0.342)	(0.093)	(0.055)	(0.017)	(0.020)			
S	1.990**	0.380	0.135***	0.115**	-0.058	0.550	0.422	2.181
	(0.817)	(0.233)	(0.035)	(0.047)	(0.041)			
W	1.160	0.626**	0.076	0.087***	-0.028	0.629	0.523	2.058
	(0.988)	(0.223)	(0.071)	(0.017)	(0.029)			

***,**,* indicate significance at 1, 5 and 10 percent levels

Appendix 4.40. Aggregate Michigan Survey Disagreement and Forecast Errors

Testing Equation:

$$\sigma_{i,t} = \gamma_0 + \gamma_1\sigma_{i,t-1} + \gamma_2(\pi_t - E_{t-h}[\pi_t])^2 + \gamma_3\pi_t + \gamma_4|\pi_t - \pi_{t-4}| + \gamma_5 Gap_t + \epsilon_t$$

	γ_0	γ_1	γ_2	γ_3	γ_4	γ_5	R^2	$\bar{R}^2$	D.W. Stat
Period: Whole 1982Q3 – 2011Q1									
MS	0.335** (0.166)	0.775*** (0.044)	0.016* (0.008)	0.246*** (0.041)	-0.024 (0.042)	-0.044** (0.018)	0.836	0.828	2.602
Period: Greenspan-Bernanke 1987Q2 – 2011Q1									
MS	0.439** (0.177)	0.739*** (0.053)	0.020* (0.012)	0.263*** (0.052)	-0.045 (0.068)	-0.050** (0.019)	0.786	0.775	2.530
Period: Stable 1990Q1 – 2006Q2									
MS	0.617 (0.402)	0.662*** (0.082)	0.097** (0.044)	0.307*** (0.049)	-0.069 (0.054)	-0.117 (0.079)	0.791	0.774	2.321
Period: Volatile 2006Q3 – 2011Q1									
MS	0.418 (0.372)	0.859*** (0.137)	-0.015 (0.009)	0.045 (0.059)	0.081** (0.027)	-0.009 (0.022)	0.695	0.577	2.144

***,**,* indicate significance at 1, 5 and 10 percent levels

Appendix 4.41. Age Disaggregated Michigan Survey Disagreement and Forecast Errors

Testing Equation:

$$\sigma_{i,t} = \gamma_0 + \gamma_1 \sigma_{i,t-1} + \gamma_2 (\pi_t - E_{t-h}[\pi_t])^2 + \gamma_3 \pi_t + \gamma_4 |\pi_t - \pi_{t-4}| + \gamma_5 Gap_t + \epsilon_t$$

	γ_0	γ_1	γ_2	γ_3	γ_4	γ_5	R^2	$\bar{R}^2$	D.W. Stat
Period: Whole 1982Q3 – 2011Q1									
A1834	0.696**	0.677***	0.024**	0.292***	-0.043	-0.062	0.702	0.688	2.539
	(0.292)	(0.061)	(0.012)	(0.075)	(0.079)	(0.048)			
A3544	0.515	0.655***	0.037***	0.382***	-0.088	-0.077**	0.702	0.688	2.391
	(0.314)	(0.068)	(0.007)	(0.049)	(0.062)	(0.035)			
A4554	1.041***	0.486***	0.020	0.432***	0.026	-0.096	0.519	0.497	2.513
	(0.342)	(0.080)	(0.023)	(0.106)	(0.086)	(0.067)			
A5564	1.161***	0.473***	0.028	0.407***	-0.007	-0.094**	0.496	0.473	2.277
	(0.417)	(0.108)	(0.020)	(0.086)	(0.130)	(0.042)			
A6597	1.196***	0.504***	0.014	0.408***	0.067	-0.068*	0.506	0.483	2.502
	(0.382)	(0.093)	(0.022)	(0.113)	(0.114)	(0.036)			
Period: Greenspan-Bernanke 1987Q2 – 2011Q1									
A1834	0.823**	0.625***	0.029*	0.317***	-0.071	-0.070*	0.640	0.620	2.362
	(0.313)	(0.073)	(0.017)	(0.103)	(0.104)	(0.037)			
A3544	0.746**	0.634***	0.047***	0.344***	-0.187**	-0.078**	0.670	0.651	2.292
	(0.314)	(0.080)	(0.013)	(0.051)	(0.082)	(0.033)			
A4554	0.832**	0.495***	0.030	0.479***	-0.014	-0.101	0.541	0.515	2.556
	(0.322)	(0.080)	(0.026)	(0.125)	(0.173)	(0.064)			
A5564	1.684***	0.379***	0.063**	0.406***	-0.254	-0.109***	0.430	0.399	2.170
	(0.507)	(0.141)	(0.026)	(0.082)	(0.166)	(0.041)			
A6597	1.263***	0.470***	0.019	0.419***	0.021	-0.076**	0.459	0.429	2.446
	(0.411)	(0.094)	(0.025)	(0.122)	(0.169)	(0.038)			
Period: Stable 1990Q1 – 2006Q2									
A1834	0.916**	0.567***	0.108**	0.360***	-0.124	-0.160**	0.724	0.701	2.162
	(0.446)	(0.098)	(0.042)	(0.065)	(0.119)	(0.071)			
A3544	0.743*	0.625***	0.071	0.358***	-0.181**	-0.146	0.736	0.714	2.044
	(0.423)	(0.088)	(0.046)	(0.051)	(0.081)	(0.096)			
A4554	1.022*	0.366**	0.096	0.539***	0.172	-0.277*	0.594	0.560	2.278
	(0.556)	(0.158)	(0.105)	(0.112)	(0.328)	(0.142)			
A5564	1.838***	0.300*	0.016	0.473***	-0.204	-0.232**	0.458	0.413	2.052
	(0.656)	(0.155)	(0.060)	(0.101)	(0.149	(0.106)			
A6597	1.560*	0.395**	0.073*	0.407***	0.023	-0.187	0.442	0.395	2.238
	(0.850)	(0.155)	(0.039)	(0.086)	(0.130)	(0.157)			
Period: Volatile 2006Q3 – 2011Q1									
A1834†	3.520***	-0.081	0.020	0.133	0.228	-0.072	0.418	0.195	2.009
	(0.625)	(0.266)	(0.038)	(0.211)	(0.177)	(0.043)			
A3544†	0.428	0.724**	0.008	0.206	0.052	-0.037	0.669	0.541	1.884
	(0.937)	(0.329)	(0.040)	(0.178)	(0.135)	(0.058)			
A4554	1.178***	0.616***	-0.011	0.066	0.105	-0.037	0.600	0.446	2.090
	(0.302)	(0.094)	(0.051)	(0.057)	(0.281)	(0.043)			
A5564	0.615	0.828***	0.007	0.072	0.003	0.001	0.731	0.629	2.330
	(0.664)	(0.177)	(0.012)	(0.045)	(0.030)	(0.024)			
A6597†	0.812	0.783**	-0.020	0.036	0.065	-0.019	0.592	0.434	2.144
	(0.921)	(0.293)	(0.039)	(0.157)	(0.183)	(0.033)			

†Due to length of volatile period, no lag can be specified for the Newey-West covariance matrix

***,**,* indicate significance at 1, 5 and 10 percent levels

Appendix 4.42. Education Disaggregated Michigan Survey Disagreement and Forecast Errors

Testing Equation:

$$\sigma_{i,t} = \gamma_0 + \gamma_1\sigma_{i,t-1} + \gamma_2(\pi_t - E_{t-h}[\pi_t])^2 + \gamma_3\pi_t + \gamma_4|\pi_t - \pi_{t-4}| + \gamma_5 Gap_t + \epsilon_t$$

	γ_0	γ_1	γ_2	γ_3	γ_4	γ_5	R^2	$\bar{R}^2$	D.W. Stat
Period: Whole 1982Q3 – 2011Q1									
ELHS	0.848*	0.606***	0.035*	0.568***	-0.100	-0.092*	0.575	0.556	2.683
	(0.458)	(0.065)	(0.020)	(0.117)	(0.122)	(0.048)			
EHSD	0.708***	0.682***	0.011	0.306***	-0.009	-0.068**	0.718	0.705	2.585
	(0.235)	(0.058)	(0.009)	(0.059)	(0.071)	(0.031)			
ESC	1.142***	0.574***	0.016	0.257***	-0.020	-0.071**	0.582	0.563	2.153
	(0.255)	(0.071)	(0.014)	(0.078)	(0.061)	(0.031)			
ECD	1.103***	0.398***	0.034***	0.387***	0.044	-0.088***	0.554	0.533	2.442
	(0.295)	(0.105)	(0.013)	(0.083)	(0.044)	(0.032)			
EGS	1.750***	0.205***	0.024**	0.281***	0.041	-0.105***	0.383	0.355	2.001
	(0.261)	(0.075)	(0.011)	(0.069)	(0.053)	(0.024)			
Period: Greenspan-Bernanke 1987Q2 – 2011Q1									
ELHS	1.002*	0.567***	0.063**	0.613***	-0.300	-0.097**	0.543	0.518	2.621
	(0.505)	(0.065)	(0.027)	(0.143)	(0.212)	(0.044)			
EHSD	0.802***	0.643***	0.023*	0.337***	-0.067	-0.075**	0.668	0.649	2.488
	(0.274)	(0.067)	(0.013)	(0.061)	(0.117)	(0.029)			
ESC	1.188***	0.548***	0.024**	0.273***	-0.088	-0.083*	0.573	0.550	1.957
	(0.299)	(0.100)	(0.011)	(0.083)	(0.079)	(0.043)			
ECD	1.259***	0.399***	0.035**	0.334***	-0.007	-0.080***	0.509	0.481	2.448
	(0.330)	(0.119)	(0.016)	(0.096)	(0.066)	(0.024)			
EGS	1.380***	0.318***	0.015	0.263***	0.061	-0.095***	0.395	0.362	1.963
	(0.248)	(0.082)	(0.011)	(0.073)	(0.059)	(0.020)			
Period: Stable 1990Q1 – 2006Q2									
ELHS	1.382	0.457***	0.076	0.668***	-0.261	-0.297*	0.511	0.471	2.498
	(1.152)	(0.126)	(0.084)	(0.096)	(0.196)	(0.171)			
EHSD	1.037*	0.537***	0.007	0.432***	-0.030	-0.210*	0.702	0.677	2.394
	(0.565)	(0.110)	(0.050)	(0.067)	(0.137)	(0.110)			
ESC	1.067*	0.556***	0.105*	0.295***	-0.094	-0.118	0.662	0.634	1.829
	(0.607)	(0.109)	(0.059)	(0.054)	(0.121)	(0.090)			
ECD	1.126**	0.398**	-0.026	0.386***	0.027	-0.122*	0.582	0.547	2.317
	(0.481)	(0.168)	(0.031)	(0.084)	(0.074)	(0.071)			
EGS	1.531***	0.277**	0.230***	0.223**	0.047	-0.147***	0.444	0.398	1.829
	(0.365)	(0.128)	(0.069)	(0.088)	(0.123)	(0.044)			
Period: Volatile 2006Q3 – 2011Q1									
ELHS†	3.082***	0.413**	-0.002	-0.025	0.023	-0.018	0.256	-0.030	1.819
	(0.918)	(0.150)	(0.031)	(0.114)	(0.212)	(0.054)			
EHSD	3.140***	0.083	0.007	0.216*	0.171***	-0.066**	0.519	0.334	2.107
	(0.460)	(0.149)	(0.013)	(0.107)	(0.028)	(0.028)			
ESC	1.192	0.563**	0.003	0.163*	0.057	-0.058*	0.568	0.401	2.080
	(0.755)	(0.254)	(0.022)	(0.083)	(0.100)	(0.031)			
ECD	1.080**	0.702***	-0.013	-0.013	0.084*	-0.013	0.579	0.417	1.986
	(0.446)	(0.182)	(0.016)	(0.076)	(0.047)	(0.060)			
EGS	0.549**	0.557***	0.010	0.270***	0.061	-0.065**	0.658	0.526	2.412
	(0.197)	(0.096)	(0.025)	(0.044)	(0.151)	(0.026)			

†Due to length of volatile period, no lag can be specified for the Newey-West covariance matrix

***,**,* indicate significance at 1, 5 and 10 percent levels

Appendix 4.43. Gender Disaggregated Michigan Survey Disagreement and Forecast Errors

Testing Equation:

$$\sigma_{i,t} = \gamma_0 + \gamma_1\sigma_{i,t-1} + \gamma_2(\pi_t - E_{t-h}[\pi_t])^2 + \gamma_3\pi_t + \gamma_4|\pi_t - \pi_{t-4}| + \gamma_5 Gap_t + \epsilon_t$$

	γ_0	γ_1	γ_2	γ_3	γ_4	γ_5	R^2	$\bar{R}^2$	D.W. Stat
Period: Whole 1982Q3 – 2011Q1									
MALE	1.014***	0.452***	0.016	0.328***	0.111**	-0.071***	0.678	0.663	2.328
	(0.279)	(0.126)	(0.010)	(0.074)	(0.052)	(0.025)			
FEMALE	0.363*	0.779***	0.025***	0.291***	-0.091*	-0.054**	0.805	0.797	2.655
	(0.214)	(0.039)	(0.009)	(0.050)	(0.051)	(0.025)			
Period: Greenspan-Bernanke 1987Q2 – 2011Q1									
MALE	1.295***	0.345**	0.031*	0.368***	0.036	-0.089***	0.604	0.582	2.243
	(0.305)	(0.143)	(0.016)	(0.081)	(0.074)	(0.024)			
FEMALE	0.487*	0.746***	0.030**	0.303***	-0.121	-0.057**	0.760	0.747	2.599
	(0.253)	(0.050)	(0.014)	(0.062)	(0.089)	(0.027)			
Period: Stable 1990Q1 – 2006Q2									
MALE	1.749***	0.227**	0.163***	0.306***	0.072	-0.151**	0.648	0.619	1.747
	(0.320)	(0.104)	(0.042)	(0.048)	(0.123)	(0.062)			
FEMALE	0.557	0.675***	0.032	0.397***	-0.102	-0.150	0.776	0.758	2.301
	(0.576)	(0.101)	(0.066)	(0.035)	(0.097)	(0.104)			
Period: Volatile 2006Q3 – 2011Q1									
MALE	-0.106	0.959***	-0.016*	0.101	0.083***	-0.001	0.800	0.723	2.657
	(0.331)	(0.155)	(0.008)	(0.059)	(0.020)	(0.025)			
FEMALE†	1.923	0.459	0.015	0.124	0.000	-0.050	0.557	0.386	2.020
	(1.202)	(0.444)	(0.051)	(0.263)	(0.155)	(0.058)			

†Due to length of volatile period, no lag can be specified for the Newey-West covariance matrix

***,**,* indicate significance at 1, 5 and 10 percent levels

Appendix 4.44. Income Disaggregated Michigan Survey Disagreement and Forecast Errors

Testing Equation:

$$\sigma_{i,t} = \gamma_0 + \gamma_1\sigma_{i,t-1} + \gamma_2(\pi_t - E_{t-h}[\pi_t])^2 + \gamma_3\pi_t + \gamma_4|\pi_t - \pi_{t-4}| + \gamma_5 Gap_t + \epsilon_t$$

	γ_0	γ_1	γ_2	γ_3	γ_4	γ_5	R^2	$\bar{R}^2$	D.W. Stat
Period: Whole 1982Q3 – 2011Q1									
Y14	0.979**	0.670***	-0.028	0.458***	-0.038	-0.099**	0.677	0.662	2.693
	(0.416)	(0.071)	(0.020)	(0.130)	(0.092)	(0.050)			
Y24	0.709**	0.621***	0.027**	0.370***	0.037	-0.056*	0.660	0.644	2.615
	(0.278)	(0.068)	(0.011)	(0.069)	(0.094)	(0.031)			
Y34	0.916***	0.519***	0.012	0.358***	0.028	-0.089*	0.650	0.634	2.502
	(0.257)	(0.087)	(0.012)	(0.0800)	(0.058)	(0.047)			
Y44	0.923***	0.472***	0.010	0.262***	0.117*	-0.067**	0.640	0.623	2.220
	(0.200)	(0.090)	(0.016)	(0.063)	(0.062)	(0.029)			
Period: Greenspan-Bernanke 1987Q2 – 2011Q1									
Y14	0.836**	0.672***	-0.012	0.401***	-0.008	-0.086*	0.642	0.623	2.618
	(0.401)	(0.074)	(0.020)	(0.141)	(0.117)	(0.048)			
Y24	0.852**	0.596***	0.042***	0.383***	-0.098	-0.063*	0.621	0.600	2.471
	(0.327)	(0.093)	(0.014)	(0.075)	(0.109)	(0.033)			
Y34	1.223**	0.419**	0.036	0.394***	-0.082	-0.104	0.590	0.567	2.288
	(0.467)	(0.169)	(0.026)	(0.140)	(0.143)	(0.063)			
Y44	1.216***	0.367***	0.030	0.288***	0.013	-0.085***	0.560	0.535	2.056
	(0.232)	(0.101)	(0.021)	(0.066)	(0.080)	(0.028)			
Period: Stable 1990Q1 – 2006Q2									
Y14	1.168*	0.542***	-0.024	0.615***	-0.114	-0.249**	0.639	0.609	2.455
	(0.654)	(0.115)	(0.034)	(0.179)	(0.356)	(0.115)			
Y24	0.944*	0.554***	0.053	0.383***	-0.020	-0.168*	0.666	0.638	2.385
	(0.480)	(0.104)	(0.039)	(0.093)	(0.065)	(0.091)			
Y34	1.625**	0.255	0.015	0.487***	-0.099	-0.214**	0.617	0.585	2.109
	(0.627)	(0.192)	(0.071)	(0.137)	(0.185)	(0.104)			
Y44	1.455***	0.249**	0.153**	0.297***	0.055	-0.135***	0.589	0.555	1.916
	(0.323)	(0.112)	(0.065)	(0.066)	(0.083)	(0.043)			
Period: Volatile 2006Q3 – 2011Q1									
Y14	1.652**	0.479***	0.049***	-0.047	0.024	-0.040***	0.599	0.445	2.472
	(0.587)	(0.119)	(0.012)	(0.066)	(0.049)	(0.009)			
Y24	1.507***	0.409**	0.036	0.285**	-0.009	-0.060**	0.655	0.522	2.231
	(0.416)	(0.155)	(0.022)	(0.099)	(0.078)	(0.020)			
Y34	0.599	0.770**	-0.042	0.026	0.227	-0.018	0.624	0.479	2.151
	(0.813)	(0.324)	(0.050)	(0.209)	(0.164)	(0.049)			
Y44	0.195	0.891**	-0.012	0.074	0.057	-0.006	0.724	0.617	2.050
	(0.383)	(0.357)	(0.075)	(0.212)	(0.427)	(0.188)			

†Due to length of volatile period, no lag can be specified for the Newey-West covariance matrix

***,**,* indicate significance at 1, 5 and 10 percent levels

Appendix 4.45. Regionally Disaggregated Michigan Survey Disagreement and Forecast Errors

Testing Equation:

$$\sigma_{i,t} = \gamma_0 + \gamma_1\sigma_{i,t-1} + \gamma_2(\pi_t - E_{t-h}[\pi_t])^2 + \gamma_3\pi_t + \gamma_4|\pi_t - \pi_{t-4}| + \gamma_5 Gap_t + \epsilon_t$$

	γ_0	γ_1	γ_2	γ_3	γ_4	γ_5	R^2	$\bar{R}^2$	D.W. Stat
Period: Whole 1982Q3 – 2011Q1									
NC	0.822*** (0.313)	0.582*** (0.098)	0.033** (0.014)	0.389*** (0.094)	-0.062 (0.098)	-0.076** (0.032)	0.626	0.609	2.531
NE	0.898*** (0.295)	0.563*** (0.101)	0.004 (0.014)	0.368*** (0.104)	0.087 (0.072)	-0.076* (0.042)	0.593	0.574	2.539
S	0.415** (0.189)	0.723*** (0.043)	0.017 (0.010)	0.314*** (0.058)	-0.009 (0.059)	-0.059** (0.023)	0.777	0.767	2.395
W	1.355*** (0.422)	0.461*** (0.092)	0.041*** (0.015)	0.373*** (0.068)	-0.065 (0.075)	-0.093** (0.042)	0.494	0.471	2.419
Period: Greenspan-Bernanke 1987Q2 – 2011Q1									
NC	1.087*** (0.321)	0.509*** (0.118)	0.053*** (0.017)	0.420*** (0.128)	-0.191 (0.130)	-0.089*** (0.029)	0.575	0.551	2.448
NE	1.055*** (0.267)	0.456*** (0.091)	0.033** (0.016)	0.487*** (0.094)	-0.046 (0.116)	-0.101** (0.044)	0.528	0.502	2.419
S	0.506** (0.233)	0.705*** (0.051)	0.017 (0.013)	0.301*** (0.063)	-0.012 (0.077)	-0.058* (0.031)	0.729	0.714	2.290
W	1.633 (2.357)	0.411 (0.632)	0.058* (0.030)	0.358 (0.348)	-0.204 (0.281)	-0.101 (0.326)	0.459	0.429	2.273
Period: Stable 1990Q1 – 2006Q2									
NC	1.243 (0.834)	0.413** (0.180)	0.119* (0.067)	0.436*** (0.079)	-0.045 (0.092)	-0.211 (0.168)	0.609	0.577	2.275
NE	1.457** (0.712)	0.328** (0.157)	0.080 (0.061)	0.567*** (0.067)	-0.140 (0.195)	-0.258* (0.139)	0.591	0.556	2.040
S	0.728 (0.439)	0.635*** (0.079)	0.132** (0.050)	0.337*** (0.053)	-0.111 (0.138)	-0.143** (0.069)	0.753	0.733	2.103
W	1.682* (0.894)	0.362 (0.195)	0.053 (0.050)	0.379*** 0.070)	-0.087 (0.098)	-0.208 (0.135)	0.515	0.475	2.274
Period: Volatile 2006Q3 – 2011Q1									
NC	1.077** (0.378)	0.697*** (0.105)	-0.009 (0.025)	0.035 (0.066)	0.047 (0.103)	-0.024 (0.040)	0.570	0.404	2.349
NE†	-0.217 (0.498)	1.016*** (0.182)	-0.042 (0.033)	0.034 (0.147)	0.158 (0.131)	-0.003 (0.039)	0.707	0.594	2.135
S	1.930** (0.854)	0.406* (0.206)	-0.006 (0.028)	0.113* (0.053)	0.138 (0.164)	-0.054* (0.030)	0.552	0.380	2.174
W†	1.348 (1.313)	0.545 (0.395)	0.022 (0.043)	0.145 (0.154)	0.005 (0.169)	-0.043 (0.056)	0.645	0.509	2.001

†Due to length of volatile period, no lag can be specified for the Newey-West covariance matrix

***,**,* indicate significance at 1, 5 and 10 percent levels

Appendix 4.46. Age Disaggregated Disagreement and Macroeconomic Uncertainty

Testing Equation: $\sigma_{i,t} = \gamma_0 + \gamma_1\sigma_{i,t-1} + \gamma_2\sigma_{P,t} + \gamma_3 Bloom_t + \gamma_4\pi_t + \epsilon_t$

	γ_0	γ_1	γ_2	γ_3	γ_4	R^2	$\bar{R}^2$	D.W. Stat
Period: Whole 1982Q3 – 2011Q1†								
A1834	0.237 (0.397)	0.713*** (0.044)	0.182 (0.300)	0.510** (0.250)	0.182** (0.075)	0.639	0.625	2.542
A3544	0.117 (0.364)	0.711*** (0.059)	0.048 (0.351)	0.589** (0.275)	0.217*** (0.059)	0.654	0.641	2.417
A4554	0.617 (0.499)	0.561*** (0.075)	0.105 (0.369)	0.566 (0.358)	0.292*** (0.107)	0.478	0.457	2.624
A5564	1.029* (0.568)	0.483*** (0.120)	0.259 (0.470)	0.573** (0.234)	0.213** (0.083)	0.365	0.340	2.276
A6597	0.822* (0.458)	0.524*** (0.090)	0.742* (0.415)	0.360 (0.319)	0.253*** (0.067)	0.452	0.430	2.504
Period: Greenspan-Bernanke 1987Q2 – 2011Q1								
A1834	0.222 (0.407)	0.708*** (0.050)	0.166 (0.334)	0.533** (0.250)	0.180** (0.084)	0.631	0.615	2.458
A3544	0.094 (0.373)	0.729*** (0.067)	0.076 (0.405)	0.544** (0.261)	0.202*** (0.063)	0.653	0.638	2.447
A4554	0.480 (0.454)	0.586*** (0.075)	0.109 (0.414)	0.600* (0.350)	0.279*** (0.104)	0.509	0.487	2.665
A5564	1.032* (0.571)	0.496*** (0.133)	0.068 (0.578)	0.575** (0.231)	0.226* (0.116)	0.371	0.343	2.266
A6597	1.017** (0.440)	0.524*** (0.093)	0.415 (0.436)	0.321 (0.317)	0.259*** (0.082)	0.437	0.412	2.501
Period: Stable 1990Q1 – 2006Q2								
A1834	-0.082 (0.335)	0.708*** (0.060)	-0.920 (0.588)	0.806*** (0.288)	0.398*** (0.119)	0.727	0.709	2.225
A3544	-0.141 (0.442)	0.737*** (0.079)	-0.281 (0.584)	0.533* (0.315)	0.345*** (0.069)	0.724	0.706	2.224
A4554	0.511 (0.805)	0.542*** (0.094)	-0.905* (0.530)	0.562 (0.537)	0.536*** (0.120)	0.527	0.496	2.618
A5564	1.502* (0.867)	0.442*** (0.131)	-2.336*** (0.722)	0.408 (0.354)	0.678*** (0.117)	0.445	0.408	2.169
A6597	1.418** (0.545)	0.493*** (0.106)	-1.005 (0.675)	0.202 (0.448)	0.481*** (0.120)	0.406	0.368	2.411
Period: Volatile 2006Q3 – 2011Q1								
A1834	2.352 (1.525)	0.155 (1.016)	1.229 (2.637)	0.443 (4.709)	-0.089 (1.014)	0.339	0.151	1.931
A3544	0.094 (0.434)	0.684*** (0.101)	0.435 (0.385)	0.612*** (0.151)	0.103*** (0.018)	0.705	0.621	2.149
A4554	1.258** (0.424)	0.663*** (0.194)	-0.675 (0.501)	0.703** (0.251)	0.005 (0.045)	0.680	0.588	2.341
A5564	0.659 (0.548)	0.718*** (0.131)	0.321 (0.402)	0.223 (0.203)	0.043 (0.045)	0.742	0.668	2.321
A6597	1.072** (0.419)	0.704*** (0.177)	-0.625* (0.321)	0.639* (0.303)	0.057** (0.021)	0.685	0.595	2.469

† Sample period adjusted to 1985Q1 – 2011Q1 due to availability of Bloom Uncertainty data.

***,**,* indicate significance at 1, 5 and 10 percent levels

Appendix 4.47. Education Disaggregated Disagreement and Macroeconomic Uncertainty

Testing Equation: $\sigma_{i,t} = \gamma_0 + \gamma_1\sigma_{i,t-1} + \gamma_2\sigma_{P,t} + \gamma_3 Bloom_t + \gamma_4\pi_t + \epsilon_t$

	γ_0	γ_1	γ_2	γ_3	γ_4	R^2	$\bar{R}^2$	D.W. Stat
Period: Whole 1982Q3 – 2011Q1 †								
ELHS	1.417* (0.758)	0.628*** (0.062)	-0.016 (0.556)	0.006 (0.470)	0.347*** (0.111)	0.521	0.502	2.663
EHSD	0.352 (0.378)	0.726*** (0.052)	0.024 (0.363)	0.480* (0.274)	0.201*** (0.063)	0.659	0.645	2.590
ESC	0.306 (0.362)	0.628*** (0.065)	0.448 (0.382)	0.672*** (0.226)	0.142*** (0.053)	0.554	0.536	2.154
ECD	0.588* (0.306)	0.439*** (0.101)	0.684 (0.461)	0.626*** (0.197)	0.189** (0.090)	0.458	0.437	2.543
EGS	0.935** (0.406)	0.386*** (0.083)	0.138 (0.327)	0.743*** (0.228)	0.122* (0.067)	0.296	0.267	2.248
Period: Greenspan-Bernanke 1987Q2 – 2011Q1								
ELHS	1.452* (0.774)	0.628*** (0.065)	-0.096 (0.646)	-0.010 (0.480)	0.344*** (0.126)	0.517	0.496	2.661
EHSD	0.420 (0.395)	0.726*** (0.058)	-0.052 (0.397)	0.451* (0.269)	0.200*** (0.070)	0.653	0.638	2.580
ESC	0.241 (0.368)	0.648*** (0.071)	0.283 (0.382)	0.700*** (0.227)	0.151** (0.061)	0.576	0.558	2.041
ECD	0.449 (0.290)	0.478*** (0.098)	0.831* (0.473)	0.596*** (0.204)	0.160** (0.072)	0.500	0.478	2.582
EGS	0.764** (0.359)	0.430*** (0.081)	0.125 (0.359)	0.754*** (0.215)	0.124* (0.066)	0.344	0.315	2.209
Period: Stable 1990Q1 – 2006Q2								
ELHS	2.425* (1.294)	0.551*** (0.065)	-3.295*** (0.959)	-0.397 (0.703)	0.911*** (0.159)	0.499	0.466	2.654
EHSD	0.245 (0.482)	0.698*** (0.070)	-0.693 (0.601)	0.517 (0.393)	0.407*** (0.086)	0.678	0.657	2.660
ESC	0.096 (0.278)	0.657*** (0.078)	-0.581 (0.445)	0.758*** (0.279)	0.348*** (0.072)	0.672	0.651	1.839
ECD	0.401 (0.255)	0.486*** (0.066)	-0.203 (0.444)	0.646** (0.306)	0.357*** (0.065)	0.579	0.552	2.514
EGS	1.028** (0.396)	0.356*** (0.097)	-0.939 (0.568)	0.643** (0.254)	0.368*** (0.079)	0.340	0.297	2.156
Period: Volatile 2006Q3 – 2011Q1								
ELHS	3.328*** (0.763)	0.230 (0.169)	-0.200 (0.881)	0.955 (0.704)	-0.062 (0.058)	0.383	0.207	1.926
EHSD	2.144*** (0.343)	0.212* (0.114)	1.173*** (0.253)	0.419 (0.319)	0.047 (0.046)	0.487	0.340	2.093
ESC	1.065** (0.384)	0.690*** (0.145)	-0.587 (0.524)	0.685*** (0.160)	0.042* (0.022)	0.616	0.506	2.384
ECD	1.030** (0.446)	0.628*** (0.082)	-0.245 (0.275)	0.658** (0.276)	-0.024 (0.024)	0.632	0.527	2.171
EGS	0.118 (0.474)	0.622*** (0.161)	0.335 (0.518)	0.645 (0.402)	0.128* (0.070)	0.681	0.590	2.498

† Sample period adjusted to 1985Q1 – 2011Q1 due to availability of Bloom Uncertainty data.

***,**,* indicate significance at 1, 5 and 10 percent levels

Appendix 4.48. Gender Disaggregated Disagreement and Macroeconomic Uncertainty

Testing Equation: $\sigma_{i,t} = \gamma_0 + \gamma_1\sigma_{i,t-1} + \gamma_2\sigma_{P,t} + \gamma_3 Bloom_t + \gamma_4\pi_t + \epsilon_t$

	γ_0	γ_1	γ_2	γ_3	γ_4	R^2	$\bar{R}^2$	D.W. Stat
Period: Whole 1982Q3 – 2011Q1 †								
MALE	0.522*	0.524***	0.465*	0.558**	0.167**	0.554	0.536	2.493
	(0.278)	(0.095)	(0.243)	(0.218)	(0.068)			
FEMALE	0.050	0.809***	-0.120	0.484**	0.199***	0.768	0.759	2.695
	(0.294)	(0.038)	(0.273)	(0.213)	(0.060)			
Period: Greenspan-Bernanke 1987Q2 – 2011Q1								
MALE	0.513*	0.523***	0.443	0.557**	0.173**	0.544	0.524	2.487
	(0.307)	(0.104)	(0.314)	(0.214)	(0.086)			
FEMALE	0.079	0.807***	-0.122	0.486**	0.188***	0.757	0.746	2.668
	(0.310)	(0.044)	(0.307)	(0.217)	(0.065)			
Period: Stable 1990Q1 – 2006Q2								
MALE	0.857**	0.380***	-0.357	0.548**	0.386***	0.548	0.518	2.197
	(0.348)	(0.132)	(0.444)	(0.265)	(0.125)			
FEMALE	0.124	0.777	-1.526**	0.528	0.483***	0.784	0.770	2.435
	(0.428)	(0.055)	(0.624)	(0.326)	(0.113)			
Period: Volatile 2006Q3 – 2011Q1								
MALE	0.018	0.887***	-0.054	0.244	0.117***	0.799	0.742	2.810
	(0.328)	(0.096)	(0.229)	(0.172)	(0.020)			
FEMALE	1.308*	0.656**	-0.410	0.612	-0.007	0.624	0.516	2.328
	(0.624)	(0.243)	(0.730)	(0.378)	(0.046)			

† Sample period adjusted to 1985Q1 – 2011Q1 due to availability of Bloom Uncertainty data.

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 4.49. Income Disaggregated Disagreement and Macroeconomic Uncertainty

Testing Equation: $\sigma_{i,t} = \gamma_0 + \gamma_1\sigma_{i,t-1} + \gamma_2\sigma_{P,t} + \gamma_3 Bloom_t + \gamma_4\pi_t + \epsilon_t$

	γ_0	γ_1	γ_2	γ_3	γ_4	R^2	$\bar{R}^2$	D.W. Stat
Period: Whole 1982Q3 – 2011Q1 †								
Y14	0.272	0.708***	0.009	0.621*	0.300***	0.629	0.614	2.717
	(0.451)	(0.055)	(0.479)	(0.330)	(0.089)			
Y24	0.708	0.642***	0.328	0.249	0.212***	0.573	0.556	2.575
	(0.435)	(0.070)	(0.381)	(0.259)	(0.068)			
Y34	0.385	0.581***	0.262	0.642***	0.203**	0.572	0.555	2.543
	(0.296)	(0.071)	(0.271)	(0.189)	(0.085)			
Y44	0.424	0.529***	0.413**	0.605***	0.124**	0.531	0.512	2.338
	(0.270)	(0.070)	(0.205)	(0.197)	(0.054)			
Period: Greenspan-Bernanke 1987Q2 – 2011Q1								
Y14	0.477	0.723***	-0.265	0.554*	0.268***	0.638	0.622	2.676
	(0.432)	(0.056)	(0.486)	(0.310)	(0.101)			
Y24	0.511	0.671***	0.408	0.260	0.208***	0.601	0.583	2.564
	(0.394)	(0.070)	(0.388)	(0.238)	(0.068)			
Y34	0.341	0.577***	0.237	0.684***	0.211**	0.558	0.539	2.470
	(0.315)	(0.082)	(0.28)	(0.189)	(0.099)			
Y44	0.447	0.517***	0.349	0.624***	0.134*	0.515	0.493	2.326
	(0.292)	(0.080)	(0.273)	(0.194)	(0.072)			
Period: Stable 1990Q1 – 2006Q2								
Y14	0.473	0.673***	-1.385	0.576	0.576***	0.622	0.597	2.659
	(0.590)	(0.062)	(0.852)	(0.494)	(0.110)			
Y24	0.514	0.676***	-0.908**	0.355	0.421***	0.647	0.624	2.620
	(0.525)	(0.082)	(0.401)	(0.298)	(0.067)			
Y34	0.649	0.477***	-0.877*	0.615**	0.479***	0.572	0.544	2.380
	(0.474)	(0.082)	(0.458)	(0.268)	(0.096)			
Y44	0.800**	0.354***	-0.794**	0.644***	0.414***	0.542	0.512	2.225
	(0.320)	(0.091)	(0.392)	(0.231)	(0.092)			
Period: Volatile 2006Q3 – 2011Q1								
Y14	2.265***	0.393**	0.133	0.614	-0.001	0.524	0.388	2.205
	(0.619)	(0.163)	(0.489)	(0.490)	(0.047)			
Y24	1.002*	0.500**	0.721	0.443	0.043	0.607	0.495	2.116
	(0.551)	(0.202)	(0.647)	(0.380)	(0.058)			
Y34	0.995**	0.708***	-0.843*	0.807**	0.041	0.670	0.575	2.458
	(0.448)	(0.085)	(0.396)	(0.360)	(0.072)			
Y44	0.301***	0.827***	-0.254	0.392**	0.075***	0.745	0.673	2.296
	(0.065)	(0.057)	(0.352)	(0.175)	(0.024)			

† Sample period adjusted to 1985Q1 – 2011Q1 due to availability of Bloom Uncertainty data.

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 4.50. Regionally Disaggregated Disagreement and Macroeconomic Uncertainty

Testing Equation: $\sigma_{i,t} = \gamma_0 + \gamma_1\sigma_{i,t-1} + \gamma_2\sigma_{P,t} + \gamma_3 Bloom_t + \gamma_4\pi_t + \epsilon_t$

	γ_0	γ_1	γ_2	γ_3	γ_4	R^2	$\bar{R}^2$	D.W. Stat
Period: Whole 1982Q3 – 2011Q1 †								
NC	0.438 (0.444)	0.617*** (0.089)	0.562 (0.374)	0.360 (0.367)	0.220*** (0.073)	0.569	0.552	2.533
NE	0.544 (0.373)	0.566*** (0.075)	0.204 (0.325)	0.633** (0.242)	0.272*** (0.073)	0.499	0.479	2.596
S	0.202 (0.302)	0.778*** (0.039)	-0.222 (0.340)	0.483** (0.197)	0.200*** (0.066)	0.729	0.718	2.447
W	0.843 (0.707)	0.514*** (0.102)	0.379 (0.514)	0.601 (0.408)	0.190** (0.075)	0.396	0.372	2.447
Period: Greenspan-Bernanke 1987Q2 – 2011Q1								
NC	0.483 (0.461)	0.615*** (0.097)	0.502 (0.404)	0.359 (0.358)	0.220*** (0.081)	0.547	0.527	2.516
NE	0.595 (0.362)	0.553*** (0.076)	0.136 (0.388)	0.606** (0.247)	0.291*** (0.088)	0.492	0.469	2.581
S	0.207 (0.305)	0.774*** (0.042)	-0.166 (0.393)	0.470** (0.199)	0.192*** (0.071)	0.722	0.710	2.370
W	0.815 (0.707)	0.546*** (0.121)	0.101 (0.486)	0.655* (0.348)	0.179* (0.099)	0.419	0.393	2.370
Period: Stable 1990Q1 – 2006Q2								
NC	0.366 (0.513)	0.559*** (0.174)	-0.605 (0.688)	0.665 (0.472)	0.454** (0.177)	0.569	0.541	2.487
NE	0.759 (0.523)	0.532*** (0.076)	-1.138 (0.741)	0.399 (0.354)	0.588*** (0.099)	0.530	0.499	2.423
S	0.198 (0.239)	0.735*** (0.039)	-1.055*** (0.362)	0.440** (0.188)	0.437*** (0.052)	0.742	0.726	2.334
W	1.162 (0.732)	0.511*** (0.120)	-1.639* (0.910)	0.515 (0.395)	0.498*** (0.137)	0.498	0.466	2.377
Period: Volatile 2006Q3 – 2011Q1								
NC	1.173** (0.511)	0.584*** (0.148)	-0.187 (0.170)	0.678** (0.308)	0.012 (0.038)	0.636	0.532	2.630
NE	0.339 (0.281)	0.779*** (0.059)	-0.331 (0.322)	0.634** (0.295)	0.112** (0.042)	0.732	0.655	2.369
S	1.450** (0.498)	0.561** (0.192)	-0.013 (0.395)	0.480 (0.311)	0.016 (0.047)	0.542	0.411	2.493
W	0.805 (0.676)	0.613*** (0.116)	0.245 (0.229)	0.591** (0.237)	0.009 (0.039)	0.680	0.588	2.094

† Sample period adjusted to 1985Q1 – 2011Q1 due to availability of Bloom Uncertainty data.

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 4.51. Aggregate Michigan Survey Disagreement and Perceived News Intensity regarding Business Conditions

Testing Equation:

$$\sigma_{i,t} = \alpha_0 + \alpha_1\sigma_{i,t-1} + \alpha_2 News_{i,t} + \alpha_3\pi_t + \alpha_4|\Delta\pi_t| + \alpha_5 GAP_t + \epsilon_t$$

	α_0	α_1	α_2	α_3	α_4	α_6	R^2	$\bar{R}^2$	D.W. Stat
Period: Whole 1982Q3 – 2011Q1									
MS	-0.331 (0.266)	0.808*** (0.037)	1.141** (0.432)	0.178*** (0.037)			0.830	0.826	2.638
	0.328 (0.528)	0.781*** (0.049)	0.048 (0.764)	0.223*** (0.048)	0.010 (0.046)	-0.045 (0.030)	0.834	0.826	2.603
Period: Greenspan-Bernanke 1987Q2 – 2011Q1									
MS	-0.357 (0.302)	0.794*** (0.048)	1.259*** (0.451)	0.177*** (0.043)			0.779	0.772	2.581
	0.276 (0.556)	0.760*** (0.064)	0.195 (0.764)	0.231*** (0.062)	0.014 (0.057)	-0.045 (0.034)	0.784	0.772	2.548
Period: Stable 1990Q1 – 2006Q2									
MS	-0.417 (0.276)	0.744*** (0.060)	1.217** (0.551)	0.286*** (0.045)			0.774	0.763	2.508
	0.981 (0.922)	0.638*** (0.114)	-0.661 (1.179)	0.363*** (0.068)	0.023 (0.145)	-0.149* (0.089)	0.788	0.770	2.341
Period: Volatile 2006Q3 – 2011Q1									
MS	-2.202* (1.173)	0.236 (0.187)	7.270*** (2.394)	0.034 (0.029)			0.816	0.779	1.892
	-3.249 (2.448)	0.266*** (0.034)	9.154* (4.765)	-0.044 (0.221)	-0.037 (0.134)	0.049 (0.068)	0.838	0.776	2.267

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 4.52. Age Disaggregated Michigan Survey Disagreement and Perceived News Intensity regarding Business Conditions

Testing Equation:

$$\sigma_{i,t} = \alpha_0 + \alpha_1\sigma_{i,t-1} + \alpha_2 News_{i,t} + \alpha_3\pi_t + \alpha_4|\Delta\pi_t| + \alpha_5 GAP_t + \epsilon_t$$

	α_0	α_1	α_2	α_3	α_4	α_6	R^2	$\bar{R}^2$	D.W. Stat
				Period: Whole 1982Q3 – 2011Q1					
A1834	0.926** (0.383)	0.711*** (0.063)	-0.273 (0.355)	0.232** (0.089)	-0.005 (0.059)	-0.054 (0.044)	0.701	0.687	2.562
A3544	0.717*** (0.241)	0.685*** (0.074)	-0.223 (0.212)	0.311*** (0.068)	-0.007 (0.069)	-0.072* (0.040)	0.697	0.683	2.461
A4554	1.094*** (0.243)	0.494*** (0.083)	-0.025 (0.225)	0.400*** (0.101)	0.070 (0.077)	-0.097* (0.051)	0.517	0.495	2.508
A5564	1.079*** (0.360)	0.466*** (0.120)	0.187 (0.291)	0.388*** (0.101)	0.063 (0.106)	-0.104* (0.056)	0.492	0.469	2.259
A6597	0.914** (0.370)	0.495*** (0.096)	0.399 (0.349)	0.411*** (0.095)	0.114 (0.079)	-0.079* (0.043)	0.507	0.485	2.501
				Period: Greenspan-Bernanke 1987Q2 – 2011Q1					
A1834	1.662*** (0.526)	0.679*** (0.073)	-0.864* (0.454)	0.193 (0.134)	-0.066 (0.110)	-0.043 (0.057)	0.654	0.632	2.383
A3544	1.376*** (0.313)	0.679*** (0.084)	-0.655*** (0.150)	0.217*** (0.069)	-0.110 (0.086)	-0.061* (0.031)	0.672	0.654	2.409
A4554	0.978*** (0.291)	0.517*** (0.089)	-0.163 (0.277)	0.421*** (0.126)	0.063 (0.117)	-0.098** (0.044)	0.538	0.511	2.560
A5564	1.750*** (0.473)	0.420*** (0.141)	-0.179 (0.310)	0.331*** (0.112)	-0.067 (0.121)	-0.110** (0.052)	0.403	0.370	2.208
A6597	1.146** (0.550)	0.480*** (0.102)	0.099 (0.478)	0.403*** (0.116)	0.088 (0.107)	-0.079* (0.041)	0.457	0.427	2.456
				Period: Stable 1990Q1 – 2006Q2					
A1834	1.669** (0.722)	0.584*** (0.105)	-0.770 (0.497)	0.317** (0.125)	-0.119 (0.151)	-0.131* (0.067)	0.729	0.707	2.132
A3544	1.326* (0.726)	0.638*** (0.101)	-0.576** (0.264)	0.309*** (0.050)	-0.194* (0.100)	-0.125 (0.098)	0.741	0.720	2.108
A4554	0.951 (0.638)	0.361** (0.171)	0.052 (0.478)	0.566*** (0.159)	0.244 (0.397)	-0.282** (0.132)	0.590	0.556	2.287
A5564	1.833*** (0.642)	0.299* (0.154)	-0.012 (0.484)	0.480*** (0.082)	-0.193 (0.153)	-0.232* (0.127)	0.458	0.413	2.055
A6597	1.405** (0.698)	0.385** (0.174)	0.113 (0.840)	0.452*** (0.132)	0.081 (0.207)	-0.196 (0.167)	0.440	0.393	2.243
				Period: Volatile 2006Q3 – 2011Q1					
A1834†	6.190*** (0.532)	-0.168 (0.160)	-1.995*** (0.318)	-0.143 (0.099)	0.130 (0.100)	-0.038 (0.023)	0.709	0.597	2.334
A3544	3.624*** (0.436)	0.190** (0.072)	-1.393*** (0.185)	0.043 (0.037)	0.028 (0.041)	-0.081*** (0.011)	0.856	0.801	1.681
A4554	4.755*** (0.637)	-0.036 (0.191)	-1.645*** (0.156)	-0.045 (0.029)	-0.082*** (0.022)	-0.126*** (0.032)	0.873	0.824	2.512
A5564	2.816*** (0.331)	0.403*** (0.082)	-0.809*** (0.175)	0.002 (0.039)	-0.017 (0.032)	-0.049*** (0.016)	0.805	0.730	2.669
A6597	4.891*** (0.989)	0.119 (0.172)	-1.948*** (0.413)	-0.018 (0.036)	-0.061 (0.0387)	-0.055*** (0.009)	0.841	0.780	2.576

†Due to length of volatile period, no lag can be specified for the Newey-West covariance matrix

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 4.53. Education Disaggregated Michigan Survey Disagreement and Perceived News Intensity regarding Business Conditions

Testing Equation:

$$\sigma_{i,t} = \alpha_0 + \alpha_1\sigma_{i,t-1} + \alpha_2 News_{i,t} + \alpha_3\pi_t + \alpha_4|\Delta\pi_t| + \alpha_5 GAP_t + \epsilon_t$$

	α_0	α_1	α_2	α_3	α_4	α_6	R^2	$\bar{R}^2$	D.W. Stat
Period: Whole 1982Q3 – 2011Q1									
ELHS	0.452 (0.858)	0.597*** (0.073)	0.711 (1.006)	0.512*** (0.126)	0.009 (0.097)	-0.114* (0.068)	0.572	0.553	2.684
EHSD	0.687*** (0.213)	0.680*** (0.066)	0.068 (0.201)	0.293*** (0.065)	0.017 (0.067)	-0.072* (0.036)	0.717	0.704	2.576
ESC	1.250*** (0.292)	0.590*** (0.076)	-0.131 (0.297)	0.225*** (0.073)	0.014 (0.055)	-0.068* (0.035)	0.580	0.561	2.166
ECD	1.153*** (0.252)	0.423*** (0.106)	-0.049 (0.192)	0.339*** (0.093)	0.115*** (0.040)	-0.089* (0.047)	0.544	0.523	2.465
EGS	2.067*** (0.285)	0.205** (0.103)	-0.278* (0.144)	0.238*** (0.060)	0.080 (0.054)	-0.109*** (0.031)	0.394	0.366	2.018
Period: Greenspan-Bernanke 1987Q2 – 2011Q1									
ELHS	1.165 (1.359)	0.594*** (0.073)	-0.019 (1.452)	0.469*** (0.163)	-0.060 (0.154)	-0.100 (0.068)	0.531	0.504	2.661
EHSD	0.892** (0.383)	0.665*** (0.071)	-0.144 (0.352)	0.295*** (0.080)	-0.003 (0.091)	-0.072** (0.035)	0.665	0.646	2.506
ESC	2.034*** (0.409)	0.576*** (0.086)	-0.848*** (0.265)	0.163** (0.081)	-0.088 (0.070)	-0.056** (0.027)	0.597	0.574	1.973
ECD	1.717*** (0.321)	0.435*** (0.093)	-0.463** (0.212)	0.241** (0.114)	0.043 (0.053)	-0.067** (0.032)	0.514	0.487	2.499
EGS	2.244*** (0.360)	0.278*** (0.101)	-0.564*** (0.162)	0.172*** (0.059)	-0.002 (0.049)	-0.098*** (0.024)	0.440	0.409	1.998
Period: Stable 1990Q1 – 2006Q2									
ELHS	0.289 (1.076)	0.428*** (0.142)	1.421 (1.384)	0.710*** 0.117)	-0.121 (0.272)	-0.363* (0.208)	0.513	0.472	2.493
EHSD	0.698 (0.680)	0.525*** (0.138)	0.374 (0.552)	0.462*** (0.093)	0.010 (0.209)	-0.230** (0.102)	0.703	0.678	2.381
ESC	1.859 (1.141)	0.554*** (0.108)	-0.793 (0.522)	0.259*** (0.096)	-0.110 (0.141)	-0.090 (0.058)	0.675	0.648	2.387
ECD	1.683*** (0.456)	0.386** (0.146)	-0.412 (0.277)	0.325*** (0.083)	-0.043 (0.083)	-0.112 (0.076)	0.593	0.559	2.323
EGS	2.311*** (0.589)	0.197 (0.143)	-0.555** (0.252)	0.221** (0.083)	0.138 (0.118)	-0.171*** (0.045)	0.426	0.378	1.852
Period: Volatile 2006Q3 – 2011Q1									
ELHS†	9.782*** (1.343)	-0.025 (0.168)	-5.239*** (1.019)	-0.203*** (0.059)	-0.268*** (0.073)	-0.007 (0.033)	0.654	0.521	1.836
EHSD	5.917*** (0.174)	-0.270*** (0.041)	-1.558*** (0.048)	0.125*** (0.022)	0.140*** (0.022)	-0.071*** (0.008)	0.762	0.671	2.147
ESC	5.070*** (0.673)	0.047 (0.128)	-2.170*** (0.276)	-0.057 (0.071)	-0.055 (0.054)	-0.091*** (0.015)	0.857	0.802	2.696
ECD	4.464*** (0.553)	0.063 (0.140)	-1.556*** (0.283)	-0.171*** (0.037)	-0.019 (0.059)	-0.071*** (0.014)	0.848	0.789	2.178
EGS	2.504** (0.932)	0.149 (0.296)	-0.877** (0.298)	0.142 (0.093)	0.003 (0.081)	-0.128 (0.057)	0.795	0.717	2.646

***,**,* indicate significance at 1, 5 and 10 percent levels.

†Due to length of volatile period, no lag can be specified for the Newey-West covariance matrix

Appendix 4.54. Gender Disaggregated Michigan Survey Disagreement and Perceived News Intensity regarding Business Conditions

Testing Equation:

$$\sigma_{i,t} = \alpha_0 + \alpha_1 \sigma_{i,t-1} + \alpha_2 News_{i,t} + \alpha_3 \pi_t + \alpha_4 |\Delta\pi_t| + \alpha_5 GAP_t + \epsilon_t$$

	α_0	α_1	α_2	α_3	α_4	α_6	R^2	$\bar{R}^2$	D.W. Stat
Period: Whole 1982Q3 – 2011Q1									
MALE	1.037*** (0.278)	0.465*** (0.116)	-0.028 (0.188)	0.307*** (0.071)	0.142** (0.056)	-0.072** (0.028)	0.674	0.659	2.423
FEMALE	0.502*** (0.185)	0.792*** (0.051)	-0.108 (0.210)	0.238*** (0.066)	-0.037 (0.044)	-0.053 (0.033)	0.803	0.794	2.661
Period: Greenspan-Bernanke 1987Q2 – 2011Q1									
MALE	1.685*** (0.432)	0.389*** (0.145)	-0.442** (0.205)	0.295*** (0.089)	0.076 (0.058)	-0.080*** (0.030)	0.604	0.582	2.302
FEMALE	0.744** (0.294)	0.776*** (0.056)	-0.302 (0.259)	0.222*** (0.080)	-0.048 (0.078)	-0.047 (0.029)	0.758	0.745	2.629
Period: Stable 1990Q1 – 2006Q2									
MALE	2.002*** (0.544)	0.197 (0.161)	-0.404 (0.295)	0.394*** (0.102)	0.141 (0.155)	-0.155*** (0.055)	0.622	0.591	1.938
FEMALE	0.646 (0.534)	0.678*** (0.098)	-0.089 (0.462)	0.387*** (0.107)	-0.080 (0.198)	-0.146* (0.086)	0.776	0.758	2.309
Period: Volatile 2006Q3 – 2011Q1									
MALE	3.323*** (0.627)	0.213 (0.149)	-1.315*** (0.224)	0.065*** (0.004)	0.010 (0.021)	-0.084*** (0.013)	0.896	0.857	2.886
FEMALE	4.823*** (0.666)	0.126 (0.190)	-1.648*** (0.212)	-0.088 (0.050)	-0.056 (0.087)	-0.061*** (0.020)	0.845	0.786	2.611

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 4.55. Income Disaggregated Michigan Survey Disagreement and Perceived News Intensity regarding Business Conditions

Testing Equation:

$$\sigma_{i,t} = \alpha_0 + \alpha_1\sigma_{i,t-1} + \alpha_2 News_{i,t} + \alpha_3\pi_t + \alpha_4|\Delta\pi_t| + \alpha_5 GAP_t + \epsilon_t$$

	α_0	α_1	α_2	α_3	α_4	α_6	R^2	$\bar{R}^2$	D.W. Stat
Period: Whole 1982Q3 – 2011Q1									
Y14	0.342 (0.352)	0.664*** (0.067)	0.606 (0.434)	0.406*** (0.091)	-0.023 (0.091)	-0.100* (0.053)	0.677	0.662	2.681
Y24	0.585** (0.243)	0.607*** (0.090)	0.286 (0.329)	0.348*** (0.086)	0.112 (0.081)	-0.069 (0.046)	0.657	0.642	2.613
Y34	1.050*** (0.238)	0.541*** (0.127)	-0.183 (0.301)	0.327*** (0.103)	0.042 (0.052)	-0.084 (0.069)	0.651	0.635	2.522
Y44	1.058*** (0.231)	0.486*** (0.092)	-0.154 (0.137)	0.240*** (0.059)	0.129** (0.054)	-0.064** (0.029)	0.643	0.626	2.243
Period: Greenspan-Bernanke 1987Q2 – 2011Q1									
Y14	0.533 (0.495)	0.672*** (0.066)	0.273 (0.564)	0.380*** (0.110)	0.001 (0.121)	-0.087* (0.048)	0.642	0.622	2.615
Y24	0.892*** (0.292)	0.632*** (0.104)	-0.094 (0.312)	0.309*** (0.117)	0.030 (0.089)	-0.061 (0.046)	0.611	0.589	2.529
Y34	1.763*** (0.406)	0.471*** (0.089)	-0.619** (0.254)	0.291*** (0.094)	-0.044 (0.069)	-0.086*** (0.032)	0.597	0.575	2.358
Y44	2.108*** (0.315)	0.324*** (0.095)	-0.642*** (0.145)	0.205*** (0.058)	0.011 (0.048)	-0.082*** (0.026)	0.606	0.584	2.104
Period: Stable 1990Q1 – 2006Q2									
Y14	-0.009 (0.824)	0.499*** (0.118)	1.331 (0.940)	0.638*** (0.125)	-0.013 (0.312)	-0.325** (0.136)	0.645	0.615	2.434
Y24	0.941 (0.751)	0.550*** (0.123)	-0.032 (0.313)	0.401*** (0.074)	0.026 (0.109)	-0.171 (0.119)	0.665	0.637	2.416
Y34	2.250*** (0.726)	0.253 (0.159)	-0.568 (0.350)	0.436*** (0.103)	-0.151 (0.153)	-0.196* (0.102)	0.629	0.598	2.121
Y44	2.415*** (0.493)	0.142 (0.108)	-0.673*** (0.215)	0.303*** (0.070)	0.065 (0.080)	-0.149*** (0.045)	0.615	0.583	1.951
Period: Volatile 2006Q3 – 2011Q1									
Y14	7.996*** (1.095)	-0.341* (0.180)	-2.593*** (0.474)	-0.075* (0.025)	-0.018 (0.033)	-0.081*** (0.018)	0.785	0.702	2.391
Y24	3.969*** (0.630)	0.202 (0.132)	-1.497*** (0.294)	0.008 (0.041)	0.012 (0.070)	-0.051** (0.017)	0.841	0.779	2.351
Y34	4.711*** (0.215)	-0.026 (0.130)	-1.844*** (0.071)	-0.036 (0.064)	-0.029 (0.047)	-0.113*** (0.028)	0.887	0.844	2.579
Y44	2.465*** (0.271)	0.372*** (0.084)	-0.962*** (0.281)	0.025 (0.039)	-0.030 (0.054)	-0.067*** (0.015)	0.842	0.781	2.164

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 4.56. Regionally Disaggregated Michigan Survey Disagreement and Perceived News Intensity regarding Business Conditions

Testing Equation:

$$\sigma_{i,t} = \alpha_0 + \alpha_1\sigma_{i,t-1} + \alpha_2 News_{i,t} + \alpha_3\pi_t + \alpha_4|\Delta\pi_t| + \alpha_5 GAP_t + \epsilon_t$$

	α_0	α_1	α_2	α_3	α_4	α_6	R^2	$\bar{R}^2$	D.W. Stat
				Period: Whole 1982Q3 – 2011Q1					
NC	0.632** (0.318)	0.577*** (0.108)	0.311 (0.276)	0.362*** (0.103)	0.028 (0.084)	-0.087* (0.048)	0.623	0.606	2.500
NE	0.821** (0.323)	0.556*** (0.100)	0.116 (0.301)	0.373*** (0.094)	0.101 (0.070)	-0.081 (0.054)	0.593	0.574	2.534
S	0.503** (0.219)	0.733*** (0.053)	-0.079 (0.219)	0.284*** (0.066)	0.023 (0.054)	-0.059** (0.029)	0.776	0.765	2.408
W	1.443*** (0.383)	0.474*** (0.113)	-0.051 (0.230)	0.318*** (0.092)	0.029 (0.068)	-0.095 (0.061)	0.483	0.459	2.433
				Period: Greenspan-Bernanke 1987Q2 – 2011Q1					
NC	1.020** (0.436)	0.560*** (0.117)	-0.034 (0.349)	0.341*** (0.121)	-0.027 (0.097)	-0.088* (0.045)	0.560	0.535	2.464
NE	1.378*** (0.400)	0.480*** (0.093)	-0.330 (0.335)	0.406*** (0.116)	0.022 (0.082)	-0.096* (0.052)	0.525	0.499	2.453
S	0.795** (0.324)	0.733*** (0.055)	-0.347 (0.238)	0.246*** (0.079)	0.011 (0.075)	-0.047* (0.025)	0.730	0.715	2.326
W	2.155*** (0.558)	0.466*** (0.131)	-0.592** (0.257)	0.232** (0.119)	-0.090 (0.108)	-0.082 (0.053)	0.448	0.417	2.325
				Period: Stable 1990Q1 – 2006Q2					
NC	1.020 (1.281)	0.401 (0.338)	0.114 (0.397)	0.506** (0.204)	0.065 (0.104)	-0.222 (0.175)	0.601	0.568	2.274
NE	1.385** (0.607)	0.312** (0.130)	0.081 (0.582)	0.596*** (0.115)	-0.074 (0.175)	-0.274** (0.125)	0.589	0.554	2.055
S	0.843 (0.543)	0.624*** (0.094)	-0.195 (0.344)	0.381*** (0.068)	-0.033 (0.146)	-0.145* (0.079)	0.748	0.727	2.172
W	2.176** (1.044)	0.371** (0.174)	-0.517* (0.292)	0.349*** (0.082)	-0.098 (0.106)	-0.185 (0.114)	0.522	0.482	2.274
				Period: Volatile 2006Q3 – 2011Q1					
NC	5.074 (18.928)	-0.098 (3.591)	-1.919 (3.560)	-0.008 (1.039)	-0.044 (1.237)	-0.129 (0.508)	0.870	0.820	2.427
NE	3.676** (1.389)	0.278 (0.253)	-1.416*** (0.413)	-0.001 (0.100)	-0.061 (0.052)	-0.065** (0.026)	0.824	0.756	1.847
S	5.063*** (1.147)	-0.054 (0.272)	-1.552*** (0.299)	0.000 (0.049)	0.044 (0.048)	-0.076** (0.030)	0.802	0.726	2.455
W	3.492*** (0.892)	0.329* (0.163)	-1.168*** (0.170)	-0.073 (0.069)	-0.040 (0.058)	-0.049** (0.022)	0.796	0.717	2.912

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 4.57. Aggregate Michigan Survey Disagreement and Perceived News Intensity regarding Favourable and Unfavourable Business Conditions

Testing Equation:

$$\sigma_{i,t} = \alpha_0 + \alpha_1\sigma_{i,t-1} + \alpha_2 NewsF_{i,t} + \alpha_3 NewsU_{i,t} + \alpha_4\pi_t + \alpha_5|\pi_t - \pi_{t-4}| + \alpha_6 Gap_t + \epsilon_t$$

	α_0	α_1	α_2	α_3	α_4	α_5	α_6	R^2	$\bar{R}^2$	D.W. Stat
					Period: Whole 1982Q3 – 2011Q1					
MS	0.077 (0.200)	0.812*** (0.045)	0.413 (0.430)	0.644*** (0.207)	0.177*** (0.043)			0.833	0.827	2.653
	0.378 (0.389)	0.796*** (0.053)	-0.317 (0.624)	0.081 (0.416)	0.209*** (0.050)	0.004 (0.044)	-0.044 (0.029)	0.835	0.826	2.636
					Period: Greenspan-Bernanke 1987Q2 – 2011Q1					
MS	0.148 (0.343)	0.798*** (0.047)	-0.063 (0.656)	0.652*** (0.216)	0.158*** (0.052)			0.784	0.774	2.597
	1.007 (0.651)	0.769*** (0.056)	-1.559 (1.147)	-0.141 (0.519)	0.193*** (0.057)	-0.025 (0.054)	-0.066* (0.036)	0.790	0.776	2.598
					Period: Stable 1990Q1 – 2006Q2					
MS	-0.123 (0.412)	0.740*** (0.062)	0.376 (1.037)	0.837** (0.375)	0.268*** (0.062)			0.777	0.763	2.492
	1.251 (1.041)	0.653*** (0.103)	-1.518 (1.711)	-0.326 (0.703)	0.316*** (0.061)	-0.015 (0.129)	-0.156 (0.096)	0.790	0.769	2.372
					Period: Volatile 2006Q3 – 2011Q1					
MS	0.994* (0.485)	0.086 (0.111)	1.860* (0.878)	3.294*** (0.588)	-0.042 (0.035)			0.890	0.859	2.142
	2.116* (0.976)	0.102 (0.068)	-0.284 (1.559)	2.293* (1.115)	-0.039 (0.036)	-0.034 (0.055)	-0.051 (0.033)	0.903	0.855	2.416

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 4.58. Age Disaggregated Michigan Survey Disagreement and Perceived News Intensity regarding Favourable and Unfavourable Business Conditions

Testing Equation:

$$\sigma_{i,t} = \alpha_0 + \alpha_1\sigma_{i,t-1} + \alpha_2 NewsF_{i,t} + \alpha_3 NewsU_{i,t} + \alpha_4\pi_t + \alpha_5|\pi_t - \pi_{t-4}| + \alpha_6 Gap_t + \epsilon_t$$

	α_0	α_1	α_2	α_3	α_4	α_5	α_6	R^2	$\bar{R}^2$	D.W. Stat
Period: Whole 1982Q3 – 2011Q1										
A1834	-0.031 (0.332)	0.667*** (0.064)	0.014* (0.008)	0.014** (0.006)	0.220** (0.099)	-0.048 (0.062)	-0.014 (0.039)	0.709	0.693	2.522
A3544	0.524 (0.481)	0.686*** (0.081)	-0.003 (0.010)	0.002 (0.006)	0.311*** (0.068)	-0.006 (0.066)	-0.074 (0.046)	0.697	0.680	2.460
A4554	1.032 (0.925)	0.493*** (0.081)	0.000 (0.014)	0.001 (0.009)	0.400*** (0.095)	0.071 (0.085)	-0.096 (0.067)	0.517	0.490	2.508
A5564	2.337** (0.932)	0.458*** (0.121)	-0.015 (0.011)	-0.011 (0.007)	0.386*** (0.098)	0.071 (0.110)	-0.158** (0.074)	0.501	0.473	2.274
A6597	1.126 (0.685)	0.496*** (0.095)	0.008 (0.016)	-0.002 (0.008)	0.409*** (0.094)	0.113 (0.079)	-0.067 (0.060)	0.508	0.480	2.501
Period: Greenspan-Bernanke 1987Q2 – 2011Q1										
A1834	0.360 (0.529)	0.666*** (0.079)	0.002 (0.012)	0.013** (0.006)	0.201 (0.148)	-0.064 (0.103)	-0.025 (0.048)	0.653	0.629	2.362
A3544	1.675** (0.679)	0.696*** (0.088)	-0.024** (0.012)	-0.002 (0.006)	0.221*** (0.066)	-0.103 (0.080)	-0.098** (0.039)	0.677	0.655	2.395
A4554	0.386 (1.015)	0.511*** (0.091)	0.005 (0.017)	0.005 (0.008)	0.433*** (0.130)	0.075 (0.115)	-0.083 (0.056)	0.538	0.506	2.552
A5564	3.072*** (1.144)	0.402*** (0.143)	-0.026* (0.014)	-0.009 (0.007)	0.308*** (0.111)	-0.079 (0.127)	-0.178** (0.068)	0.421	0.382	2.219
A6597	1.091 (0.798)	0.482*** (0.103)	0.004 (0.021)	0.001 (0.008)	0.404*** (0.118)	0.090 (0.107)	-0.070 (0.060)	0.457	0.421	2.456
Period: Stable 1990Q1 – 2006Q2										
A1834	0.660 (0.764)	0.576*** (0.109)	-0.002 (0.016)	0.010 (0.007)	0.324** (0.132)	-0.125 (0.150)	-0.117 (0.075)	0.790	0.702	2.121
A3544	2.277* (1.143)	0.649*** (0.117)	-0.032** (0.015)	-0.008 (0.006)	0.314*** (0.069)	-0.163* (0.087)	-0.215* (0.113)	0.750	0.724	2.035
A4554	0.135 (1.361)	0.351** (0.173)	0.013 (0.022)	0.006 (0.010)	0.593*** (0.168)	0.257 (0.402)	-0.236 (0.162)	0.593	0.551	2.270
A5564	3.836*** (0.956)	0.286*** (0.098)	-0.032** (0.015)	-0.016** (0.008)	0.441*** (0.104)	-0.170 (0.135)	-0.352*** (0.117)	0.488	0.435	2.064
A6597	1.041 (0.629)	0.392* (0.225)	0.012 (0.045)	0.004 (0.011)	0.458** (0.212)	0.081 (0.307)	-0.161* (0.094)	0.441	0.384	2.243
Period: Volatile 2006Q3 – 2011Q1										
A1834	4.383*** (0.558)	-0.166 (0.558)	-0.024* (0.013)	0.018*** (0.006)	-0.148 (0.085)	0.127 (0.080)	-0.044 (0.031)	0.710	0.564	2.267
A3544	2.798 (3.732)	0.229 (0.506)	-0.025 (0.070)	0.007 (0.049)	0.054 (0.094)	0.033 (0.224)	-0.100 (0.142)	0.860	0.790	1.776
A4554	1.433 (0.864)	-0.051 (0.245)	0.013 (0.013)	0.029*** (0.007)	-0.051 (0.051)	-0.066 (0.056)	-0.071* (0.039)	0.891	0.837	2.591
A5564	1.018 (1.077)	0.233 (0.316)	0.011 (0.021)	0.024 (0.021)	-0.029 (0.018)	-0.055*** (0.016)	-0.024 (0.027)	0.821	0.732	2.428
A6597	0.722 (1.684)	0.154 (0.213)	0.024 (0.027)	0.042*** (0.012)	-0.042 (0.037)	-0.066 (0.066)	0.050 (0.069)	0.877	0.816	2.489

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 4.59. Education Disaggregated Michigan Survey Disagreement and Perceived News Intensity regarding Favourable and Unfavourable Business Conditions

Testing Equation:

$$\sigma_{i,t} = \alpha_0 + \alpha_1\sigma_{i,t-1} + \alpha_2 NewsF_{i,t} + \alpha_3 NewsU_{i,t} + \alpha_4\pi_t + \alpha_5|\pi_t - \pi_{t-4}| + \alpha_6 Gap_t + \epsilon_t$$

	α_0	α_1	α_2	α_3	α_4	α_5	α_6	R^2	$\bar{R}^2$	D.W. Stat
					Period: Whole 1982Q3 – 2011Q1					
ELHS	1.145* (0.655)	0.597*** (0.076)	0.008 (0.021)	-0.007 (0.018)	0.511*** (0.127)	0.008 (0.106)	-0.113 (0.076)	0.572	0.549	2.684
EHSD	0.485 (0.313)	0.661*** (0.068)	0.008 (0.006)	0.005 (0.005)	0.289*** (0.067)	-0.003 (0.068)	-0.054 (0.037)	0.718	0.703	2.565
ESC	0.300 (0.399)	0.538*** (0.087)	0.017* (0.009)	0.014** (0.006)	0.189** (0.073)	-0.037 (0.054)	-0.021 (0.035)	0.594	0.571	2.160
ECD	0.346 (0.341)	0.393*** (0.113)	0.011 (0.008)	0.009* (0.005)	0.317*** (0.100)	0.098** (0.042)	-0.048 (0.042)	0.553	0.528	2.380
EGS	0.552 (0.452)	0.167 (0.103)	0.011** (0.004)	0.014*** (0.004)	0.210*** (0.057)	0.059 (0.055)	-0.060* (0.036)	0.421	0.389	2.076
					Period: Greenspan-Bernanke 1987Q2 – 2011Q1					
ELHS	1.355** (0.763)	0.595*** (0.074)	-0.009 (0.028)	-0.003 (0.018)	0.473*** (0.163)	-0.060 (0.155)	-0.113 (0.071)	0.531	0.499	2.662
EHSD	0.432 (0.613)	0.650*** (0.074)	0.009 (0.019)	0.006 (0.007)	0.300*** (0.083)	-0.007 (0.093)	-0.057 (0.042)	0.665	0.643	2.493
ESC	1.593*** (0.530)	0.588*** (0.087)	-0.018* (0.009)	0.004 (0.006)	0.166** (0.080)	-0.088 (0.071)	-0.074** (0.034)	0.599	0.572	1.968
ECD	0.583 (0.530)	0.433*** (0.094)	0.006 (0.011)	0.010* (0.005)	0.231** (0.108)	0.043 (0.065)	-0.035 (0.038)	0.519	0.487	2.418
EGS	0.637 (0.606)	0.251** (0.102)	0.007 (0.007)	0.014*** (0.004)	0.158*** (0.057)	-0.004 (0.052)	-0.058* (0.033)	0.458	0.421	1.991
					Period: Stable 1990Q1 – 2006Q2					
ELHS	1.541 (1.342)	0.428*** (0.112)	0.021 (0.043)	-0.012 (0.024)	0.710*** (0.182)	-0.119 (0.438)	-0.352** (0.157)	0.513	0.463	2.495
EHSD	0.731 (0.906)	0.511*** (0.126)	0.015 (0.024)	0.000 (0.010)	0.473*** (0.108)	-0.002 (0.246)	-0.209* (0.106)	0.704	0.674	2.367
ESC	1.243 (1.245)	0.557*** (0.111)	-0.012 (0.017)	0.006 (0.005)	0.260** (0.099)	-0.107 (0.145)	-0.102 (0.099)	0.675	0.642	0.741
ECD	0.269 (0.474)	0.378** (0.168)	0.011 (0.014)	0.013** (0.006)	0.308*** (0.081)	-0.067 (0.087)	-0.037 (0.028)	0.605	0.565	2.237
EGS	0.958 (0.867)	0.187 (0.141)	0.003 (0.009)	0.012** (0.005)	0.218*** (0.081)	0.125 (0.120)	-0.124** (0.061)	0.434	0.376	1.863
					Period: Volatile 2006Q3 – 2011Q1					
ELHS	4.115*** (0.700)	-0.056 (0.178)	-0.029 (0.024)	0.062*** (0.016)	-0.232** (0.103)	-0.271*** (0.085)	0.026 (0.055)	0.669	0.504	1.804
EHSD	4.372*** (0.626)	-0.269*** (0.083)	-0.016 (0.020)	0.015 (0.009)	0.125*** (0.024)	0.140*** (0.018)	-0.072*** (0.016)	0.762	0.643	2.150
ESC	3.592** (1.375)	0.081 (0.210)	-0.037 (0.037)	0.014 (0.018)	-0.051 (0.028)	-0.051 (0.087)	-0.116** (0.053)	0.860	0.790	2.719
ECD	1.862 (1.436)	0.010 (0.192)	0.001 (0.017)	0.025* (0.013)	-0.189** (0.066)	-0.026 (0.094)	-0.042 (0.047)	0.854	0.781	1.931
EGS	-1.315 (1.414)	0.128 (0.282)	0.024* (0.013)	0.032*** (0.009)	0.041 (0.111)	-0.060 (0.097)	-0.048 (0.070)	0.847	0.770	2.537

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 4.60. Gender Disaggregated Michigan Survey Disagreement and Perceived News Intensity regarding Favourable and Unfavourable Business Conditions

Testing Equation:

$$\sigma_{i,t} = \alpha_0 + \alpha_1\sigma_{i,t-1} + \alpha_2 NewsF_{i,t} + \alpha_3 NewsU_{i,t} + \alpha_4\pi_t + \alpha_5|\pi_t - \pi_{t-4}| + \alpha_6 Gap_t + \epsilon_t$$

	α_0	α_1	α_2	α_3	α_4	α_5	α_6	R^2	$\bar{R}^2$	D.W. Stat
Period: Whole 1982Q3 – 2011Q1										
MALE	0.811* (0.423)	0.460*** (0.117)	0.003 (0.006)	0.003 (0.004)	0.303*** (0.074)	0.136** (0.056)	-0.061* (0.035)	0.675	0.657	2.339
FEMALE	0.198 (0.434)	0.790 (0.053)	0.003 (0.010)	0.003 (0.005)	0.237*** (0.068)	-0.043 (0.051)	-0.042 (0.036)	0.803	0.792	2.657
Period: Greenspan-Bernanke 1987Q2 – 2011Q1										
MALE	1.744*** (0.572)	0.388*** (0.116)	-0.012 (0.008)	0.000 (0.004)	0.297*** (0.077)	0.073 (0.061)	-0.103*** (0.038)	0.608	0.581	2.308
FEMALE	0.393 (0.872)	0.776*** (0.061)	-0.002 (0.021)	0.003 (0.007)	0.223** (0.089)	-0.048 (0.084)	-0.045 (0.046)	0.758	0.742	2.627
Period: Stable 1990Q1 – 2006Q2										
MALE	1.915** (0.880)	0.200 (0.160)	-0.009 (0.013)	0.001 (0.006)	0.392*** (0.099)	0.144 (0.154)	-0.176** (0.083)	0.624	0.586	1.952
FEMALE	0.185 (1.062)	0.678*** (0.100)	0.007 (0.027)	0.004 (0.008)	0.396*** (0.117)	-0.083 (0.205)	-0.125 (0.094)	0.777	0.754	2.302
Period: Volatile 2006Q3 – 2011Q1										
MALE	0.758 (1.002)	0.146 (0.176)	0.006 (0.011)	0.027*** (0.007)	0.051 (0.027)	0.008 (0.036)	-0.053* (0.027)	0.905	0.858	2.587
FEMALE	2.687** (1.119)	0.112 (0.198)	-0.005 (0.024)	0.022* (0.012)	-0.093 (0.053)	-0.058 (0.088)	-0.038 (0.049)	0.848	0.772	2.585

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 4.61. Income Disaggregated Michigan Survey Disagreement and Perceived News Intensity regarding Favourable and Unfavourable Business Conditions

Testing Equation:

$$\sigma_{i,t} = \alpha_0 + \alpha_1\sigma_{i,t-1} + \alpha_2 NewsF_{i,t} + \alpha_3 NewsU_{i,t} + \alpha_4\pi_t + \alpha_5|\pi_t - \pi_{t-4}| + \alpha_6 Gap_t + \epsilon_t$$

	α_0	α_1	α_2	α_3	α_4	α_5	α_6	R^2	$\bar{R}^2$	D.W. Stat
Period: Whole 1982Q3 – 2011Q1										
Y14	1.386* (0.803)	0.667*** (0.066)	-0.006 (0.020)	-0.012 (0.010)	0.412*** (0.092)	-0.008 (0.099)	-0.125* (0.067)	0.678	0.660	2.670
Y24	0.635 (0.561)	0.602*** (0.091)	0.008 (0.010)	0.000 (0.007)	0.344*** (0.088)	0.100 (0.090)	-0.054 (0.052)	0.658	0.639	2.604
Y34	0.756 (0.522)	0.540*** (0.117)	0.000 (0.008)	0.003 (0.006)	0.328*** (0.099)	0.039 (0.053)	-0.079 (0.074)	0.651	0.631	2.520
Y44	0.298 (0.429)	0.462*** (0.095)	0.006 (0.005)	0.007* (0.004)	0.236*** (0.060)	0.128** (0.055)	-0.036 (0.036)	0.649	0.629	2.225
Period: Greenspan-Bernanke 1987Q2 – 2011Q1										
Y14	2.173* (1.273)	0.671*** (0.059)	-0.038 (0.040)	-0.017 (0.013)	0.369*** (0.097)	0.001 (0.118)	-0.152** (0.072)	0.648	0.625	2.590
Y24	0.859 (0.625)	0.632*** (0.109)	-0.002 (0.019)	0.000 (0.006)	0.309** (0.122)	0.031 (0.090)	-0.064 (0.044)	0.611	0.585	2.530
Y34	1.695** (0.662)	0.462*** (0.086)	-0.015 (0.011)	0.002 (0.005)	0.285*** (0.092)	-0.049 (0.069)	-0.110*** (0.039)	0.600	0.573	2.385
Y44	1.063* (0.615)	0.318*** (0.098)	-0.001 (0.008)	0.010** (0.004)	0.206*** (0.059)	0.017 (0.051)	-0.065* (0.037)	0.609	0.582	2.081
Period: Stable 1990Q1 – 2006Q2										
Y14	2.855 (1.849)	0.507*** (0.113)	-0.031 (0.055)	-0.029 (0.019)	0.589*** (0.131)	-0.019 (0.303)	-0.396** (0.173)	0.651	0.616	2.389
Y24	0.870 (0.560)	0.549*** (0.131)	0.001 (0.014)	0.001 (0.005)	0.402*** (0.082)	0.024 (0.101)	-0.169* (0.101)	0.665	0.631	2.415
Y34	1.683** (0.715)	0.253 (0.167)	-0.006 (0.016)	0.006 (0.005)	0.436*** (0.135)	-0.151 (0.162)	-0.196** (0.075)	0.628	0.591	2.121
Y44	1.367 (0.935)	0.132 (0.104)	-0.002 (0.011)	0.010* (0.006)	0.305*** (0.072)	0.065 (0.084)	-0.126* (0.072)	0.617	0.578	1.927
Period: Volatile 2006Q3 – 2011Q1										
Y14	5.403*** (1.637)	-0.341 (0.216)	-0.026 (0.033)	0.026** (0.011)	-0.075** (0.026)	-0.018 (0.033)	-0.081 (0.061)	0.785	0.677	2.391
Y24	1.870*** (0.359)	0.194** (0.070)	-0.001 (0.008)	0.021*** (0.004)	0.000 (0.032)	0.009 (0.045)	-0.018 (0.024)	0.844	0.767	2.325
Y34	4.024*** (0.860)	0.042*** (0.004)	-0.038*** (0.012)	0.007 (0.007)	-0.035*** (0.010)	-0.035*** (0.004)	-0.145*** (0.020)	0.893	0.840	2.712
Y44	-0.444 (0.437)	0.254*** (0.039)	0.016*** (0.004)	0.027*** (0.004)	0.006 (0.015)	-0.024 (0.022)	-0.014 (0.008)	0.876	0.814	2.087

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 4.62. Regionally Disaggregated Michigan Survey Disagreement and Perceived News Intensity regarding Favourable and Unfavourable Business Conditions

Testing Equation:

$$\sigma_{i,t} = \alpha_0 + \alpha_1\sigma_{i,t-1} + \alpha_2 NewsF_{i,t} + \alpha_3 NewsU_{i,t} + \alpha_4\pi_t + \alpha_5|\pi_t - \pi_{t-4}| + \alpha_6 Gap_t + \epsilon_t$$

	α_0	α_1	α_2	α_3	α_4	α_5	α_6	R^2	$\bar{R}^2$	D.W. Stat
				Period: Whole 1982Q3 – 2011Q1						
NC	1.226** (0.547)	0.579*** (0.110)	-0.002 (0.007)	-0.007 (0.006)	0.371*** (0.107)	0.042 (0.085)	-0.102 (0.062)	0.624	0.603	2.494
NE	1.070 (0.747)	0.558*** (0.101)	-0.001 (0.013)	-0.003 (0.007)	0.374*** (0.094)	0.102 (0.072)	-0.087 (0.064)	0.593	0.571	2.531
S	0.409 (0.501)	0.733*** (0.054)	-0.001 (0.011)	0.001 (0.006)	0.284*** (0.065)	0.023 (0.056)	-0.058 (0.036)	0.776	0.763	2.408
W	0.968 (0.742)	0.468*** (0.112)	0.007 (0.010)	0.005 (0.007)	0.313*** (0.094)	0.014 (0.073)	-0.072 (0.070)	0.485	0.456	2.434
				Period: Greenspan-Bernanke 1987Q2 – 2011Q1						
NC	2.273*** (0.829)	0.544*** (0.120)	-0.026* (0.014)	-0.011* (0.006)	0.352*** (0.117)	-0.022 (0.117)	-0.149 (0.062)	0.571	0.542	2.425
NE	1.684 (1.198)	0.483*** (0.092)	-0.015 (0.022)	-0.002 (0.009)	0.396*** (0.116)	0.015 (0.079)	-0.123* (0.065)	0.527	0.496	2.442
S	0.709 (0.675)	0.733*** (0.054)	-0.009 (0.014)	0.001 (0.006)	0.245*** (0.079)	0.009 (0.075)	-0.059 (0.037)	0.730	0.712	2.340
W	1.993 (1.274)	0.466*** (0.135)	-0.013 (0.017)	0.002 (0.010)	0.228* (0.116)	-0.092 (0.099)	-0.102 (0.082)	0.449	0.412	2.321
				Period: Stable 1990Q1 – 2006Q2						
NC	2.982*** (0.914)	0.378* (0.219)	-0.035** (0.015)	-0.017*** (0.006)	0.500*** (0.141)	0.094 (0.080)	-0.338** (0.143)	0.626	0.588	2.194
NE	2.108 (1.866)	0.319** (0.143)	-0.010 (0.032)	-0.006 (0.013)	0.575*** (0.151)	-0.065 (0.220)	-0.313* (0.171)	0.590	0.548	2.045
S	0.922 (0.585)	0.622*** (0.086)	-0.007 (0.017)	-0.001 (0.005)	0.381*** (0.064)	-0.031 (0.159)	-0.163** (0.066)	0.748	0.722	2.180
W	1.625 (1.567)	0.371** (0.175)	-0.005 (0.017)	0.005 (0.008)	0.349*** (0.068)	-0.099 (0.100)	-0.183 (0.150)	0.522	0.473	2.274
				Period: Volatile 2006Q3 – 2011Q1						
NC	2.813*** (0.728)	-0.109 (0.179)	-0.012 (0.008)	0.023*** (0.004)	-0.011 (0.068)	-0.044 (0.073)	-0.117*** (0.020)	0.872	0.807	2.367
NE	2.833* (1.488)	0.283 (0.246)	-0.024 (0.017)	0.008 (0.007)	0.017 (0.077)	-0.048 (0.046)	-0.084 (0.034)	0.826	0.739	1.885
S	2.659*** (0.457)	-0.118 (0.189)	0.003 (0.016)	0.026** (0.011)	0.001 (0.034)	0.047** (0.017)	-0.044 (0.030)	0.813	0.719	2.269
W	0.629 (1.514)	0.171 (0.286)	0.025 (0.033)	0.033 (0.020)	-0.107 (0.090)	-0.033 (0.076)	0.032 (0.071)	0.827	0.741	2.703

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 4.63. Aggregate Michigan Survey Disagreement and Perceived News Intensity regarding Prices

Testing Equation:

$$\sigma_{i,t} = \alpha_0 + \alpha_1 \sigma_{i,t-1} + \alpha_2 NewsP_{i,t} + \alpha_3 \pi_t + \alpha_4 |\Delta \pi_t| + \alpha_5 GAP_t + \epsilon_t$$

		α_0	α_1	α_2	α_3	α_4	α_6	R^2	$\bar{R}^2$	D.W. Stat
Period: Whole 1982Q3 – 2011Q1										
MS	**(1)**	0.494** (0.240)	0.691*** (0.079)	-1.105 (1.067)	0.343*** (0.074)	-0.097** (0.040)	-0.056*** (0.018)	0.841	0.834	2.449
	(2)	0.364* (0.217)	0.904*** (0.038)	2.006*** (0.694)		0.022 (0.030)	-0.007 (0.013)	0.816	0.809	2.613
Period: Greenspan-Bernanke 1987Q2 – 2011Q1										
MS	**(1)**	0.498* (0.285)	0.593*** (0.115)	-2.116 (1.371)	0.502*** (0.116)	-0.179*** (0.056)	-0.085*** (0.025)	0.801	0.790	2.312
	(2)	0.404 (0.252)	0.892*** (0.048)	2.137*** (0.749)		0.022 (0.034)	-0.006 (0.012)	0.763	0.753	2.565
Period: Stable 1990Q1 – 2006Q2										
MS	**(1)**	0.637 (0.451)	0.530*** (0.147)	-2.153 (1.862)	0.549*** (0.128)	-0.188* (0.095)	-0.123** (0.058)	0.798	0.782	2.210
	(2)	0.595 (0.433)	0.828*** (0.091)	4.035*** (1.120)		0.010 (0.107)	-0.084 (0.053)	0.755	0.739	2.414
Period: Volatile 2006Q3 – 2011Q1										
MS	**(1) †**	1.213 (0.884)	0.471* (0.246)	4.559 (3.475)	0.072 (0.211)	-0.063 (0.083)	0.097 (0.061)	0.768	0.679	1.779
	(2)	1.315*** (0.316)	0.481*** (0.121)	5.197*** (1.230)		-0.036 (0.028)	-0.089*** (0.030)	0.766	0.700	1.738

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 4.64. Age Disaggregated Michigan Survey Disagreement and Perceived News Intensity regarding Prices

Testing Equation:

$$\sigma_{i,t} = \alpha_0 + \alpha_1\sigma_{i,t-1} + \alpha_2 NewsP_{i,t} + \alpha_3\pi_t + \alpha_4|\Delta\pi_t| + \alpha_5 GAP_t + \epsilon_t$$

	α_0	α_1	α_2	α_3	α_4	α_6	R^2	$\bar{R}^2$	D.W. Stat
Period: Whole 1982Q3 – 2011Q1									
A1834	0.822*** (0.246)	0.574*** (0.068)	-1.194 (1.364)	0.426*** (0.081)	-0.160*** (0.041)	-0.073*** (0.024)	0.715	0.703	2.377
A3544	0.749*** (0.088)	0.526*** (0.088)	-2.975** (1.190)	0.542*** (0.071)	-0.174*** (0.044)	-0.093*** (0.027)	0.720	0.707	2.299
A4554	1.401*** (0.327)	0.293** (0.125)	-3.770** (1.845)	0.696*** (0.168)	-0.247*** (0.093)	-0.127*** (0.032)	0.569	0.549	2.268
A5564	1.468*** (0.375)	0.318*** (0.112)	-2.971*** (1.101)	0.596*** (0.088)	-0.207*** (0.057)	-0.120*** (0.028)	0.534	0.512	2.146
A6597	1.427*** (0.428)	0.374*** (0.112)	-5.548** (2.676)	0.642*** (0.154)	-0.221*** (0.078)	-0.093*** (0.030)	0.545	0.524	2.325
Period: Greenspan-Bernanke 1987Q2 – 2011Q1									
A1834	0.727*** (0.254)	0.487*** (0.078)	-2.301 (1.475)	0.588*** (0.096)	-0.235*** (0.053)	-0.105*** (0.028)	0.666	0.648	2.214
A3544	0.578* (0.334)	0.521*** (0.135)	-2.397* (1.242)	0.579*** (0.111)	-0.219*** (0.055)	-0.104*** (0.033)	0.684	0.666	2.217
A4554	0.888*** (0.254)	0.154 (0.183)	-5.704** (2.534)	1.107*** (0.311)	-0.468*** (0.170)	-0.192*** (0.048)	0.637	0.616	2.217
A5564	1.467*** (0.445)	0.252* (0.146)	-3.129** (1.213)	0.674*** (0.118)	-0.258*** (0.062)	-0.138*** (0.029)	0.458	0.428	2.050
A6597	1.217*** (0.406)	0.316** (0.139)	-6.560** (3.051)	0.785*** (0.220)	-0.280*** (0.105)	-0.125*** (0.039)	0.509	0.481	2.233
Period: Stable 1990Q1 – 2006Q2									
A1834	0.800** (0.358)	0.464*** (0.105)	-1.909 (1.701)	0.581*** (0.125)	-0.191*** (0.071)	-0.154** (0.060)	0.732	0.709	2.046
A3544	0.590 (0.450)	0.544*** (0.076)	-3.408** (1.597)	0.565*** (0.059)	-0.112 (0.120)	-0.138* (0.080)	0.743	0.721	2.064
A4554	1.144** (0.488)	0.100 (0.271)	-3.685 (3.521)	1.056** (0.418)	-0.595* (0.352)	-0.255*** (0.085)	0.654	0.626	2.013
A5564	1.603*** (0.550)	0.238* (0.134)	-3.009 (2.027)	0.648*** (0.156)	-0.154 (0.182)	-0.198** (0.086)	0.466	0.422	2.000
A6597	1.345* (0.804)	0.260** (0.115)	-4.038 (3.140)	0.776*** (0.118)	-0.444*** (0.131)	-0.133 (0.119)	0.492	0.450	2.067
Period: Volatile 2006Q3 – 2011Q1									
A1834	3.279*** (0.486)	-0.084 (0.139)	12.293*** (2.682)	-0.224** (0.102)	-0.076** (0.027)	-0.157*** (0.032)	0.670	0.544	1.768
A3544†	0.692 (0.837)	0.478* (0.232)	4.919 (4.055)	0.171 (0.288)	-0.099 (0.113)	-0.129 (0.082)	0.730	0.627	1.660
A4554†	1.332** (0.534)	0.364 (0.268)	2.934 (1.928)	0.176 (0.277)	-0.104 (0.113)	-0.124 (0.085)	0.692	0.573	1.917
A5564†	1.228 (0.703)	0.601*** (0.198)	4.408 (2.572)	-0.074 (0.174)	-0.009 (0.063)	-0.050 (0.048)	0.797	0.719	2.084
A6597†	0.983 (0.929)	0.517*** (0.162)	0.582 (3.712)	0.323 (0.226)	-0.123 (0.095)	-0.085** (0.034)	0.635	0.494	2.094

† Due to length of volatile period, no lag can be specified for the Newey-West covariance matrix

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 4.65. Education Disaggregated Michigan Survey Disagreement and Perceived News Intensity regarding Prices

Testing Equation:

$$\sigma_{i,t} = \alpha_0 + \alpha_1\sigma_{i,t-1} + \alpha_2 News_{i,t} + \alpha_3\pi_t + \alpha_4|\Delta\pi_t| + \alpha_5 GAP_t + \epsilon_t$$

	α_0	α_1	α_2	α_3	α_4	α_6	R^2	$\bar{R}^2$	D.W. Stat
Period: Whole 1982Q3 – 2011Q1									
ELHS	1.403** (0.546)	0.443*** (0.085)	-12.407*** (4.203)	0.863*** (0.130)	-0.260*** (0.077)	-0.116*** (0.039)	0.609	0.591	2.535
EHSD	1.003*** (0.318)	0.535*** (0.092)	-4.319** (2.009)	0.511*** (0.096)	-0.167*** (0.050)	-0.092*** (0.024)	0.739	0.727	2.358
ESC	1.253*** (0.271)	0.506*** (-0.339)	-0.339 (1.236)	0.325*** (0.075)	-0.110*** (0.036)	-0.081*** (0.026)	0.594	0.575	2.055
ECD	1.359*** (0.232)	0.231*** (0.084)	-1.586 (1.004)	0.570*** (0.077)	-0.242*** (0.045)	-0.124*** (0.025)	0.608	0.590	2.259
EGS	1.897*** (0.334)	0.128 (0.119)	-0.050 (1.072)	0.335*** (0.083)	-0.125** (0.050)	-0.129*** (0.030)	0.398	0.370	1.906
Period: Greenspan-Bernanke 1987Q2 – 2011Q1									
ELHS	-1.041* (0.565)	0.360*** (0.096)	-15.671*** (4.728)	1.174*** (0.254)	-0.423*** (0.127)	-0.164*** (0.047)	0.589	0.566	2.417
EHSD	0.844** (0.350)	0.471*** (0.117)	-5.451** (2.173)	0.670*** (0.133)	-0.245*** (0.064)	-0.123*** (0.026)	0.703	0.686	2.243
ESC	1.043*** (0.300)	0.500*** (0.089)	-0.184 (1.084)	0.377*** (0.088)	-0.136*** (0.037)	-0.096*** (0.027)	0.587	0.564	1.897
ECD	1.289*** (0.258)	0.198* (0.115)	-1.792 (1.197)	0.626*** (0.112)	-0.283*** (0.078)	-0.134*** (0.030)	0.571	0.547	2.191
EGS	1.408*** (0.325)	0.253** (0.105)	0.247 (1.024)	0.344*** (0.114)	-0.141* (0.073)	-0.121*** (0.042)	0.414	0.381	1.920
Period: Stable 1990Q1 – 2006Q2									
ELHS	1.441 (0.976)	0.293*** (0.095)	-16.527*** (5.122)	1.146*** (0.102)	-0.374** (0.153)	-0.255* (0.136)	0.547	0.509	2.341
EHSD	0.993* (0.574)	0.427*** (0.144)	-5.405 (3.601)	0.688*** (0.137)	-0.252** (0.119)	-0.189** (0.078)	0.725	0.702	2.229
ESC	0.916** (0.357)	0.543*** (0.103)	0.467 (1.386)	0.362*** (0.114)	-0.073 (0.078)	-0.116** (0.052)	0.658	0.629	1.809
ECD	1.266*** (0.407)	0.167* (0.096)	-2.668** (1.074)	0.687*** (0.053)	-0.307** (0.115)	-0.099* (0.052)	0.643	0.614	2.134
EGS	1.647*** (0.364)	0.168* (0.089)	0.066 (1.426)	0.381*** (0.058)	-0.184** (0.071)	-0.152*** (0.050)	0.387	0.336	1.901
Period: Volatile 2006Q3 – 2011Q1									
ELHS	3.961*** (0.323)	0.044 (0.115)	9.920*** (2.683)	-0.031 (0.117)	-0.107** (0.039)	-0.088* (0.049)	0.404	0.174	1.757
EHSD	3.369** (1.357)	0.145 (0.340)	11.737*** (2.041)	-0.263* (0.144)	0.069 (0.096)	-0.070 (0.057)	0.669	0.541	2.048
ESC†	1.578* (0.776)	0.320 (0.227)	8.824** (3.652)	-0.051 (0.284)	-0.035 (0.117)	-0.147* (0.069)	0.708	0.596	2.021
ECD†	1.181 (0.737)	0.281 (0.248)	3.880 (3.064)	0.184 (0.280)	-0.175 (0.144)	-0.147 (0.085)	0.700	0.585	1.670
EGS†	0.102 (0.348)	0.344* (0.179)	1.374* (0.665)	0.529** (0.205)	-0.207** (0.093)	-0.173** (0.070)	0.760	0.668	2.212

† Due to length of volatile period, no lag can be specified for the Newey-West covariance matrix

Appendix 4.66. Gender Disaggregated Michigan Survey Disagreement and Perceived News Intensity regarding Prices

Testing Equation:

$$\sigma_{i,t} = \alpha_0 + \alpha_1 \sigma_{i,t-1} + \alpha_2 NewsP_{i,t} + \alpha_3 \pi_t + \alpha_4 |\Delta \pi_t| + \alpha_5 GAP_t + \epsilon_t$$

		α_0	α_1	α_2	α_3	α_4	α_6	R^2	$\bar{R}^2$	D.W. Stat
					Period: Whole 1982Q3 – 2011Q1					
MALE	**(1)**	1.298*** (0.329)	0.314** (0.139)	-0.510 (1.051)	0.459*** (0.089)	-0.167*** (0.039)	-0.110*** (0.028)	0.696	0.682	2.141
	(2)	1.007*** (0.311)	0.718*** (0.073)	2.050** (0.839)		-0.005 (0.029)	-0.025 (0.018)	0.585	0.570	2.433
FEMALE	**(1)**	0.533** (0.245)	0.688*** (0.066)	-2.533* (1.436)	0.413*** (0.075)	-0.121*** (0.044)	-0.062*** (0.020)	0.811	0.802	2.478
	(2)	0.580** (0.254)	0.880*** (0.037)	1.741* (1.028)		0.017 (0.039)	-0.008 (0.018)	0.784	0.776	2.645
					Period: Greenspan-Bernanke 1987Q2 – 2011Q1					
MALE	**(1)**	1.398*** (0.441)	0.207 (0.191)	-0.852 (1.308)	0.547*** (0.114)	-0.196*** (0.053)	-0.136*** (0.032)	0.624	0.603	2.068
	(2)	1.223*** (0.375)	0.653*** (0.087)	1.842* (0.932)		0.034 (0.028)	-0.031 (0.025)	0.482	0.459	2.372
FEMALE	**(1)**	0.414 (0.272)	0.595*** (0.087)	-4.085** (1.630)	0.625*** (0.104)	-0.240*** (0.049)	-0.097*** (0.023)	0.779	0.767	2.372
	(2)	0.612** (0.276)	0.870*** (0.045)	1.912* (1.029)		0.008 (0.041)	-0.005 (0.016)	0.737	0.725	2.608
					Period: Stable 1990Q1 – 2006Q2					
MALE	**(1)**	1.804*** (0.331)	0.021 (0.130)	-2.199*** (0.588)	0.654*** (0.077)	-0.227*** (0.063)	-0.139*** (0.042)	0.644	0.614	1.952
	(2)	1.617*** (0.466)	0.518*** (0.115)	2.652** (1.026)		0.023 (0.045)	-0.123* (0.066)	0.458	0.422	2.154
FEMALE	**(1)**	0.435 (0.450)	0.592*** (0.099)	-1.985 (1.983)	0.595*** (0.113)	-0.231** (0.094)	-0.140** (0.066)	0.786	0.768	2.171
	(2)	0.720 (0.434)	0.821*** (0.082)	5.346*** (1.303)		-0.007 (0.119)	-0.097 (0.068)	0.749	0.732	2.283
					Period: Volatile 2006Q3 – 2011Q1					
MALE	**(1)**	0.196 (0.286)	0.749*** (0.089)	2.791*** (0.713)	0.118** (0.049)	-0.036 (0.027)	-0.055** (0.025)	0.823	0.755	2.328
	(2)	0.362 (0.419)	0.770*** (0.111)	3.696*** (0.555)		0.009 (0.016)	-0.041** (0.018)	0.819	0.767	2.222
FEMALE	**(1)**	2.344*** (0.614)	0.146 (0.166)	4.919 (2.845)	0.183* (0.103)	-0.152*** (0.029)	-0.147*** (0.039)	0.712	0.601	1.958
	(2)	2.607*** (0.468)	0.169 (0.172)	6.727*** (2.218)		-0.084** (0.038)	-0.128** (0.044)	0.702	0.616	1.958

†Due to length of volatile period, no lag can be specified for the Newey-West covariance matrix

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 4.67. Income Disaggregated Michigan Survey Disagreement and Perceived News Intensity regarding Prices

Testing Equation:

$$\sigma_{i,t} = \alpha_0 + \alpha_1\sigma_{i,t-1} + \alpha_2 NewsP_{i,t} + \alpha_3\pi_t + \alpha_4|\Delta\pi_t| + \alpha_5 GAP_t + \epsilon_t$$

	α_0	α_1	α_2	α_3	α_4	α_6	R^2	$\bar{R}^2$	D.W. Stat
Period: Whole 1982Q3 – 2011Q1									
Y14	1.050** (0.432)	0.540*** (0.095)	-8.734*** (3.325)	0.676*** (0.129)	-0.199*** (0.069)	-0.094*** (0.028)	0.699	0.685	2.505
Y24	1.087*** (0.320)	0.436*** (0.089)	-4.931*** (1.817)	0.641*** (0.117)	-0.223*** (0.058)	-0.102*** (0.026)	0.689	0.674	2.425
Y34	1.324*** (0.257)	0.276*** (0.104)	-2.772** (1.337)	0.620*** (0.110)	-0.221*** (0.043)	-0.133*** (0.031)	0.696	0.682	2.199
Y44	1.151*** (0.211)	0.328*** (0.093)	0.753 (0.909)	0.371*** (0.067)	-0.181*** (0.031)	-0.103*** (0.023)	0.678	0.663	2.054
Period: Greenspan-Bernanke 1987Q2 – 2011Q1									
Y14	0.833** (0.401)	0.419*** (0.120)	-12.289*** (3.993)	0.999*** (0.200)	-0.377*** (0.091)	-0.147*** (0.035)	0.695	0.678	2.355
Y24	0.908** (0.349)	0.415*** (0.108)	-5.213*** (1.977)	0.722*** (0.140)	-0.250*** (0.068)	-0.117*** (0.027)	0.651	0.632	2.284
Y34	1.371*** (0.424)	0.154 (0.164)	-3.642 (2.514)	0.757*** (0.134)	-0.272*** (0.035)	-0.170*** (0.037)	0.652	0.633	2.080
Y44	1.230*** (0.249)	0.252** (0.105)	0.683 (0.939)	0.413*** (0.085)	-0.185*** (0.046)	-0.121*** (0.025)	0.599	0.577	1.917
Period: Stable 1990Q1 – 2006Q2									
Y14	0.978 (0.639)	0.360** (0.146)	-14.784** (5.774)	1.085*** (0.253)	-0.396** (0.187)	-0.209** (0.090)	0.679	0.652	2.245
Y24	0.953 (0.588)	0.432*** (0.140)	-3.145 (2.830)	0.631*** (0.201)	-0.221 (0.146)	-0.164* (0.083)	0.681	0.654	2.297
Y34	1.771*** (0.510)	-0.013 (0.129)	-6.512*** (1.510)	0.884*** (00056)	-0.245** (0.111)	-0.205*** (0.061)	0.687	0.661	2.019
Y44	1.487*** (0.314)	0.131 (0.120)	0.320 (1.416)	0.472*** (0.114)	-0.198** (0.086)	-0.131*** (0.044)	0.579	0.544	1.946
Period: Volatile 2006Q3 – 2011Q1									
Y14†	2.482*** (0.544)	0.222 (0.134)	5.269*** (1.594)	0.186 (0.138)	-0.122* (0.065)	-0.115** (0.050)	0.645	0.509	1.911
Y24	1.921*** (0.464)	0.268** (0.123)	6.156** (2.067)	0.080 (0.134)	-0.087 (0.056)	-0.112** (0.040)	0.685	0.564	1.684
Y34†	1.105 (0.797)	0.468** (0.187)	5.145* (2.894)	0.011 (0.329)	-0.037 (0.153)	-0.107 (0.062)	0.658	0.526	2.012
Y44	0.395 (0.295)	0.515*** (0.077)	3.607** (1.339)	0.174 (0.153)	-0.101 (0.064)	-0.114** (0.040)	0.800	0.723	1.969

†Due to length of volatile period, no lag can be specified for the Newey-West covariance matrix

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 4.68. Regionally Disaggregated Michigan Survey Disagreement and Perceived News Intensity regarding Prices

Testing Equation:

$$\sigma_{i,t} = \alpha_0 + \alpha_1\sigma_{i,t-1} + \alpha_2 NewsP_{i,t} + \alpha_3\pi_t + \alpha_4|\Delta\pi_t| + \alpha_5 GAP_t + \epsilon_t$$

	α_0	α_1	α_2	α_3	α_4	α_5	R^2	$\bar{R}^2$	D.W. Stat
Period: Whole 1982Q3 – 2011Q1									
NC	1.050*** (0.358)	0.409*** (0.139)	-4.004** (1.667)	0.632*** (0.143)	-0.222*** (0.066)	-0.097*** (0.029)	0.662	0.646	2.259
NE	1.136*** (0.346)	0.429*** (0.119)	-2.018 (1.706)	0.564*** (0.125)	-0.192*** (0.058)	-0.103*** (0.036)	0.614	0.597	2.375
S	0.663*** (0.231)	0.616*** (0.055)	-2.404** (0.943)	0.454*** (0.063)	-0.123*** (0.043)	-0.078*** (0.019)	0.787	0.777	2.292
W	1.824*** (0.388)	0.201** (0.096)	-4.603*** (1.583)	0.675*** (0.113)	-0.308*** (0.066)	-0.130*** (0.027)	0.576	0.556	2.116
Period: Greenspan-Bernanke 1987Q2 – 2011Q1									
NC	0.833** (0.365)	0.271* (0.161)	-5.704*** (1.827)	0.919*** (0.192)	-0.368*** (0.095)	-0.147*** (0.033)	0.639	0.618	2.147
NE	1.156*** (0.349)	0.228* (0.128)	-4.693** (1.846)	0.885*** (0.144)	-0.305*** (0.086)	-0.161*** (0.036)	0.580	0.556	2.211
S	0.612** (0.240)	0.568*** (0.072)	-2.826*** (1.015)	0.541*** (0.080)	-0.176*** (0.044)	-0.097*** (0.021)	0.746	0.732	2.153
W	1.576*** (0.351)	0.159 (0.128)	-4.842*** (1.742)	0.790*** (0.125)	-0.371*** (0.061)	-0.157*** (0.031)	0.547	0.522	2.084
Period: Stable 1990Q1 – 2006Q2									
NC	1.053 (0.910)	0.242 (0.288)	-3.838* (2.132)	0.842*** (0.240)	-0.365** (0.163)	-0.185 (0.148)	0.643	0.613	2.054
NE	1.399* (0.703)	0.124 (0.131)	-5.526* (3.095)	0.972*** (0.171)	-0.356** (0.154)	-0.243** (0.098)	0.637	0.607	1.940
S	0.654 (0.481)	0.518*** (0.077)	-2.352* (1.229)	0.598*** (0.069)	-0.202*** (0.069)	-0.140** (0.068)	0.760	0.740	2.097
W	1.658** (0.762)	0.187 (0.141)	-4.536* (2.416)	0.712*** (0.127)	-0.301*** (0.062)	-0.187* (0.095)	0.556	0.519	2.120
Period: Volatile 2006Q3 – 2011Q1									
NC†	2.031* (1.085)	0.257 (0.378)	5.521 (3.468)	0.005 (0.264)	-0.047 (0.140)	-0.118 (0.089)	0.643	0.505	2.022
NE	0.527 (0.378)	0.665*** (0.094)	3.887 (2.217)	0.099 (0.174)	-0.036 (0.081)	-0.070** (0.029)	0.714	0.604	1.845
S	2.063 (1.574)	0.249 (0.450)	5.698** (2.435)	0.054 (0.119)	-0.072 (0.053)	-0.122* (0.068)	0.688	0.568	2.018
W	1.221 (1.313)	0.353 (0.327)	2.083 (1.857)	0.305* (0.161)	-0.183*** (0.055)	-0.132*** (0.029)	0.713	0.603	1.807

†Due to length of volatile period, no lag can be specified for the Newey-West covariance matrix

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 4.69. Aggregate Michigan Survey Disagreement and Perceived News Intensity regarding Favourable and Unfavourable Prices

Testing Equation:

$$\sigma_{i,t} = \alpha_0 + \alpha_1 \sigma_{i,t-1} + \alpha_2 NewsF_{i,t} + \alpha_3 NewsU_{i,t} + \alpha_4 \pi_t + \alpha_5 |\pi_t - \pi_{t-4}| + \alpha_6 Gap_t + \epsilon_t$$

	α_0	α_1	α_2	α_3	α_4	α_5	α_6	R^2	$\bar{R}^2$	D.W. Stat
				Period: Whole 1982Q3 – 2011Q1						
MS	0.310	0.865***	-4.888**	1.191	0.124**			0.829	0.823	2.662
	(0.194)	(0.046)	(0.024)	(0.787)	(0.052)					
	0.356	0.790***	-3.030	-0.026	0.217***	0.020	-0.042	0.834	0.825	2.607
	(0.217)	(0.073)	(3.010)	(1.157)	(0.071)	(0.047)	(0.027)			
				Period: Greenspan-Bernanke 1987Q2 – 2011Q1						
MS	0.459*	0.841***	-8.826**	1.470*	0.110*			0.778	0.769	2.596
	(0.238)	(0.053)	(4.210)	(0.796)	(0.058)					
	0.456**	0.762***	-6.593	0.066	0.225**	0.025	-0.045	0.786	0.772	2.549
	(0.239)	(0.088)	(4.206)	(1.325)	(0.092)	(0.092)	(0.032)			
				Period: Stable 1990Q1 – 2006Q2						
MS	0.476	0.746***	-22.692	-1.080	0.309***			0.776	0.761	2.530
	(0.320)	(0.067)	(18.702)	(2.006)	(0.077)					
	0.703	0.624***	-13.583	-1.669	0.395***	0.007	-0.118	0.790	0.769	2.360
	(0.441)	(0.121)	(16.893)	(2.067)	(0.092)	(0.133)	(0.064)			
				Period: Volatile 2006Q3 – 2011Q1						
MS	1.220***	0.732***	-7.803***	4.487**	-0.123			0.788	0.727	2.134
	(0.366)	(0.061)	(1.129)	(1.675)	(0.099)					
	1.388***	0.648***	-4.447*	5.998***	-0.155***	-0.045	-0.036	0.803	0.705	1.951
	(0.081)	(0.020)	(2.487)	(0.936)	(0.041)	(0.046)	(0.013)			

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 4.70. Age Disaggregated Michigan Survey Disagreement and Perceived News Intensity regarding Favourable and Unfavourable Prices

Testing Equation:

$$\sigma_{i,t} = \alpha_0 + \alpha_1\sigma_{i,t-1} + \alpha_2 NewsPF_{i,t} + \alpha_3 NewsPU_{i,t} + \alpha_4\pi_t + \alpha_5|\pi_t - \pi_{t-4}| + \alpha_6 Gap_t + \epsilon_t$$

	α_0	α_1	α_2	α_3	α_4	α_5	α_6	R^2	$\bar{R}^2$	D.W. Stat
				Period: Whole 1982Q3 – 2011Q1						
A1834	0.814*** (0.279)	0.622*** (0.080)	0.077 (0.046)	-0.020 (0.017)	0.329*** (0.106)	0.002 (0.060)	-0.077* (0.043)	0.705	0.689	2.490
A3544	0.640** (0.290)	0.642*** (0.100)	-0.028 (0.039)	-0.020 (0.016)	0.375*** (0.100)	0.030 (0.077)	-0.081 (0.051)	0.699	0.683	2.423
A4554	1.256*** (0.339)	0.411*** (0.101)	0.032 (0.073)	-0.037* (0.019)	0.508*** (0.126)	0.082 (0.106)	-0.115** (0.055)	0.532	0.506	2.443
A5564	1.355*** (0.413)	0.416*** (0.129)	0.013 (0.052)	-0.033** (0.014)	0.454*** (0.112)	0.076 (0.106)	-0.108* (0.054)	0.501	0.474	2.255
A6597	1.366*** (0.428)	0.406*** (0.107)	0.200* (0.116)	-0.079*** (0.030)	0.545*** (0.128)	0.133 (0.096)	-0.087* (0.046)	0.532	0.506	2.400
				Period: Greenspan-Bernanke 1987Q2 – 2011Q1						
A1834	0.770** (0.322)	0.626*** (0.091)	0.035 (0.077)	-0.014 (0.018)	0.321** (0.129)	0.024 (0.072)	-0.075 (0.046)	0.637	0.612	2.365
A3544	0.737** (0.293)	0.667*** (0.107)	-0.065** (0.028)	-0.004 (0.014)	0.286*** (0.107)	-0.018 (0.082)	-0.073 (0.046)	0.661	0.638	2.377
A4554	0.928*** (0.279)	0.435*** (0.122)	-0.004 (0.076)	-0.037 (0.024)	0.568*** (0.174)	0.128 (0.139)	-0.118** (0.054)	0.551	0.521	2.508
A5564	1.633*** (0.477)	0.378** (0.160)	-0.005 (0.050)	-0.025 (0.016)	0.416*** (0.130)	-0.018 (0.126)	-0.120** (0.058)	0.410	0.371	2.184
A6597	1.177*** (0.390)	0.378*** (0.123)	0.220 (0.150)	-0.084** (0.038)	0.610*** (0.172)	0.180 (0.119)	-0.099** (0.048)	0.489	0.454	2.367
				Period: Stable 1990Q1 – 2006Q2						
A1834	0.830* (0.419)	0.504*** (0.126)	0.191 (0.167)	-0.029 (0.016)	0.485*** (0.126)	-0.010 (0.132)	-0.170** (0.067)	0.728	0.700	2.148
A3544	0.852 (0.662)	0.554*** (0.117)	-0.087 (0.157)	-0.035* (0.018)	0.502*** (0.077)	-0.120 (0.114)	-0.157 (0.098)	0.742	0.716	2.113
A4554	1.151** (0.522)	0.301 (0.202)	-0.129 (0.207)	-0.047 (0.045)	0.705*** (0.258)	0.276 (0.415)	-0.265** (0.122)	0.603	0.563	2.235
A5564	1.789*** (0..612)	0.259** (0.124)	0.061 (0.148)	-0.034* (0.019)	0.576*** (0.134)	-0.161 (0.252)	-0.225*** (0.083)	0.467	0.413	2.057
A6597	1.370 (0.851)	0.297 (0.191)	0.434 (0.330)	-0.059 (0.041)	0.621*** (0.134)	0.123 (0.163)	-0.215 (0.150)	0.465	0.411	2.203
				Period: Volatile 2006Q3 – 2011Q1						
A1834	4.251*** (1.027)	-0.186 (0.556)	0.015 (0.091)	0.132 (0.113)	-0.400 (0.544)	0.140 (1.213)	-0.104 (0.221)	0.721	0.582	2.225
A3544	1.450** (0.505)	0.588*** (0.044)	-0.064*** (0.014)	0.079*** (0.006)	-0.194* (0.107)	-0.027 (0.057)	-0.050*** (0.009)	0.820	0.730	1.734
A4554	1.602* (0.781)	0.470* (0.228)	0.014 (0.035)	0.043*** (0.006)	-0.079 (0.068)	-0.002 (0.045)	-0.078 (0.049)	0.678	0.517	1.939
A5564	1.324** (0.599)	0.691*** (0.117)	-0.007 (0.011)	0.052*** (0.006)	-0.176*** (0.049)	-0.049 (0.032)	-0.024* (0.012)	0.824	0.735	2.222
A6597	1.256*** (0.228)	0.595*** (0.113)	0.065 (0.100)	0.042*** (0.005)	0.024 (0.090)	-0.033 (0.065)	-0.057* (0.030)	0.605	0.408	2.029

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 4.71. Education Disaggregated Michigan Survey Disagreement and Perceived News Intensity regarding Favourable and Unfavourable Prices

Testing Equation:

$$\sigma_{i,t} = \alpha_0 + \alpha_1\sigma_{i,t-1} + \alpha_2 NewsPF_{i,t} + \alpha_3 NewsPU_{i,t} + \alpha_4\pi_t + \alpha_5|\pi_t - \pi_{t-4}| + \alpha_6 Gap_t + \epsilon_t$$

	α_0	α_1	α_2	α_3	α_4	α_5	α_6	R^2	$\bar{R}^2$	D.W. Stat
Period: Whole 1982Q3 – 2011Q1										
ELHS	1.405*** (0.515)	0.503*** (0.092)	0.163 (0.185)	-0.140*** (0.050)	0.692*** (0.148)	0.047 (0.103)	-0.122* (0.070)	0.594	0.572	2.666
EHSD	0.902*** (0.325)	0.626*** (0.089)	0.038 (0.072)	-0.038* (0.023)	0.363*** (0.089)	0.029 (0.077)	-0.082* (0.042)	0.722	0.707	2.515
ESC	1.177*** (0.287)	0.572*** (0.088)	0.014 (0.079)	-0.003 (0.014)	0.242*** (0.080)	0.015 (0.054)	-0.076** (0.035)	0.579	0.556	2.139
ECD	1.286*** (0.298)	0.300** (0.136)	0.059 (0.040)	-0.026** (0.012)	0.441*** (0.113)	0.132*** (0.043)	-0.113** (0.047)	0.571	0.547	2.335
EGS	1.794*** (0.307)	0.202* (0.112)	-0.003 (0.022)	-0.002 (0.009)	0.261*** (0.070)	0.105** (0.053)	-0.109*** (0.035)	0.376	0.341	1.991
Period: Greenspan-Bernanke 1987Q2 – 2011Q1										
ELHS	1.364*** (0.509)	0.488*** (0.094)	0.091 (0.239)	-0.143** (0.057)	0.726*** (0.196)	0.047 (0.154)	-0.131* (0.072)	0.556	0.526	2.621
EHSD	0.879** (0.336)	0.619*** (0.090)	-0.089 (0.160)	-0.033 (0.024)	0.373*** (0.097)	0.043 (0.098)	-0.088** (0.040)	0.671	0.649	2.437
ESC	1.174*** (0.336)	0.603*** (0.090)	-0.116* (0.059)	0.015 (0.010)	0.192** (0.093)	-0.007 (0.068)	-0.070** (0.034)	0.580	0.551	2.027
ECD	1.124*** (0.286)	0.394** (0.170)	0.045 (0.069)	-0.018 (0.017)	0.367** (0.171)	0.123*** (0.039)	-0.091** (0.042)	0.509	0.476	2.425
EGS	1.428*** (0.293)	0.331*** (0.104)	-0.024 (0.020)	0.004 (0.009)	0.231*** (0.082)	0.101 (0.066)	-0.093*** (0.031)	0.396	0.355	1.981
Period: Stable 1990Q1 – 2006Q2										
ELHS	1.849 (1.123)	0.340*** (0.122)	-0.070 (0.201)	-0.197*** (0.057)	0.963*** (0.069)	-0.149 (0.272)	-0.298* (0.160)	0.537	0.490	2.506
EHSD	1.136* (0.568)	0.488*** (0.133)	-0.123 (0.250)	-0.055 (0.038)	0.535*** (0.116)	0.003 (0.235)	-0.210** (0.090)	0.709	0.680	2.329
ESC	1.054** (0.418)	0.575*** (0.092)	-0.219 (0.138)	0.013 (0.015)	0.301*** (0.105)	-0.010 (0.107)	-0.117** (0.048)	0.671	0.638	1.955
ECD	1.008*** (0.349)	0.299** (0.139)	0.158 (0.141)	-0.032** (0.015)	0.539*** (0.110)	0.066 (0.103)	-0.122** (0.053)	0.614	0.574	2.251
EGS	1.544*** (0.550)	0.221** (0.107)	-0.057 (0.097)	-0.007 (0.013)	0.334*** (0.055)	0.233*** (0.081)	-0.158*** (0.051)	0.396	0.334	1.873
Period: Volatile 2006Q3 – 2011Q1										
ELHS	5.213*** (0.726)	-0.026 (0.076)	0.203 (0.336)	0.184*** (0.033)	-0.475*** (0.079)	-0.185*** (0.042)	-0.074* (0.034)	0.444	0.166	2.764
EHSD	3.637*** (0.517)	-0.083 (0.092)	0.126*** (0.027)	0.084*** (0.013)	0.003 (0.037)	0.135*** (0.040)	-0.097*** (0.021)	0.712	0.568	2.243
ESC	1.861* (0.909)	0.446** (0.162)	0.011 (0.117)	0.105*** (0.013)	-0.252*** (0.078)	-0.085 (0.099)	-0.101** (0.040)	0.734	0.602	2.023
ECD	1.990*** (0.113)	0.457*** (0.048)	-0.010 (0.015)	0.064*** (0.008)	-0.290*** (0.040)	-0.042* (0.020)	-0.058* (0.030)	0.704	0.556	2.252
EGS	0.900*** (0.176)	0.488*** (0.092)	-0.010** (0.004)	0.034** (0.012)	0.070 (0.109)	0.040 (0.106)	-0.085*** (0.023)	0.714	0.571	1.990

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 4.72. Gender Disaggregated Michigan Survey Disagreement and Perceived News Intensity regarding Favourable and Unfavourable Prices

Testing Equation:

$$\sigma_{i,t} = \alpha_0 + \alpha_1\sigma_{i,t-1} + \alpha_2 NewsPF_{i,t} + \alpha_3 NewsPU_{i,t} + \alpha_4\pi_t + \alpha_5|\pi_t - \pi_{t-4}| + \alpha_6 Gap_t + \epsilon_t$$

	α_0	α_1	α_2	α_3	α_4	α_5	α_6	R^2	$\bar{R}^2$	D.W. Stat
Period: Whole 1982Q3 – 2011Q1										
MALE	1.091*** (0.314)	0.428*** (0.142)	0.002 (0.035)	-0.010 (0.011)	0.339*** (0.091)	0.153** (0.064)	-0.077** (0.035)	0.677	0.659	2.314
FEMALE	0.523* (0.271)	0.744*** (0.079)	0.035 (0.065)	-0.020 (0.020)	0.304*** (0.096)	-0.023 (0.061)	-0.065* (0.037)	0.804	0.794	2.608
Period: Greenspan-Bernanke 1987Q2 – 2011Q1										
MALE	1.279*** (0.317)	0.387** (0.150)	-0.083** (0.040)	-0.006 (0.012)	0.337*** (0.108)	0.147* (0.079)	-0.080** (0.037)	0.601	0.574	2.269
FEMALE	0.518* (0.266)	0.730*** (0.088)	0.027 (0.085)	-0.021 (0.022)	0.316*** (0.115)	-0.002 (0.073)	-0.066 (0.040)	0.758	0.742	2.574
Period: Stable 1990Q1 – 2006Q2										
MALE	1.714*** (0.333)	0.165 (0.140)	-0.186** (0.075)	-0.030 (0.021)	0.511*** (0.110)	0.189 (0.157)	-0.123*** (0.045)	0.641	0.604	1.949
FEMALE	0.607 (0.547)	0.581*** (0.158)	0.472 (0.284)	-0.039 (0.027)	0.546*** (0.135)	-0.041 (0.163)	-0.140 (0.107)	0.788	0.767	2.276
Period: Volatile 2006Q3 – 2011Q1										
MALE	0.637 (0.889)	0.820** (0.336)	-0.067*** (0.007)	0.032*** (0.001)	-0.027 (0.046)	-0.008 (0.127)	-0.005 (0.024)	0.860	0.790	2.627
FEMALE	2.608*** (0.841)	0.379 (0.241)	-0.015 (0.091)	0.087** (0.038)	-0.264* (0.145)	-0.074 (0.081)	-0.074 (0.054)	0.711	0.566	2.075

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 4.73. Income Disaggregated Michigan Survey Disagreement and Perceived News Intensity regarding Favourable and Unfavourable Prices

Testing Equation:

$$\sigma_{i,t} = \alpha_0 + \alpha_1\sigma_{i,t-1} + \alpha_2 NewsPF_{i,t} + \alpha_3 NewsPU_{i,t} + \alpha_4\pi_t + \alpha_5|\pi_t - \pi_{t-4}| + \alpha_6 Gap_t + \epsilon_t$$

	α_0	α_1	α_2	α_3	α_4	α_5	α_6	R^2	$\bar{R}^2$	D.W. Stat
Period: Whole 1982Q3 – 2011Q1										
Y14	1.111** (0.430)	0.580*** (0.092)	0.180 (0.119)	-0.096** (0.039)	0.549*** (0.133)	-0.018 (0.106)	-0.103* (0.055)	0.692	0.675	2.614
Y24	0.941*** (0.330)	0.551*** (0.109)	-0.018 (0.078)	-0.047** (0.023)	0.448*** (0.121)	0.138* (0.080)	-0.074 (0.049)	0.666	0.647	2.575
Y34	1.096*** (0.289)	0.414*** (0.116)	0.077 (0.053)	-0.032** (0.015)	0.455*** (0.106)	0.065 (0.063)	-0.111** (0.050)	0.672	0.654	2.396
Y44	0.935*** (0.213)	0.465*** (0.098)	0.016 (0.031)	0.003 (0.007)	0.250*** (0.066)	0.130** (0.054)	-0.072** (0.029)	0.640	0.620	2.213
Period: Greenspan-Bernanke 1987Q2 – 2011Q1										
Y14	1.002** (0.399)	0.585*** (0.101)	0.002 (0.129)	-0.087** (0.041)	0.544*** (0.157)	0.047 (0.121)	-0.101* (0.054)	0.657	0.634	2.552
Y24	0.985*** (0.344)	0.569*** (0.114)	-0.112 (0.086)	-0.032 (0.022)	0.406*** (0.127)	0.080 (0.091)	-0.074 (0.046)	0.623	0.598	2.516
Y34	1.200*** (0.355)	0.387*** (0.134)	0.004 (0.046)	-0.029* (0.015)	0.450*** (0.120)	0.071 (0.083)	-0.116** (0.054)	0.592	0.565	2.249
Y44	1.139*** (0.262)	0.439*** (0.120)	-0.031* (0.019)	0.011 (0.008)	0.220** (0.085)	0.080 (0.052)	-0.076** (0.038)	0.554	0.524	2.080
Period: Stable 1990Q1 – 2006Q2										
Y14	1.255* (0.658)	0.434*** (0.137)	-0.118 (0.268)	-0.144** (0.063)	0.837*** (0.208)	-0.021 (0.352)	-0.247** (0.112)	0.659	0.625	2.387
Y24	1.032 (0.728)	0.495*** (0.127)	-0.076 (0.311)	-0.033** (0.016)	0.500*** (0.083)	0.032 (0.059)	-0.177* (0.091)	0.669	0.636	2.405
Y34	1.820*** (0.472)	0.101 (0.155)	-0.066 (0.130)	-0.068*** (0.025)	0.721*** (0.115)	-0.044 (0.139)	-0.216*** (0.060)	0.662	0.627	2.025
Y44	1.393*** (0.347)	0.231* (0.116)	-0.052 (0.051)	-0.001 (0.014)	0.378*** (0.090)	0.153* (0.088)	-0.134*** (0.047)	0.564	0.520	1.940
Period: Volatile 2006Q3 – 2011Q1										
Y14	2.467*** (0.417)	0.292*** (0.068)	0.185** (0.081)	0.078*** (0.020)	-0.033 (0.079)	0.018 (0.023)	-0.090*** (0.008)	0.627	0.441	1.689
Y24	1.814*** (0.238)	0.571*** (0.140)	-0.150*** (0.019)	0.063*** (0.012)	-0.145 (0.104)	0.033 (0.076)	-0.010 (0.011)	0.798	0.696	1.302
Y34	1.300 (1.067)	0.465 (0.523)	0.047 (0.105)	0.056*** (0.008)	-0.069 (0.118)	0.015 (0.415)	-0.096*** (0.012)	0.657	0.485	2.371
Y44	0.893*** (0.084)	0.729*** (0.102)	-0.021 (0.015)	0.056*** (0.004)	-0.182*** (0.037)	-0.080* (0.039)	-0.040* (0.022)	0.827	0.741	2.193

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 4.74. Regionally Disaggregated Michigan Survey Disagreement and Perceived News Intensity regarding Favourable and Unfavourable Prices

Testing Equation:

$$\sigma_{i,t} = \alpha_0 + \alpha_1\sigma_{i,t-1} + \alpha_2 NewsPF_{i,t} + \alpha_3 NewsPU_{i,t} + \alpha_4\pi_t + \alpha_5|\pi_t - \pi_{t-4}| + \alpha_6 Gap_t + \epsilon_t$$

	α_0	α_1	α_2	α_3	α_4	α_5	α_6	R^2	$\bar{R}^2$	D.W. Stat
				Period: Whole 1982Q3 – 2011Q1						
NC	1.003*** (0.369)	0.487*** (0.149)	0.122 (0.103)	-0.048** (0.024)	0.484*** (0.149)	0.028 (0.097)	-0.099** (0.049)	0.640	0.620	2.416
NE	1.006*** (0.361)	0.513*** (0.119)	0.038 (0.060)	-0.023 (0.020)	0.425*** (0.119)	0.099 (0.067)	-0.088 (0.055)	0.597	0.575	2.520
S	0.587** (0.236)	0.652*** (0.070)	0.049 (0.044)	-0.028** (0.014)	0.386*** (0.081)	0.038 (0.061)	-0.077** (0.034)	0.781	0.769	2.321
W	1.678*** (0.466)	0.360*** (0.132)	0.050 (0.055)	-0.048** (0.022)	0.435*** (0.117)	0.049 (0.092)	-0.117** (0.058)	0.505	0.477	2.316
				Period: Greenspan-Bernanke 1987Q2 – 2011Q1						
NC	1.016** (0.390)	0.486*** (0.166)	0.043 (0.084)	-0.042 (0.027)	0.478** (0.188)	0.024 (0.134)	-0.102* (0.052)	0.573	0.544	2.393
NE	1.182*** (0.326)	0.424*** (0.133)	-0.097 (0.061)	-0.030 (0.024)	0.527*** (0.154)	0.104 (0.088)	-0.107 (0.065)	0.536	0.505	2.425
S	0.565** (0.243)	0.670*** (0.074)	0.003 (0.061)	-0.021 (0.014)	0.350*** (0.089)	0.064 (0.064)	-0.069** (0.034)	0.731	0.713	2.283
W	1.580** (0.603)	0.388** (0.176)	0.058 (0.099)	-0.036 (0.024)	0.392** (0.151)	0.017 (0.095)	-0.115 (0.071)	0.450	0.413	2.206
				Period: Stable 1990Q1 – 2006Q2						
NC	1.031* (0.573)	0.323 (0.254)	0.290 (0.223)	-0.051* (0.029)	0.666*** (0.210)	0.064 (0.229)	-0.196 (0.124)	0.625	0.587	2.197
NE	1.643** (0.756)	0.256 (0.183)	-0.216* (0.120)	-0.055** (0.023)	0.733*** (0.088)	-0.071 (0.198)	-0.252* (0.140)	0.609	0.570	2.086
S	0.425 (0.389)	0.535*** (0.081)	0.300 (0.243)	-0.043 (0.044)	0.583*** (0.147)	0.036 (0.175)	-0.174*** (0.061)	0.762	0.738	2.063
W	1.714* (0.927)	0.284 (0.215)	0.038 (0.219)	-0.048 (0.032)	0.531** (0.162)	-0.012 (0.088)	-0.212* (0.118)	0.527	0.479	2.211
				Period: Volatile 2006Q3 – 2011Q1						
NC	2.192* (1.087)	0.391 (0.309)	-0.022 (0.084)	0.067** (0.030)	-0.169 (0.122)	-0.041 (0.079)	-0.073 (0.057)	0.666	0.500	2.242
NE	1.126 (0.684)	0.665*** (0.193)	-0.022 (0.038)	0.054** (0.020)	-0.068 (0.108)	-0.043 (0.054)	-0.042 (0.026)	0.734	0.600	1.910
S	2.500** (1.022)	0.233 (0.301)	0.028 (0.085)	0.069** (0.028)	-0.107 (0.141)	0.044 (0.073)	-0.095 (0.055)	0.694	0.540	2.062
W	1.568 (4.979)	0.536 (0.832)	-0.005 (0.348)	0.043 (0.070)	-0.087 (0.130)	0.023 (0.121)	-0.053 (0.143)	0.667	0.500	2.073

***,**,* indicate significance at 1, 5 and 10 percent levels.

APPENDICES FOR CHAPTER 5

Appendix 5.1. Survey Updating Model (including Inflation) – Aggregate Michigan Survey Forecasts

Testing Equation:

$$E_{H,t}[\pi_{t+h}] = \alpha_0 + \alpha_1 E_{P,t}[\pi_{t+h}] + \alpha_2 E_{H,t-1}[\pi_{t+h-1}] + \alpha_3 \pi_{t-k} + \epsilon_t$$

	α_0	α_1	α_2	α_3	Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
PANEL A: Period: Whole 1982Q3 – 2011Q1								
(1)		0.149***	0.885***	-0.054*	$\alpha_1+\alpha_2+\alpha_3=1$	0.336	0.324	2.148
$k=1$		(0.056)	(0.057)	(0.028)	1.982			
(2)		0.138**	0.913***	-0.051	$\alpha_1+\alpha_3=0.25$	0.323	0.317	2.174
$k=1,R$		(0.059)	(0.048)	(0.032)	11.533***			
(3)		0.075	0.785***	0.126**	$\alpha_1+\alpha_2+\alpha_3=1$	0.369	0.358	2.008
$k=0$		(0.046)	(0.047)	(0.049)	1.287			
(4)		0.065*	0.803***	0.132***	$\alpha_1+\alpha_3=0.25$	0.363	0.357	2.027
$k=0,R$		(0.038)	(0.036)	(0.043)	2.134			
PANEL B: Period: Greenspan-Bernanke 1987Q2 – 2011Q1								
(1)		0.206**	0.875***	-0.082**	$\alpha_1+\alpha_2+\alpha_3=1$	0.407	0.394	1.979
$k=1$		(0.086)	(0.094)	(0.035)	0.008			
(2)		0.207**	0.875***	-0.082	$\alpha_1+\alpha_3=0.25$	0.407	0.400	1.979
$k=1,R$		(0.082)	(0.081)	(0.034)	2.371			
(3)		0.105*	0.789***	0.105**	$\alpha_1+\alpha_2+\alpha_3=1$	0.419	0.406	1.864
$k=0$		(0.062)	(0.047)	(0.051)	0.004			
(4)		0.106	0.789***	0.105**	$\alpha_1+\alpha_3=0.25$	0.418	0.413	1.864
$k=0,R$		(0.065)	(0.047)	(0.050)	0.705			
PANEL C: Period: Stable 1990Q1 – 2006Q2								
(1)		0.291*	0.776***	-0.070	$\alpha_1+\alpha_2+\alpha_3=1$	0.413	0.394	2.092
$k=1$		(0.154)	(0.156)	(0.068)	0.042			
(2)		0.293*	0.778***	-0.071	$\alpha_1+\alpha_3=0.25$	0.413	0.403	2.094
$k=1,R$		(0.154)	(0.152)	(0.074)	0.034			
(3)		0.234*	0.605***	0.154***	$\alpha_1+\alpha_2+\alpha_3=1$	0.448	0.431	1.817
$k=0$		(0.140)	(0.159)	(0.057)	0.068			
(4)		0.239*	0.609***	0.152***	$\alpha_1+\alpha_3=0.25$	0.446	0.438	1.821
$k=0,R$		(0.126)	(0.147)	(0.054)	0.917			
PANEL D: Period: Volatile 2006Q3 – 2011Q1								
(1)		0.886***	0.398**	0.011	$\alpha_1+\alpha_2+\alpha_3=1$	0.381	0.303	1.319
$k=1$		(0.182)	(0.178)	(0.068)	6.253**			
(2)		0.175	0.902***	-0.076	$\alpha_1+\alpha_3=0.25$	0.202	0.155	1.438
$k=1,R$		(0.203)	(0.145)	(0.083)	1.103			
(3)		0.931***	0.253	0.180***	$\alpha_1+\alpha_2+\alpha_3=1$	0.534	0.476	1.261
$k=0$		(0.230)	(0.152)	(0.059)	8.342***			
(4)		0.048	0.846***	0.107	$\alpha_1+\alpha_3=0.25$	0.232	0.187	1.432
$k=0,R$		(0.111)	(0.057)	(0.074)	2.831*			

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.2. Differenced Survey-Updating Model

Testing Equation:

$$(1)\ \Delta E_{H,t}[\pi_{t+h}] = \gamma_1 \Delta E_{P,t}[\pi_{t+h}] + \gamma_2 \Delta E_{H,t-j}[\pi_{t+h-j}] + \epsilon_t$$
$$(2)\ \Delta E_{H,t}[\pi_{t+h}] = \gamma_0 + \gamma_1 \Delta E_{P,t}[\pi_{t+h}] + \gamma_2 \Delta E_{H,t-j}[\pi_{t+h-j}] + \epsilon_t$$
$$(3)\ \Delta E_{H,t}[\pi_{t+h}] = \gamma_1 \Delta E_{P,t}[\pi_{t+h}] + \gamma_2 \Delta E_{H,t-j}[\pi_{t+h-j}] + \gamma_3 \Delta\pi_t + \epsilon_t$$
$$(4)\ \Delta E_{H,t}[\pi_{t+h}] = \gamma_0 + \gamma_1 \Delta E_{P,t}[\pi_{t+h}] + \gamma_2 \Delta E_{H,t-j}[\pi_{t+h-j}] + \gamma_3 \Delta\pi_t + \epsilon_t$$

		γ_0	γ_1	γ_2	γ_3	Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
				Period: Whole 1982Q3 – 2011Q1					
MS	**(1)**		0.889*** (0.128)	-0.249* (0.127)		$\gamma_1+\gamma_2=1$ 2.753*	0.204	0.197	2.035
	(2)	0.022 (0.015)	0.903*** (0.141)	-0.249** (0.119)		$\gamma_1+\gamma_2=1$ 2.364	0.206	0.192	2.044
	(3)		0.734*** (0.120)	-0.302*** (0.086)	0.278*** (0.044)	$\gamma_1+\gamma_2+\gamma_3=1$ 2.473	0.371	0.360	2.104
	(4)	0.028** (0.012)	0.751*** (0.125)	-0.302*** (0.079)	0.279*** (0.040)	$\gamma_1+\gamma_2+\gamma_3=1$ 2.214	0.374	0.357	2.115
				Period: Greenspan-Bernanke 1987Q2 – 2011Q1					
MS	**(1)**		0.925*** (0.247)	-0.165 (0.116)		$\gamma_1+\gamma_2=1$ 0.794	0.125	0.116	1.970
	(2)	0.028* (0.016)	0.945*** (0.258)	-0.166 (0.117)		$\gamma_1+\gamma_2=1$ 0.593	0.129	0.110	1.979
	(3)		0.738*** (0.239)	-0.238*** (0.077)	0.303*** (0.049)	$\gamma_1+\gamma_2+\gamma_3=1$ 0.685	0.349	0.335	2.043
	(4)	0.024** (0.011)	0.755*** (0.243)	-0.239*** (0.075)	0.302 (0.044)	$\gamma_1+\gamma_2+\gamma_3=1$ 0.569	0.352	0.331	2.049
				Period: Stable 1990Q1 – 2006Q2					
MS	**(1)**		0.863*** (0.312)	-0.278*** (0.071)		$\gamma_1+\gamma_2=1$ 1.641	0.196	0.183	1.965
	(2)	0.024 (0.027)	0.887*** (0.305)	-0.278*** (0.059)		$\gamma_1+\gamma_2=1$ 1.494	0.199	0.174	1.973
	(3)		0.529** (0.229)	-0.326*** (0.083)	0.429*** (0.080)	$\gamma_1+\gamma_2+\gamma_3=1$ 2.262	0.402	0.383	2.158
	(4)	0.016 (0.018)	0.547** (0.247)	-0.326*** (0.067)	0.428*** (0.083)	$\gamma_1+\gamma_2+\gamma_3=1$ 1.731	0.404	0.375	2.160
				Period: Volatile 2006Q3 – 2011Q1					
MS	**(1)**		1.371* (0.698)	0.077 (0.133)		$\gamma_1+\gamma_2=1$ 0.406	0.135	0.085	1.859
	(2)	0.040 (0.131)	1.393* (0.732)	0.076 (0.133)		$\gamma_1+\gamma_2=1$ 0.401	0.139	0.032	1.872
	(3)		1.512*** (0.428)	-0.098 (0.067)	0.263*** (0.072)	$\gamma_1+\gamma_2+\gamma_3=1$ 2.356	0.421	0.348	1.984
	(4)	0.067 (0.066)	1.551*** (0.382)	-0.103* (0.053)	0.266*** (0.071)	$\gamma_1+\gamma_2+\gamma_3=1$ 3.144*	0.431	0.317	2.028

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.3. Naïve Sticky Information Model – Sub-Sample Periods

Testing Equation:

$$(1).\ E_t^H[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + \beta_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

$$(2).\ E_{t,H}[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + (1-\beta_1)E_{t-j,H}[\pi_{t+h-j}] + \epsilon_t$$

$$(3).\ E_t^H[\pi_{t+h}] = \beta_0 + \beta_1(\beta_2\pi_{t-k} + (1-\beta_2)E_t^P[\pi_{t+h}]) + (1-\beta_1)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

		β_0	β_1	$(1-\beta_1)$	β_2	$(1-\beta_2)$	Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
Period: Greenspan-Bernanke 1987Q2 – 2011Q1										
MS	(1)		0.140*** (0.050)		0.855*** (0.051)		$\beta_1+\beta_2=1$ 0.150	0.402	0.396	1.936
	(2)		0.141*** (0.044)		0.859*** (0.044)		$\beta_1=0.35$ 22.258***	0.402	0.402	1.941
	(3)		0.211*** (0.047)	0.789*** (0.047)	0.499** (0.251)	0.501** (0.251)	$\beta_1=0.25$ 0.705 $\beta_1*(1-\beta_2)=0.25$ 4.982**	0.419	0.413	1.864
Period: Stable 1990Q1 – 2006Q2										
MS	(1)		0.184** (0.079)		0.804*** (0.082)		$\beta_1+\beta_2=1$ 0.498	0.389	0.379	2.085
	(2)		0.182** (0.072)		0.818*** (0.072)		$\beta_1=0.35$ 5.422**	0.384	0.384	2.103
	(3)		0.391** (0.147)	0.609*** (0.147)	0.388*** (0.135)	0.612*** (0.135)	$\beta_1=0.25$ 0.917 $\beta_1*(1-\beta_2)=0.25$ 0.007	0.446	0.438	1.821
Period: Volatile 2006Q3 – 2011Q1										
MS	(1)		0.160** (0.071)		0.878*** (0.051)		$\beta_1+\beta_2=1$ 1.970	0.249	0.205	1.514
	(2)		0.122 (0.105)		0.878*** (0.105)		$\beta_1=0.35$ 4.729**	0.227	0.227	1.470
	(3)		0.154** (0.057)	0.846*** (0.057)	0.691 (0.630)	0.309 (0.630)	$\beta_1=0.25$ 2.831* $\beta_1*(1-\beta_2)=0.25$ 3.340*	0.232	0.187	1.432

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.4. Rational Updating Model – Sub-Periods

Testing Equation:

$$E_{i,t}[\pi_{t+h}] = \gamma_0 + \gamma_1 E_{RE,t}[\pi_{t+h}] + \gamma_2 E_{i,t-1}[\pi_{t+h-1}] + v_t$$

		γ_0	γ_1	γ_2	Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat	J-Stat
Period: Greenspan-Bernanke 1987Q2 – 2011Q1									
MS	**(1)**		0.099** (0.049)	0.909*** (0.051)	$\gamma_1 + \gamma_2 = 1$ 4.921	0.340	0.333	2.0621	13.861*
	(2)		0.090*** (0.034)	0.910*** (0.034)	$\gamma_1 = 0.16$ 4.139**	0.346	0.346	2.070	13.358
	(3)	0.881*** (0.127)	0.000 (0.047)	0.716*** (0.076)		0.440	0.428	1.907	10.910
	(4)	0.033*** (0.011)	0.084 (0.056)	0.916*** (0.056)	$\gamma_1 = 0.16$ 1.868	0.349	0.342	2.085	15.069*
Period: Stable 1990Q1 – 2006Q2									
MS	**(1)**		0.477*** (0.135)	0.528*** (0.103)	$\gamma_1 + \gamma_2 = 1$ 0.021	0.169	0.156	1.526	139.604***
	(2)		0.210 (0.189)	0.790*** (0.189)	$\gamma_1 = 0.16$ 0.071	0.417	0.417	2.360	107.133***
	(3)	0.135 (0.279)	0.414*** (0.094)	0.554*** (0.140)		0.283	0.260	1.723	160.576***
	(4)	0.034 (0.110)	0.464*** (0.135)	0.536*** (0.135)	$\gamma_1 = 0.16$ 5.051***	0.203	0.190	1.584	152.372***
Period: Volatile 2006Q3 – 2011Q1									
MS†	**(1)**		0.125*** (0.036)	0.915*** (0.025)	$\gamma_1 + \gamma_2 = 1$ 4.235**	-0.026	-0.087	1.474	4.754
	(2)		0.078** (0.027)	0.922*** (0.027)	$\gamma_1 = 0.16$ 8.926***	0.057	0.057	1.491	5.784
	(3)	2.064*** (0.539)	-0.099* (0.054)	0.438*** (0.135)		0.424	0.352	1.285	5.701
	(4)	0.115*** (0.036)	0.118*** (0.035)	0.882*** (0.035)	$\gamma_1 = 0.16$ 645.512***	0.004	-0.055	1.465	4.579

***,**,* indicate significance at 1, 5 and 10 percent levels.

†Due to length of the volatile period, no lag can be specified for the Newey-West covariance estimation weighting matrix.

Appendix 5.5. Heterogeneous Updating Model

Testing Equation:

$$E_{t,H}[\pi_{t+h}] = \phi_0 + \phi_1 E_{t,P}[\pi_{t+h}] + \phi_2 \pi_t + \phi_3 E_{t,RE}[\pi_{t+h}] + \phi_4[\pi_{t+h-1}] + \epsilon_t$$

	ϕ_0	ϕ_1	ϕ_2	ϕ_3	ϕ_4	Wald χ^2 Test $\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$	R^2	$\bar{R}^2$	D.W. Stat	J-Stat
Period: Whole 1982Q3 – 2011Q1										
(1)		0.048 (0.050)	0.132*** (0.049)	0.036 (0.047)	0.773*** (0.051)	0.700	0.374	0.358	2.028	
(2)		-0.077* (0.042)	0.075* (0.043)	0.272*** (0.089)	0.738*** (0.090)	0.407	0.129	0.106	1.729	7.115
(3)	1.522*** (0.194)	0.038 (0.053)	0.220*** (0.041)	-0.036 (0.054)	0.291*** (0.082)	43.711***	0.568	0.552	1.652	
(4)	2.631*** (0.239)	0.286*** (0.061)	0.136*** (0.033)	-0.460*** (0.071)	0.156*** (0.058)	94.990***	-0.117	-0.158	0.629	5.487
Period: Greenspan-Bernanke 1987Q2 – 2011Q1										
(1)		0.095 (0.091)	0.107** (0.042)	0.009 (0.056)	0.789*** (0.060)	0.001	0.419	0.400	1.870	
(2)		0.163* (0.090)	-0.051 (0.034)	-0.064 (0.114)	0.959*** (0.054)	0.273	0.319	0.297	1.989	12.063*
(3)	1.449*** (0.184)	0.012 (0.058)	0.218*** (0.035)	-0.037 (0.056)	0.343*** (0.061)	89.462***	0.581	0.562	1.536	
(4)	1.905*** (0.157)	0.400*** (0.083)	0.080** (0.032)	-0.420*** (0.053)	0.318*** (0.039)	114.347***	0.033	-0.010	0.725	3.573
Period: Stable 1990Q1 – 2006Q2										
(1)		0.174** (0.081)	0.148** (0.063)	0.150*** (0.053)	0.532*** (0.122)	0.080	0.505	0.481	1.925	
(2)		-0.175 (0.147)	0.023 (0.038)	0.757*** (0.149)	0.441*** (0.063)	3.952**	-0.477	-0.549	1.038	84.450***
(3)	1.624*** (0.103)	0.074 (0.064)	0.365*** (0.045)	0.042 (0.034)	-0.029 (0.051)	285.932***	0.681	0.660	1.542	
(4)	0.928*** (0.116)	0.082*** (0.023)	0.213*** (0.025)	0.275*** (0.067)	0.137*** (0.015)	42.998***	0.553	0.524	1.564	30.920***
Period: Volatile 2006Q3 – 2011Q1										
(1)		1.420 (1.345)	0.130*** (0.025)	-0.156 (0.322)	0.063 (0.769)	2.916*	0.648	0.578	1.255	
(2)†		1.214*** (0.309)	0.072 (0.042)	-0.131 (0.085)	0.203 (0.159)	0.273	0.613	0.536	1.298	4.084
(3)	1.948 (4.152)	0.581 (2.336)	0.201 (0.154)	-0.162 (0.155)	-0.016 (0.169)	0.044	0.709	0.626	1.628	
(4)†	1.874* (0.950)	0.758 (0.445)	0.160*** (0.050)	-0.216** (0.077)	-0.054 (0.168)	0.775	0.693	0.605	1.495	4.285

***,**,* indicate significance at 1, 5 and 10 percent levels.

†Due to length of the volatile period, no lag can be specified for the Newey-West covariance estimation weighting matrix.

Appendix 5.6. Heterogeneous Updating Model – Restricted Specification

Testing Equation:

$$E_{t,H}[\pi_{t+h}] = \lambda(\phi_1 E_{t,P}[\pi_{t+h}] + \phi_2 \pi_t + (1-\phi_1+\phi_2)E_{t,RE}[\pi_{t+h}]) + (1-\lambda)E_{t,H}[\pi_{t+h-1}] + \epsilon_t$$

	λ	ϕ_1	ϕ_2	$(1-\phi_1+\phi_2)$	$(1-\lambda)$	Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat	J-Stat
Period: Whole 1982Q3 – 2011Q1										
(1) OLS	0.217*** (0.060)	0.164 (0.217)	0.633** (0.252)	0.202 (0.197)	0.783*** (0.060)	$\lambda = 0.25$ 0.299				
(2) GMM	0.213** (0.100)	-0.045 (0.252)	0.227* (0.117)	0.818*** (0.221)	0.787*** (0.100)	$\lambda = 0.25$ 0.140	0.270	0.257	1.996	11.396*
Period: Greenspan-Bernanke 1987Q2 – 2011Q1										
(1) OLS	0.211*** (0.079)	0.452 (0.321)	0.505 (0.320)	0.043 (0.249)	0.788*** (0.079)	$\lambda = 0.25$ 0.242	0.419	0.407	1.870	
(2) GMM	0.086** (0.041)	1.326 (1.054)	-0.195 (0.410)	-0.132 (1.107)	0.914*** (0.041)	$\lambda = 0.25$ 16.275***	0.368	0.355	2.054	0.003
Period: Stable 1990Q1 – 2006Q2										
(1) OLS	0.468*** (0.145)	0.370*** (0.137)	0.319** (0.140)	0.311*** (0.105)	0.531*** (0.145)	$\lambda = 0.25$ 2.263	0.505	0.489	1.919	
(2) GMM	0.393*** (0.092)	0.407 (0.386)	0.006 (0.761)	0.587 (0.408)	0.587 (0.408)	$\lambda = 0.25$ 2.379	0.445	0.428	2.069	3.551
Period: Volatile 2006Q3 – 2011Q1										
(1) OLS	0.166 (0.182)	0.738 (1.032)	0.527 (0.772)	-0.264 (0.574)	0.834*** (0.182)	$\lambda = 0.25$ 0.215	0.243	0.148	1.377	
(2)† GMM	0.090* (0.048)	-0.173 (1.081)	0.331 (0.747)	0.842 (0.787)	0.910*** (0.058)	$\lambda = 0.25$ 10.876***	0.100	-0.012	1.502	5.888

***,**,* indicate significance at 1, 5 and 10 percent levels.

†Due to length of the volatile period, no lag can be specified for the Newey-West covariance estimation weighting matrix.

Appendix 5.7. Granger Causality – Age Disaggregated Michigan Survey Expectations

	PANEL A SPF → MS(AGE)			PANEL B MS(AGE) → SPF		
LAGS	**2**	**4**	**8†**	**2**	**4**	**8†**
Period: Whole 1982Q3 – 2011Q1						
A1834	3.919**	1.707	1.371	2.342	2.229*	1.942*
A3544	6.723***	3.893***	2.705**	2.420*	1.597	2.639**
A4554	1.606	1.242	1.518	6.591***	3.422**	1.659
A5564	3.225**	1.452	0.692	2.234	1.609	0.491
A6597	0.693	0.379	0.289	6.601***	3.905***	1.501
Period: Greenspan-Bernanke 1987Q2 – 2011Q1						
A1834	3.785**	2.255*	1.505	3.665**	1.659	1.691
A3544	5.457***	3.086**	1.958*	5.224***	5.798***	3.633***
A4554	1.309	0.790	0.819	4.037**	2.088*	1.995*
A5564	2.147	1.068	0.824	2.172	2.227*	1.407
A6597	1.785	0.950	0.924	3.180**	1.635	1.510
Period: Stable 1990Q1 – 2006Q2						
A1834	4.512**	1.988	1.019	2.344	1.489	1.395
A3544	3.808**	1.920	1.042	1.192	2.683**	1.539
A4554	0.412	1.048	0.586	1.522	0.874	1.435
A5564	1.254	0.681	0.428	0.288	0.985	0.803
A6597	1.102	0.380	0.314	0.093	0.112	0.424
Period: Volatile 2006Q3 – 2011Q1						
A1834	0.814	0.625	10.252*	1.172	1.763	0.482
A3544	1.345	2.128	0.480	4.277**	4.969**	1.138
A4554	0.543	0.436	1.488	1.477	1.754	0.535
A5564	0.321	0.210	2.369	1.580	0.880	0.466
A6597	0.156	0.704	1.093	2.784*	3.338*	1.123

***,**,* indicate significance at 1, 5 and 10 percent levels.

†Estimated for 111 observations for the whole sample period due to availability of SPF CPI forecasts from 1981Q3.

Appendix 5.8. Granger Causality – Education Disaggregated Michigan Survey Expectations

	PANEL A SPF → MS(EDU)			PANEL B MS(EDU) → SPF		
LAGS	**2**	**4**	**8†**	**2**	**4**	**8†**
Period: Whole 1982Q3 – 2011Q1						
ELHS	0.097	0.156	0.980	3.461**	2.515**	1.868*
EHSD	0.521	0.451	1.182	2.742*	2.047*	1.359
ESC	3.491**	1.674	1.147	4.057**	2.855**	2.062**
ECD	5.710***	2.788**	2.375**	2.826*	1.821	1.486
EGS	7.830***	3.025**	1.530	2.704*	2.539**	1.797*
Period: Greenspan-Bernanke 1987Q2 – 2011Q1						
ELHS	0.069	0.590	1.079	2.376*	1.174	1.536
EHSD	0.414	0.795	1.281	2.372*	1.408	1.469
ESC	0.942	0.380	0.296	4.806**	2.585**	2.205**
ECD	5.253***	2.506**	1.552	2.730*	2.009	1.407
EGS	6.799***	3.627***	2.120**	2.148	2.626**	1.462
Period: Stable 1990Q1 – 2006Q2						
ELHS	0.097	0.761	0.594	1.137	0.753	0.678
EHSD	1.262	0.930	0.762	0.119	0.597	0.589
ESC	0.940	0.262	0.300	2.562*	1.919	1.297
ECD	4.674**	1.684	1.255	0.701	0.974	0.984
EGS	4.885**	2.363*	1.127	1.557	1.572	0.795
Period: Volatile 2006Q3 – 2011Q1						
ELHS	0.308	0.336	0.282	0.042	0.019	0.444
EHSD	0.214	0.838	0.883	1.037	0.978	1.263
ESC	0.270	0.279	0.626	1.711	1.396	3.143
ECD	0.306	0.192	13.251*	2.640	1.918	0.996
EGS	0.983	0.461	51.709**	1.292	0.978	0.621

***,**,* indicate significance at 1, 5 and 10 percent levels.

†Estimated for 111 observations for the whole sample period due to availability of SPF CPI forecasts from 1981Q3.

Appendix 5.9. Granger Causality – Gender Disaggregated Michigan Survey Expectations

	PANEL A SPF → MS(GEN)			PANEL B MS(EDU) → SPF		
LAGS	**2**	**4**	**8†**	**2**	**4**	**8†**
Period: Whole 1982Q3 – 2011Q1						
MALE	5.290***	1.591	1.110	5.683***	3.372**	2.982***
FEMALE	2.535*	1.794	1.984*	3.469**	2.333*	1.562
Period: Greenspan-Bernanke 1987Q2 – 2011Q1						
MALE	3.935**	2.114*	2.225**	4.882***	1.528	3.419***
FEMALE	3.152**	3.819***	1.299	3.994**	2.424*	2.099**
Period: Stable 1990Q1 – 2006Q2						
MALE	3.526**	1.594	1.064	2.401*	1.886	1.447
FEMALE	2.294	1.071	0.525	0.374	0.630	0.947
Period: Volatile 2006Q3 – 2011Q1						
MALE	0.597	0.276	3.807	1.819	1.921	0.842
FEMALE	0.504	0.327	0.231	3.357*	1.881	0.844

***,**,* indicate significance at 1, 5 and 10 percent levels.

†Estimated for 111 observations for the whole sample period due to availability of SPF CPI forecasts from 1981Q3.

Appendix 5.10. Granger Causality – Income Disaggregated Michigan Survey Expectations

	PANEL A SPF → MS(INC)			PANEL B MS(INC) → SPF		
LAGS	2	4	8†	2	4	8†
Period: Whole 1982Q3 – 2011Q1						
Y14	0.474	0.504	0.453	3.194**	1.958	1.475
Y24	1.165	0.308	0.966	6.315***	4.374***	3.713***
Y34	4.370**	1.782	1.077	1.969	2.009*	2.357**
Y44	9.638***	2.269*	1.778*	2.950*	2.272*	1.897*
Period: Greenspan-Bernanke 1987Q2 – 2011Q1						
Y14	0.456	0.495	0.828	1.692	1.045	1.635
Y24	1.759	1.131	1.563	6.113***	3.097**	2.564**
Y34	2.940*	1.473	0.836	5.095***	3.167**	2.130**
Y44	6.963***	2.566**	1.561	1.925	2.014*	1.806*
Period: Stable 1990Q1 – 2006Q2						
Y14	0.702	0.435	0.407	0.156	0.734	0.720
Y24	3.458**	2.429*	1.215	0.941	0.505	0.972
Y34	2.854*	1.727	0.746	2.514*	1.359	0.917
Y44	2.561*	0.930	0.787	0.879	1.264	1.235
Period: Volatile 2006Q3 – 2011Q1						
Y14	0.091	0.303	0.088	0.364	0.251	3.013
Y24	0.922	0.703	0.951	3.850**	7.202***	3.277
Y34	0.363	0.544	289.672***	1.890	2.804*	0.494
Y44	0.859	0.897	3.440	1.529	1.763	5.731

***,**,* indicate significance at 1, 5 and 10 percent levels.

†Estimated for 111 observations for the whole sample period due to availability of SPF CPI forecasts from 1981Q3.

Appendix 5.11. Granger Causality – Regionally Disaggregated Michigan Survey Expectations

	PANEL A SPF → MS(REG)			PANEL B MS(REG) → SPF		
LAGS	**2**	**4**	**8†**	**2**	**4**	**8†**
			Period: Whole 1982Q3 – 2011Q1			
NC	2.477*	0.696	1.316	9.369***	5.575***	2.219**
NE	2.712*	1.826	2.083**	2.143	1.583	2.677**
S	2.811*	0.690	0.486	4.681**	2.795**	3.592***
W	4.074**	1.970	1.666	1.259	1.244	1.097
			Period: Greenspan-Bernanke 1987Q2 – 2011Q1			
NC	2.432*	1.203	0.988	4.529**	2.188*	3.078***
NE	2.594*	1.956	1.268	3.276**	2.731**	2.660**
S	2.771*	1.343	1.019	5.554***	3.939***	3.602***
W	4.080**	1.780	1.233	3.923**	2.471*	1.511
			Period: Stable 1990Q1 – 2006Q2			
NC	3.619**	1.795	0.660	1.332	0.861	1.099
NE	1.987	0.778	0.478	1.341	1.524	1.657
S	2.542*	1.202	0.521	2.143	2.154*	1.632
W	2.848*	0.778	0.327	0.794	0.643	0.785
			Period: Volatile 2006Q3 – 2011Q1			
NC	0.125	0.274	0.477	1.692	1.251	1.249
NE	0.321	0.367	3.315	1.954	1.742	0.844
S	0.128	0.109	0.789	1.736	1.693	0.896
W	1.015	0.663	1.136	2.228	1.982	0.785

***,**,* indicate significance at 1, 5 and 10 percent levels.

†Estimated for 111 observations for the whole sample period due to availability of SPF CPI forecasts from 1981Q3.

Appendix 5.12. Epidemiological Tests – Age Disaggregated Michigan Survey Forecasts – Whole Sample Period

Testing Equation:

$$E_{H,t}[\pi_{t+h}] = \alpha_0 + \alpha_1 E_{P,t}[\pi_{t+h}] + \alpha_2 E_{H,t-1}[\pi_{t+h-1}] + \alpha_3 \pi_t + \epsilon_t$$

		α_0	α_1	α_2		Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
Period: Whole 1982Q3 – 2011Q1									
A1834	(1)		0.275*** (0.069)	0.698*** (0.085)		$\alpha_1 + \alpha_2 = 1$ 2.097	0.362	0.356	2.409
	(2)		0.265*** (0.052)	0.735*** (0.052)		$\alpha_1 = 0.25$ 0.089	0.345	0.345	2.446
	(3)	1.213*** (0.231)	0.281*** (0.086)	0.328** (0.145)			0.508	0.499	2.050
	(4)		0.215** (0.091)	0.608*** (0.145)	0.160*** (0.059)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 0.548	0.409	0.399	2.309
	(5)	1.365*** (0.256)	0.202** (0.100)	0.162 (0.182)	0.212*** (0.044)		0.589	0.578	1.916
A3544	(1)		0.234*** (0.064)	0.741*** (0.077)		$\alpha_1 + \alpha_2 = 1$ 2.048	0.370	0.365	2.232
	(2)		0.227*** (0.067)	0.773*** (0.067)		$\alpha_1 = 0.25$ 0.120	0.355	0.355	2.257
	(3)	1.108*** (0.177)	0.216*** (0.073)	0.426*** (0.120)			0.492	0.483	1.984
	(4)		0.165*** (0.062)	0.628*** (0.093)	0.193*** (0.070)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 0.606	0.439	0.429	2.074
	(5)	1.407*** (0.100)	0.112* (0.067)	0.178* (0.106)	0.276*** (0.038)		0.623	0.613	1.814
A4554	(1)		0.152*** (0.049)	0.829*** (0.059)		$\alpha_1 + \alpha_2 = 1$ 1.543	0.165	0.158	2.290
	(2)		0.145*** (0.053)	0.855*** (0.054)		$\alpha_1 = 0.25$ 3.845**	0.154	0.154	2.326
	(3)	1.300*** (0.216)	0.109** (0.048)	0.467*** (0.100)			0.328	0.317	1.917
	(4)		0.088 (0.055)	0.753*** (0.036)	0.144** (0.055)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 0.990)	0.217	0.203	2.192
	(5)	1.884*** (0.202)	-0.039 (0.066)	0.152 (0.105)	0.290*** (0.048)		0.506	0.493	1.695
A5564	(1)		0.144*** (0.043)	0.830*** (0.056)		$\alpha_1 + \alpha_2 = 1$ 2.329	0.042	0.034	2.144
	(2)		0.131*** (0.045)	0.869*** (0.045)		$\alpha_1 = 0.25$ 6.937***	0.024	0.024	2.197
	(3)	1.428*** (0.228)	0.048 (0.042)	0.463*** (0.091)			0.230	0.216	1.825
	(4)		0.058 (0.047)	0.762*** (0.037)	0.157*** (0.055)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 2.482	0.108	0.092	2.032
	(5)	1.921*** (0.223)	-0.138** (0.059)	0.218*** (0.054)	0.276*** (0.049)		0.410	0.394	1.688
A6597	(1)		0.147*** (0.035)	0.831*** (0.045)		$\alpha_1 + \alpha_2 = 1$ 1.890	0.078	0.070	2.330
	(2)		0.142*** (0.034)	0.858*** (0.034)		$\alpha_1 = 0.25$ 10.131***	0.068	0.068	2.374
	(3)	1.532*** (0.268)	-0.004 (0.060)	0.493*** (0.066)			0.252	0.238	1.975
	(4)		0.058 (0.044)	0.779*** (0.053)	0.145*** (0.046)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 0.603	0.122	0.106	2.203
	(5)	1.888*** (0.369)	-0.189** (0.076)	0.328*** (0.090)	0.243*** (0.048)		0.366	0.349	1.758

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.13. Epidemiological Tests – Age Disaggregated Michigan Survey Forecasts – Greenspan-Bernanke Sample Period

Testing Equation:

$$E_{H,t}[\pi_{t+h}] = \alpha_0 + \alpha_1 E_{P,t}[\pi_{t+h}] + \alpha_2 E_{H,t-1}[\pi_{t+h-1}] + \alpha_3 \pi_t + \epsilon_t$$

		α_0	α_1	α_2	α_3	Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
Period: Greenspan-Bernanke Sample Period 1987Q2 – 2011Q1									
A1834	(1)		0.258*** (0.080)	0.741*** (0.085)		$\alpha_1 + \alpha_2 = 1$ 0.004	0.439	0.433	2.178
	(2)		0.259*** (0.080)	0.741*** (0.080)		$\alpha_1 = 0.25$ 0.012	0.439	0.439	2.178
	(3)	0.889*** (0.155)	0.226*** (0.076)	0.494*** (0.095)			0.518	0.508	1.957
	(4)		0.186*** (0.068)	0.687*** (0.075)	0.127* (0.066)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 0.000	0.474	0.462	2.124
	(5)	1.192*** (0.089)	0.096 (0.073)	0.321*** (0.099)	0.209*** (0.043)		0.601	0.588	1.839
A3544	(1)		0.236*** (0.079)	0.761*** (0.086)		$\alpha_1 + \alpha_2 = 1$ 0.028	0.375	0.368	1.989
	(2)		0.238** (0.095)	0.762*** (0.095)		$\alpha_1 = 0.25$ 0.015	0.375	0.375	1.990
	(3)	0.942*** (0.181)	0.183** (0.086)	0.517*** (0.113)			0.461	0.450	1.821
	(4)		0.158** (0.078)	0.687*** (0.054)	0.153** (0.074)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 0.011	0.423	0.411	1.867
	(5)	1.528*** (0.080)	-0.003 (0.060)	0.223** (0.101)	0.296*** (0.053)		0.608	0.596	1.650
A4554	(1)		0.181** (0.074)	0.818*** (0.080)		$\alpha_1 + \alpha_2 = 1$ 0.009	0.297	0.289	2.237
	(2)		0.182** (0.086)	0.818*** (0.086)		$\alpha_1 = 0.25$ 0.622	0.297	0.297	2.238
	(3)	1.054*** (0.184)	0.122* (0.072)	0.542*** (0.106)			0.402	0.389	1.984
	(4)		0.122** (0.051)	0.772*** (0.030)	0.105** (0.048)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 0.004	0.324	0.309	2.168
	(5)	1.706*** (0.192)	-0.063 (0.085)	0.253*** (0.075)	0.268*** (0.052)		0.536	0.521	1.753
A5564	(1)		0.185*** (0.062)	0.807*** (0.073)		$\alpha_1 + \alpha_2 = 1$ 0.273	0.182	0.174	2.109
	(2)		0.187*** (0.066)	0.813*** (0.066)		$\alpha_1 = 0.25$ 0.916	0.181	0.181	2.117
	(3)	1.185*** (0.189)	0.082 (0.054)	0.520*** (0.094)			0.310	0.295	1.886
	(4)		0.101 (0.063)	0.766*** (0.039)	0.123** (0.058)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 0.407	0.221	0.204	2.031
	(5)	1.740*** (0.276)	-0.140 (0.090)	0.300*** (0.045)	0.258*** (0.053)		0.449	0.431	1.751
A6597	(1)		0.215*** (0.059)	0.784*** (0.068)		$\alpha_1 + \alpha_2 = 1$ 0.002	0.124	0.115	2.276
	(2)		0.215*** (0.063)	0.785*** (0.063)		$\alpha_1 = 0.25$ 0.296	0.124	0.124	2.277
	(3)	1.317*** (0.204)	0.113 (0.092)	0.465*** (0.114)			0.273	0.257	1.981
	(4)		0.136* (0.074)	0.755*** (0.075)	0.109** (0.052)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 0.000	0.154	0.135	2.197
	(5)	1.687*** (0.288)	-0.069 (0.101)	0.317** (0.124)	0.212*** (0.053)		0.371	0.351	1.810

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.14. Epidemiological Tests – Age Disaggregated Michigan Survey Forecasts – Stable Sample Periods

Testing Equation:

$$E_{H,t}[\pi_{t+h}] = \alpha_0 + \alpha_1 E_{P,t}[\pi_{t+h}] + \alpha_2 E_{H,t-1}[\pi_{t+h-1}] + \alpha_3 \pi_t + \epsilon_t$$

		α_0	α_1	α_2	α_3	Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
				Period: Stable 1990Q1 – 2006Q2					
A1834	**(1)**		0.412** (0.191)	0.586*** (0.195)		$\alpha_1 + \alpha_2 = 1$ 0.014	0.552	0.545	2.037
	(2)		0.414** (0.188)	0.586*** (0.188)		$\alpha_1 = 0.25$ 0.759	0.552	0.552	2.036
	(3)	0.648*** (0.102)	0.352** (0.156)	0.433*** (0.155)			0.570	0.584	1.917
	(4)		0.404** (0.182)	0.358 (0.220)	0.235*** (0.060)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 0.022	0.623	0.611	1.744
	(5)	1.138*** (0.172)	0.294*** (0.081)	-0.034 (0.101)	0.363*** (0.059)		0.742	0.729	1.647
A3544	**(1)**		0.365* (0.184)	0.635*** (0.187)		$\alpha_1 + \alpha_2 = 1$ 0.000	0.416	0.407	1.952
	(2)		0.365** (0.181)	0.635*** (0.181)		$\alpha_1 = 0.25$ 0.401	0.416	0.416	1.953
	(3)	0.942*** (0.181)	0.183** (0.086)	0.517*** (0.113)			0.461	0.450	1.821
	(4)		0.329** (0.157)	0.443** (0.197)	0.229*** (0.069)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 0.000	0.485	0.468	1.679
	(5)	1.546*** (0.089)	0.140** (0.061)	-0.075 (0.069)	0.428*** (0.045)		0.676	0.660	1.597
A4554	**(1)**		0.186* (0.108)	0.805*** (0.112)		$\alpha_1 + \alpha_2 = 1$ 0.336	0.272	0.261	2.064
	(2)		0.194* (0.108)	0.806*** (0.108)		$\alpha_1 = 0.25$ 0.273	0.269	0.269	2.057
	(3)	1.106*** (0.258)	0.127 (0.141)	0.498*** (0.106)			0.420	0.402	1.850
	(4)		0.158* (0.090)	0.727*** (0.101)	0.106** (0.041)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 0.392	0.298	0.275	1.933
	(5)	1.963*** (0.250)	-0.015 (0.084)	-0.006 (0.105)	0.358*** (0.073)		0.619	0.601	1.539
A5564	**(1)**		0.261* (0.135)	0.726*** (0.157)		$\alpha_1 + \alpha_2 = 1$ 0.253	0.110	0.096	2.059
	(2)		0.259** (0.105)	0.741*** (0.105)		$\alpha_1 = 0.25$ 0.007	0.105	0.105	2.080
	(3)	1.231*** (0.123)	0.130 (0.147)	0.435** (0.177)			0.254	0.231	1.847
	(4)		0.172 (0.107)	0.635*** (0.101)	0.174 (0.109)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$	0.169	0.143	1.899
	(5)	1.946*** (0.328)	-0.130 (0.124)	0.077 (0.054)	0.361*** (0.079)		0.461	0.435	1.670
A6597	**(1)**		0.383** (0.153)	0.606*** (0.202)		$\alpha_1 + \alpha_2 = 1$ 0.042	-0.007	-0.022	2.252
	(2)		0.387*** (0.118)	0.613*** (0.118)		$\alpha_1 = 0.25$ 1.364	-0.011	-0.011	2.260
	(3)	1.486*** (0.260)	0.225* (0.122)	0.264* (0.144)			0.206	0.181	1.923
	(4)		0.291** (0.120)	0.521*** (0.100)	0.174** (0.083)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 0.266	0.055	0.025	2.055
	(5)	2.238*** (0.410)	-0.058 (0.129)	-0.096 (0.112)	0.382*** (0.079)		0.448	0.422	1.626

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.15. Epidemiological Tests – Age Disaggregated Michigan Survey Forecasts – Volatile Sample Periods

Testing Equation:

$$E_{H,t}[\pi_{t+h}] = \alpha_0 + \alpha_1 E_{P,t}[\pi_{t+h}] + \alpha_2 E_{H,t-1}[\pi_{t+h-1}] + \alpha_3 \pi_t + \epsilon_t$$

		α_0	α_1	α_2	α_3	Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
Period: Volatile 2006Q3 – 2011Q1									
A1834	(1)		0.848*** (0.131)	0.407*** (0.101)		$\alpha_1 + \alpha_2 = 1$ 15.816***	0.330	0.291	1.715
	(2)		0.175 (0.132)	0.825*** (0.132)		$\alpha_1 = 0.25$ 0.321	0.120	0.120	1.850
	(3)	-0.006 (1.303)	0.851 (0.710)	0.407*** (0.073)			0.330	0.247	1.715
	(4)		0.789*** (0.140)	0.348*** (0.086)	0.143** (0.051)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 9.910***	0.434	0.363	1.786
	(5)	1.543* (0.811)	0.084 (0.312)	0.310*** (0.069)	0.196*** (0.051)		0.473	0.368	1.830
A3544	(1)		0.865*** (0.175)	0.394** (0.155)		$\alpha_1 + \alpha_2 = 1$ 53.973***	0.452	0.420	1.362
	(2)		0.204 (0.191)	0.796*** (0.191)		$\alpha_1 = 0.25$ 0.058	0.284	0.284	1.461
	(3)	-1.173 (1.397)	1.456* (0.787)	0.355 (0.247)			0.475	0.409	1.357
	(4)		0.973*** (0.101)	0.146** (0.060)	0.246*** (0.067)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 25.723***	0.655	0.612	1.285
	(5)	0.610 (0.696)	0.675* (0.376)	0.146*** (0.039)	0.266*** (0.075)		0.660	0.592	1.353
A4554	(1)		0.934*** (0.173)	0.373** (0.157)		$\alpha_1 + \alpha_2 = 1$ 56.363***	0.341	0.303	1.477
	(2)		0.175 (0.185)	0.825*** (0.185)		$\alpha_1 = 0.25$ 0.163	0.139	0.139	1.638
	(3)	-0.199 (1.688)	1.031 (0.948)	0.369* (0.176)			0.342	0.260	1.477
	(4)		1.134*** (0.177)	0.070 (0.123)	0.253** (0.096)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 13.961***	0.538	0.480	1.379
	(5)	2.092** (0.885)	0.180 (0.399)	0.015 (0.086)	0.334*** (0.078)		0.593	0.512	1.601
A5564	(1)		0.949*** (0.290)	0.359 (0.222)		$\alpha_1 + \alpha_2 = 1$ 12.224***	0.333	0.294	1.270
	(2)		0.185 (0.145)	0.815*** (0.145)		$\alpha_1 = 0.25$ 0.200	0.105	0.105	1.508
	(3)	-0.108 (1.538)	1.000 (0.862)	0.358** (0.141)			0.333	0.250	1.262
	(4)		1.044*** (0.265)	0.155 (0.174)	0.209*** (0.059)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 8.104***	0.503	0.441	1.220
	(5)	2.073* (1.174)	0.118 (0.632)	0.087 (0.103)	0.289*** (0.049)		0.564	0.477	1.657
A6597	(1)		0.965*** (0.225)	0.387** (0.139)		$\alpha_1 + \alpha_2 = 1$ 12.711***	0.261	0.217	1.348
	(2)		0.082 (0.159)	0.918*** (0.159)		$\alpha_1 = 0.25$ 1.116	0.004	0.004	1.536
	(3)	0.483 (1.090)	0.763 (0.639)	0.374** (0.142)			0.266	0.174	1.357
	(4)		0.936** (0.333)	0.310 (0.209)	0.147*** (0.050)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 5.671**	0.378	0.300	1.244
	(5)	2.433** (0.859)	-0.097 (0.445)	0.202** (0.088)	0.235*** (0.052)		0.476	0.371	1.487

Appendix 5.16. Epidemiological Tests – Education Disaggregated Michigan Survey Forecasts – Whole Sample Period

Testing Equation:

$$E_{H,t}[\pi_{t+h}] = \alpha_0 + \alpha_1 E_{P,t}[\pi_{t+h}] + \alpha_2 E_{H,t-1}[\pi_{t+h-1}] + \alpha_3 \pi_t + \epsilon_t$$

		α_0	α_1	α_2		Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
				Period: Whole 1982Q3 – 2011Q1					
ELHS	(1)		0.152***	0.845***		$\alpha_1 + \alpha_2 = 1$	0.066	0.058	2.450
			(0.047)	(0.047)		0.051			
	(2)		0.155***	0.845***		$\alpha_1 = 0.25$	0.066	0.066	2.451
			(0.047)	(0.047)		4.158**			
	(3)	1.779***	-0.005	0.494***			0.241	0.228	2.089
		(0.359)	(0.057)	(0.097)					
	(4)		0.069	0.804***	0.135*	$\alpha_1 + \alpha_2 + \alpha_3 = 1$	0.096	0.080	2.381
			(0.062)	(0.045)	(0.075)	0.266			
	(5)	2.139***	-0.184**	0.350***	0.242**		0.331	0.312	1.956
		(0.345)	(0.090)	(0.086)	(0.106)				
EHSD	(1)		0.097**	0.890***		$\alpha_1 + \alpha_2 = 1$	0.105	0.097	2.371
			(0.041)	(0.047)		0.938			
	(2)		0.097**	0.903***		$\alpha_1 = 0.25$	0.099	0.099	2.386
			(0.043)	(0.043)		12.549***			
	(3)	1.436***	0.040	0.512***			0.286	0.274	2.035
		(0.182)	(0.044)	(0.074)					
	(4)		0.040	0.849***	0.104***	$\alpha_1 + \alpha_2 + \alpha_3 = 1$	0.137	0.122	2.315
			(0.037)	(0.036)	(0.033)				
	(5)	1.785***	-0.082	0.342***	0.197***		0.392	0.375	1.907
		(0.186)	(0.053)	(0.062)	(0.062)				
ESC	(1)		0.129***	0.849***		$\alpha_1 + \alpha_2 = 1$	0.207	0.200	2.281
			(0.043)	(0.054)		2.544			
	(2)		0.122***	0.878***		$\alpha_1 = 0.25$	0.195	0.195	2.313
			(0.037)	(0.037)		12.029***			
	(3)	1.227***	0.077	0.523***			0.354	0.343	1.999
		(0.278)	(0.055)	(0.120)					
	(4)		0.077	0.798***	0.107*	$\alpha_1 + \alpha_2 + \alpha_3 = 1$	0.235	0.221	2.214
			(0.049)	(0.051)	(0.057)	1.691			
	(5)	1.517***	-0.031	0.351***	0.199***		0.440	0.425	1.860
		(0.190)	(0.064)	(0.120)	(0.048)				
ECD	(1)		0.366***	0.577***		$\alpha_1 + \alpha_2 = 1$	0.230	0.224	2.160
			(0.088)	(0.113)		3.922**			
	(2)		0.319***	0.681***		$\alpha_1 = 0.25$	0.177	0.177	2.277
			(0.075)	(0.075)		0.827			
	(3)	1.251***	0.302***	0.253*			0.395	0.384	1.928
		(0.214)	(0.084)	(0.134)					
	(4)		0.269***	0.396**	0.283***	$\alpha_1 + \alpha_2 + \alpha_3 = 1$	0.350	0.339	1.900
			(0.097)	(0.171)	(0.089)	2.156			
	(5)	1.511***	0.164	-0.044	0.360***		0.581	0.570	1.735
		(0.291)	(0.122)	(0.155)	(0.057)				
EGS	(1)		0.409***	0.560***		$\alpha_1 + \alpha_2 = 1$	0.552	0.548	1.986
			(0.110)	(0.124)		2.501			
	(2)		0.397***	0.603***		$\alpha_1 = 0.25$	0.538	0.538	2.020
			(0.103)	(0.103)		2.020			
	(3)	0.766***	0.369***	0.375***			0.606	0.599	1.864
		(0.130)	(0.118)	(0.121)					
	(4)		0.357***	0.367***	0.257***	$\alpha_1 + \alpha_2 + \alpha_3 = 1$	0.621	0.614	1.744
			(0.084)	(0.083)	(0.057)	0.773			
	(5)	0.878***	0.306***	0.132*	0.287***		0.692	0.683	1.661
		(0.227)	(0.094)	(0.069)	(0.066)				

Appendix 5.17. Epidemiological Tests – Education Disaggregated Michigan Survey Forecasts – Greenspan-Bernanke Sample Period

Testing Equation:

$$E_{H,t}[\pi_{t+h}] = \alpha_0 + \alpha_1 E_{P,t}[\pi_{t+h}] + \alpha_2 E_{H,t-1}[\pi_{t+h-1}] + \alpha_3 \pi_t + \epsilon_t$$

		α_0	α_1	α_2		Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
Period: Greenspan-Bernanke 1987Q2 – 2011Q1									
ELHS	**(1)**		0.234*** (0.062)	0.794*** (0.058)		$\alpha_1 + \alpha_2 = 1$ 2.994*	0.076	0.066	2.472
	(2)		0.188*** (0.058)	0.812*** (0.058)		$\alpha_1 = 0.25$ 1.158	0.063	0.063	2.487
	(3)	1.725*** (0.374)	0.042 (0.076)	0.480*** (0.106)			0.234	0.217	2.136
	(4)		0.159* (0.093)	0.775*** (0.051)	0.098 (0.084)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 2.331	0.091	0.071	2.423
	(5)	2.145*** (0.404)	-0.180 (0.149)	0.358*** (0.094)	0.229* (0.133)		0.307	0.285	1.986
EHSD	**(1)**		0.149*** (0.050)	0.857*** (0.053)		$\alpha_1 + \alpha_2 = 1$ 0.314	0.122	0.113	2.294
	(2)		0.142** (0.061)	0.858*** (0.061)		$\alpha_1 = 0.25$ 3.099*	0.121	0.121	2.293
	(3)	1.386*** (0.208)	0.068 (0.064)	0.508*** (0.089)			0.275	0.259	1.965
	(4)		0.087* (0.048)	0.836*** (0.039)	0.085** (0.033)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 0.348	0.143	0.125	2.253
	(5)	1.867*** (0.200)	-0.108 (0.080)	0.335** (0.139)	0.203*** (0.057)		0.379	0.359	1.821
ESC	**(1)**		0.142*** (0.051)	0.858*** (0.056)		$\alpha_1 + \alpha_2 = 1$ 0.001	0.383	0.376	2.058
	(2)		0.142** (0.054)	0.858*** (0.054)		$\alpha_1 = 0.25$ 3.946**	0.383	0.383	2.058
	(3)	0.905*** (0.219)	0.081 (0.057)	0.631*** (0.097)			0.458	0.446	1.861
	(4)		0.087* (0.052)	0.828*** (0.034)	0.085 (0.053)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 0.000	0.401	0.388	2.016
	(5)	1.304*** (0.161)	-0.067 (0.066)	0.465*** (0.066)	0.187*** (0.054)		0.531	0.515	1.723
ECD	**(1)**		0.343*** (0.103)	0.634*** (0.115)		$\alpha_1 + \alpha_2 = 1$ 1.023	0.273	0.265	1.960
	(2)		0.342*** (0.108)	0.658*** (0.108)		$\alpha_1 = 0.25$ 0.725	0.264	0.264	1.984
	(3)	1.012*** (0.167)	0.246*** (0.093)	0.399*** (0.111)			0.376	0.363	1.818
	(4)		0.236*** (0.065)	0.511*** (0.083)	0.225*** (0.049)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$	0.357	0.343	1.753
	(5)	1.595*** (0.306)	0.011 (0.086)	0.057 (0.062)	0.376*** (0.054)		0.575	0.561	1.634
EGS	**(1)**		0.460*** (0.123)	0.530*** (0.136)		$\alpha_1 + \alpha_2 = 1$ 0.163	0.455	0.449	1.912
	(2)		0.466*** (0.121)	0.534*** (0.121)		$\alpha_1 = 0.25$ 3.203*	0.454	0.454	1.914
	(3)	0.740*** (0.157)	0.370*** (0.114)	0.387*** (0.107)			0.506	0.496	1.828
	(4)		0.368*** (0.091)	0.351*** (0.080)	0.271*** (0.067)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$	0.540	0.530	1.712
	(5)	1.135*** (0.242)	0.196** (0.094)	0.065 (0.042)	0.370*** (0.052)		0.649	0.638	1.696

Appendix 5.18. Epidemiological Tests – Education Disaggregated Michigan Survey Forecasts – Stable Sample Period

Testing Equation:

$$E_{H,t}[\pi_{t+h}] = \alpha_0 + \alpha_1 E_{P,t}[\pi_{t+h}] + \alpha_2 E_{H,t-1}[\pi_{t+h-1}] + \alpha_3 \pi_t + \epsilon_t$$

		α_0	α_1	α_2		Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
				Period: Stable 1990Q1 – 2006Q2					
ELHS	(1)		0.345	0.699***		$\alpha_1 + \alpha_2 = 1$	0.057	0.043	2.507
			(0.290)	(0.262)		1.283			
	(2)		0.248	0.752***		$\alpha_1 = 0.25$	0.029	0.029	2.576
			(0.192)	(0.192)		0.000			
	(3)	1.684***	0.086	0.438**			0.201	0.175	2.194
		(0.492)	(0.145)	(0.176)					
	(4)		0.199	0.636***	0.216*	$\alpha_1 + \alpha_2 + \alpha_3 = 1$	0.106	0.078	2.371
			(0.145)	(0.100)	(0.128)	2.146			
	(5)	2.257***	-0.258	0.237*	0.379***		0.335	0.303	1.921
		(0.495)	(0.176)	(0.123)	(0.114)				
EHSD	(1)		0.270***	0.737***		$\alpha_1 + \alpha_2 = 1$	0.043	0.028	2.339
			(0.099)	(0.100)		0.192			
	(2)		0.260**	0.740***		$\alpha_1 = 0.25$	0.041	0.041	2.344
			(0.102)	(0.102)		0.010			
	(3)	1.473***	0.167	0.362***			0.245	0.221	1.968
		(0.337)	(0.112)	(0.107)					
	(4)		0.201**	0.673***	0.133**	$\alpha_1 + \alpha_2 + \alpha_3 = 1$	0.088	0.059	2.216
			(0.092)	(0.071)	(0.050)	0.153			
	(5)	2.530***	-0.108	-0.094	0.388***		0.520	0.497	1.820
		(0.231)	(0.084)	(0.084)	(0.072)				
ESC	(1)		0.234*	0.760***		$\alpha_1 + \alpha_2 = 1$	0.345	0.335	2.069
			(0.125)	(0.133)		0.176			
	(2)		0.238*	0.762***		$\alpha_1 = 0.25$	0.344	0.344	2.070
			(0.128)	(0.128)		0.009			
	(3)	0.926***	0.149	0.536***			0.435	0.417	1.908
		(0.193)	(0.098)	(0.059)					
	(4)		0.193*	0.630***	0.168***	$\alpha_1 + \alpha_2 + \alpha_3 = 1$	0.390	0.370	1.856
			(0.099)	(0.114)	(0.059)	0.250			
	(5)	1.688***	-0.015	0.053	0.388***		0.612	0.593	1.522
		(0.338)	(0.098)	(0.145)	(0.112)				
ECD	(1)		0.474***	0.494**		$\alpha_1 + \alpha_2 = 1$	0.380	0.370	1.929
			(0.171)	(0.193)		0.943			
	(2)		0.453***	0.547***		$\alpha_1 = 0.25$	0.356	0.356	1.974
			(0.162)	(0.162)		1.586			
	(3)	0.796***	0.361**	0.337***			0.449	0.431	1.851
		(0.197)	(0.139)	(0.106)					
	(4)		0.406***	0.293*	0.256***	$\alpha_1 + \alpha_2 + \alpha_3 = 1$	0.469	0.452	1.632
			(0.144)	(0.148)	(0.079)				
	(5)	1.225***	0.201**	-0.038	0.370***		0.615	0.597	1.625
		(0.287)	(0.094)	(0.089)	(0.064)				
EGS	(1)		0.405**	0.582***		$\alpha_1 + \alpha_2 = 1$	0.477	0.469	1.894
			(0.185)	(0.203)		0.295			
	(2)		0.405**	0.595***		$\alpha_1 = 0.25$	0.474	0.474	1.908
			(0.155)	(0.155)		1.002			
	(3)	0.596	0.303	0.484*			0.511	0.496	1.833
		(0.490)	(0.401)	(0.277)					
	(4)		0.370***	0.275	0.331***	$\alpha_1 + \alpha_2 + \alpha_3 = 1$	0.578	0.564	1.528
			(0.126)	(0.167)	(0.095)	0.940			
	(5)	1.092	0.170	-0.020	0.454***		0.678	0.662	1.488
		(0.286)	(0.123)	(0.069)	(0.077)				

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.19. Epidemiological Tests – Education Disaggregated Michigan Survey Forecasts – Volatile Sample Period

Testing Equation:

$$E_{H,t}[\pi_{t+h}] = \alpha_0 + \alpha_1 E_{P,t}[\pi_{t+h}] + \alpha_2 E_{H,t-1}[\pi_{t+h-1}] + \alpha_3 \pi_t + \epsilon_t$$

		α_0	α_1	α_2		Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
Period: Volatile 2006Q3 – 2011Q1									
ELHS	(1)		1.157*** (0.361)	0.349* (0.194)		$\alpha_1 + \alpha_2 = 1$ 7.845***	0.165	0.116	1.518
	(2)		0.130 (0.116)	0.870*** (0.116)		$\alpha_1 = 0.25$ 1.078	-0.173	-0.173	1.918
	(3)	1.042 (1.780)	0.734 (0.898)	0.319 (0.185)			0.182	0.079	1.542
	(4)		1.138*** (0.378)	0.313 (0.215)	0.084 (0.176)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 6.428**	0.190	0.089	1.478
	(5)	2.726 (2.873)	0.008 (1.233)	0.190 (0.200)	0.188 (0.321)		0.265	0.118	1.588
EHSD	(1)		1.027*** (0.336)	0.373** (0.174)		$\alpha_1 + \alpha_2 = 1$ 5.974**	0.186	0.139	1.554
	(2)		0.060 (0.114)	0.940*** (0.114)		2.754*	-0.073	-0.073	1.844
	(3)	0.953 (1.132)	0.645 (0.684)	0.341** (0.134)			0.209	0.110	1.551
	(4)		1.038** (0.453)	0.284 (0.276)	0.134** (0.057)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 4.144**	0.288	0.198	1.498
	(5)	3.140** (1.461)	-0.214 (0.568)	0.096 (0.188)	0.253** (0.111)		0.450	0.340	1.730
ESC	(1)		0.753*** (0.167)	0.514*** (0.105)		$\alpha_1 + \alpha_2 = 1$ 12.729***	0.380	0.344	1.275
	(2)		0.100 (0.146)	0.900*** (0.146)		$\alpha_1 = 0.25$ 1.062	0.224	0.224	1.429
	(3)	0.350 (1.348)	0.603 (0.802)	0.508*** (0.152)			0.383	0.306	1.276
	(4)		0.776*** (0.209)	0.422** (0.153)	0.120 (0.083)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 6.082**	0.454	0.385	1.270
	(5)	1.995* (0.990)	-0.062 (0.459)	0.325*** (0.087)	0.197** (0.077)		0.517	0.421	1.437
ECD	(1)		1.055*** (0.106)	0.217* (0.118)		$\alpha_1 + \alpha_2 = 1$ 83.171***	0.259	0.216	1.643
	(2)		0.420 (0.275)	0.580** (0.275)		$\alpha_1 = 0.25$ 0.382	0.037	0.037	1.754
	(3)	-1.366 (2.097)	1.733 (1.042)	0.176 (0.112)			0.281	0.191	1.615
	(4)		1.168*** (0.201)	-0.172 (0.135)	0.404*** (0.048)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 20.095***	0.616	0.568	1.738
	(5)	1.537 (0.936)	0.420 (0.509)	-0.177 (0.123)	0.456*** (0.039)		0.638	0.566	2.032
EGS	(1)		1.069*** (0.127)	0.188 (0.137)		$\alpha_1 + \alpha_2 = 1$ 72.029***	0.331	0.291	1.653
	(2)		0.483 (0.280)	0.517* (0.280)		$\alpha_1 = 0.25$ 0.695	0.138	0.138	1.775
	(3)	0.596 (0.490)	0.303 (0.401)	0.484* (0.277)			0.511	0.496	1.833
	(4)		1.152*** (0.114)	-0.162* (0.077)	0.383*** (0.052)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 62.810***	0.638	0.593	2.048
	(5)	-0.849 (0.886)	1.583*** (0.487)	-0.177** (0.081)	0.359*** (0.055)		0.645	0.573	1.951

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.20. Epidemiological Tests – Gender Disaggregated Michigan Survey Forecasts – Whole Sample Period

Testing Equation:

$$E_{H,t}[\pi_{t+h}] = \alpha_0 + \alpha_1 E_{P,t}[\pi_{t+h}] + \alpha_2 E_{H,t-1}[\pi_{t+h-1}] + \alpha_3 \pi_t + \epsilon_t$$

		α_0	α_1	α_2		Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
				Period: Whole 1982.3 – 2011.1					
MALE	(1)		0.167*** (0.056)	0.798*** (0.068)		$\alpha_1 + \alpha_2 = 1$ 4.745**	0.206	0.199	2.034
	(2)		0.133** (0.065)	0.867*** (0.065)		$\alpha_1 = 0.25$ 3.230*	0.176	0.176	2.104
	(3)	1.200*** (0.175)	0.137*** (0.049)	0.436*** (0.099)			0.369	0.358	1.780
	(4)		0.106** (0.052)	0.709*** (0.043)	0.149*** (0.045)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 6.147**	0.262	0.249	1.888
	(5)	1.639*** (0.232)	0.017 (0.072)	0.143*** (0.039)	0.270*** (0.046)		0.529	0.516	1.604
FEMALE	(1)		0.133** (0.054)	0.858*** (0.064)		$\alpha_1 + \alpha_2 = 1$ 0.483	0.352	0.346	2.273
	(2)		0.136*** (0.048)	0.864*** (0.048)		$\alpha_1 = 0.25$ 5.666**	0.350	0.350	1.520
	(3)	1.103*** (0.0272)	0.114* (0.061)	0.557*** (0.118)			0.458	0.448	1.994
	(4)		0.082 (0.050)	0.797*** (0.059)	0.121** (0.049)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 0.000	0.383	0.372	2.195
	(5)	1.462*** (0.282)	0.016 (0.063)	0.347* (0.198)	0.220*** (0.071)		0.548	0.536	1.831

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.21. Epidemiological Tests – Gender Disaggregated Michigan Survey Forecasts – Greenspan-Bernanke Sample Period

Testing Equation:

$$E_{H,t}[\pi_{t+h}] = \alpha_0 + \alpha_1 E_{P,t}[\pi_{t+h}] + \alpha_2 E_{H,t-1}[\pi_{t+h-1}] + \alpha_3 \pi_t + \epsilon_t$$

		α_0	α_1	α_2		Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
				Period: Greenspan-Bernanke 1987Q2 – 2011Q1					
MALE	(1)		0.226*** (0.071)	0.756*** (0.079)		$\alpha_1 + \alpha_2 = 1$ 1.222	0.238	0.230	1.980
	(2)		0.222** (0.101)	0.778*** (0.101)		$\alpha_1 = 0.25$ 0.076	0.230	0.230	2.002
	(3)	1.080*** (0.158)	0.157** (0.062)	0.464*** (0.091)			0.364	0.351	1.786
	(4)		0.156** (0.072)	0.694*** (0.057)	0.128** (0.054)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 1.841	0.278	0.263	1.868
	(5)	1.699*** (0.297)	-0.039 (0.087)	0.157*** (0.050)	0.289*** (0.057)		0.527	0.512	1.609
FEMALE	(1)		0.138** (0.066)	0.873*** (0.067)		$\alpha_1 + \alpha_2 = 1$ 1.344	0.519	0.513	1.817
	(2)		0.119* (0.069)	0.881*** (0.069)		$\alpha_1 = 0.25$ 3.623*	0.516	0.516	1.822
	(3)	0.731*** (0.163)	0.107 (0.065)	0.685*** (0.085)			0.563	0.554	1.684
	(4)		0.081 (0.064)	0.837*** (0.052)	0.095** (0.042)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 1.492	0.538	0.528	1.752
	(5)	1.130*** (0.158)	-0.020 (0.072)	0.511*** (0.100)	0.187*** (0.046)		0.626	0.614	1.539

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.22. Epidemiological Tests – Gender Disaggregated Michigan Survey Forecasts – Stable Sample Period

Testing Equation:

$$E_{H,t}[\pi_{t+h}] = \alpha_0 + \alpha_1 E_{P,t}[\pi_{t+h}] + \alpha_2 E_{H,t-1}[\pi_{t+h-1}] + \alpha_3 \pi_t + \epsilon_t$$

		α_0	α_1	α_2	α_3	Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
Period: Stable 1990Q1 – 2006Q2									
MALE	(1)		0.267 (0.189)	0.713*** (0.209)		$\alpha_1 + \alpha_2 = 1$ 0.750	0.356	0.346	2.079
	(2)		0.247* (0.136)	0.753*** (0.136)		$\alpha_1 = 0.25$ 0.001	0.342	0.342	2.126
	(3)	0.878*** (0.172)	0.201 (0.173)	0.474*** (0.172)			0.448	0.431	1.896
	(4)		0.225* (0.131)	0.587*** (0.157)	0.158*** (0.040)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 1.774	0.405	0.386	1.846
	(5)	1.560*** (0.226)	0.059 (0.094)	0.013 (0.125)	0.346*** (0.071)		0.628	0.610	1.505
FEMALE	(1)		0.248 (0.153)	0.765*** (0.149)		$\alpha_1 + \alpha_2 = 1$ 0.782	0.489	0.481	2.002
	(2)		0.215 (0.150)	0.785*** (0.150)		$\alpha_1 = 0.25$ 0.054	0.485	0.485	2.035
	(3)	0.800*** (0.270)	0.207 (0.133)	0.554*** (0.150)			0.552	0.537	1.835
	(4)		0.224* (0.130)	0.630*** (0.150)	0.164** (0.070)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 0.430	0.531	0.516	1.793
	(5)	1.765*** (0.074)	0.098* (0.058)	-0.044 (0.066)	0.420*** (0.042)		0.733	0.720	1.597

Appendix 5.23. Epidemiological Tests – Gender Disaggregated Michigan Survey Forecasts – Volatile Sample Period

Testing Equation:

$$E_{H,t}[\pi_{t+h}] = \alpha_0 + \alpha_1 E_{P,t}[\pi_{t+h}] + \alpha_2 E_{H,t-1}[\pi_{t+h-1}] + \alpha_3 \pi_t + \epsilon_t$$

		α_0	α_1	α_2	α_3	Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
Period: Volatile 2006Q3 – 2011Q1									
MALE	(1)		1.042*** (0.109)	0.239** (0.105)		$\alpha_1 + \alpha_2 = 1$ 82.634***	0.286	0.244	1.596
	(2)		0.342 (0.225)	0.658*** (0.225)		$\alpha_1 = 0.25$ 0.167	0.040	0.040	1.700
	(3)	-0.844 (1.623)	1.451* (0.806)	0.222*** (0.064)			0.297	0.209	1.586
	(4)		1.176*** (0.144)	-0.071 (0.093)	0.290*** (0.073)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 23.123***	0.526	0.466	1.634
	(5)	1.534 (0.909)	0.460 (0.490)	-0.101 (0.072)	0.348*** (0.068)		0.553	0.464	1.854
FEMALE	(1)		0.782** (0.312)	0.519** (0.210)		$\alpha_1 + \alpha_2 = 1$ 6.636**	0.396	0.361	1.029
	(2)		0.056 (0.105)	0.944*** (0.105)		$\alpha_1 = 0.25$ 3.391*	0.254	0.254	1.217
	(3)	0.166 (1.417)	0.707 (0.751)	0.518** (0.214)			0.397	0.321	1.040
	(4)		0.821*** (0.199)	0.397*** (0.125)	0.156** (0.061)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 10.082	0.505	0.443	0.945
	(5)	1.959 (1.252)	-0.038 (0.551)	0.329*** (0.097)	0.228*** (0.064)		0.563	0.475	1.268

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.24. Epidemiological Tests – Income Disaggregated Michigan Survey Forecasts – Whole Sample Period

Testing Equation:

$$E_{H,t}[\pi_{t+h}] = \alpha_0 + \alpha_1 E_{P,t}[\pi_{t+h}] + \alpha_2 E_{H,t-1}[\pi_{t+h-1}] + \alpha_3 \pi_t + \epsilon_t$$

		α_0	α_1	α_2		Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
				Period: Whole 1982Q3 – 2011Q1					
Y14	(1)		0.108** (0.045)	0.890*** (0.044)		$\alpha_1 + \alpha_2 = 1$ 0.034	0.249	0.243	2.654
	(2)		0.110** (0.044)	0.890*** (0.044)		$\alpha_1 = 0.25$ 10.170***	0.249	0.249	2.654
	(3)	1.339*** (0.362)	0.030 (0.050)	0.595*** (0.112)			0.370	0.359	2.320
	(4)		0.051 (0.046)	0.851*** (0.045)	0.106** (0.048)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 0.373	0.271	0.258	2.603
	(5)	1.690*** (0.316)	-0.101 (0.062)	0.444*** (0.104)	0.206*** (0.066)		0.444	0.429	2.184
Y24	(1)		0.142*** (0.038)	0.843*** (0.046)		$\alpha_1 + \alpha_2 = 1$ 1.261	0.203	0.196	2.228
	(2)		0.142*** (0.046)	0.858*** (0.046)		$\alpha_1 = 0.25$ 5.352**	0.196	0.196	2.243
	(3)	1.288*** (0.227)	0.096* (0.053)	0.503*** (0.094)			0.354	0.342	1.946
	(4)		0.064 (0.039)	0.766*** (0.035)	0.164*** (0.041)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 0.164	0.264	0.251	2.110
	(5)	1.683*** (0.217)	-0.044 (0.071)	0.275*** (0.091)	0.265*** (0.040)		0.499	0.486	1.771
Y34	(1)		0.175*** (0.057)	0.791*** (0.072)		$\alpha_1 + \alpha_2 = 1$ 3.693*	0.186	0.179	2.242
	(2)		0.150*** (0.056)	0.850*** (0.056)		$\alpha_1 = 0.25$ 3.212*	0.157	0.157	2.309
	(3)	1.256*** (0.278)	0.136** (0.057)	0.430*** (0.138)			0.359	0.348	1.956
	(4)		0.114** (0.051)	0.713*** (0.077)	0.141** (0.060)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 2.825*	0.234	0.220	2.149
	(5)	1.593*** (0.138)	0.022 (0.062)	0.199* (0.105)	0.242*** (0.038)		0.488	0.475	1.817
Y44	(1)		0.325*** (0.097)	0.610*** (0.121)		$\alpha_1 + \alpha_2 = 1$ 4.995**	0.313	0.307	1.858
	(2)		0.247*** (0.094)	0.753*** (0.094)		$\alpha_1 = 0.25$ 0.001	0.252	0.252	1.989
	(3)	1.031*** (0.161)	0.268*** (0.059)	0.334*** (0.066)			0.431	0.421	1.717
	(4)		0.255*** (0.077)	0.441*** (0.069)	0.234*** (0.064)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 5.573**	0.393	0.383	1.622
	(5)	1.310*** (0.209)	0.157** (0.063)	0.028 (0.060)	0.319*** (0.076)		0.573	0.561	1.568

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.25. Epidemiological Tests – Income Disaggregated Michigan Survey Forecasts – Greenspan-Bernanke Sample Period

Testing Equation:

$$E_{H,t}[\pi_{t+h}] = \alpha_0 + \alpha_1 E_{P,t}[\pi_{t+h}] + \alpha_2 E_{H,t-1}[\pi_{t+h-1}] + \alpha_3 \pi_t + \epsilon_t$$

		α_0	α_1	α_2		Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
Period: Greenspan-Bernanke 1987Q2 – 2011Q1									
Y14	(1)		0.167*** (0.058)	0.856*** (0.054)		$\alpha_1 + \alpha_2 = 1$ 3.747*	0.315	0.308	2.657
	(2)		0.123** (0.049)	0.876*** (0.049)		$\alpha_1 = 0.25$ 6.598**	0.306	0.306	2.682
	(3)	1.175*** (0.363)	0.067 (0.070)	0.618*** (0.112)			0.400	0.387	2.357
	(4)		0.102* (0.059)	0.834*** (0.051)	0.091* (0.052)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 3.838*	0.331	0.316	2.615
	(5)	1.595*** (0.389)	-0.112 (0.101)	0.484*** (0.107)	0.201** (0.077)		0.464	0.446	2.202
Y24	(1)		0.179*** (0.044)	0.828*** (0.050)		$\alpha_1 + \alpha_2 = 1$ 0.311	0.286	0.279	2.064
	(2)		0.171** (0.067)	0.829*** (0.067)		$\alpha_1 = 0.25$ 1.375	0.285	0.285	2.063
	(3)	1.098*** (0.228)	0.109 (0.070)	0.558*** (0.096)			0.389	0.376	1.849
	(4)		0.088* (0.046)	0.782*** (0.025)	0.139*** (0.041)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 0.312	0.331	0.317	1.969
	(5)	1.635*** (0.268)	-0.095 (0.084)	0.340*** (0.058)	0.261*** (0.042)		0.524	0.509	1.658
Y34	(1)		0.169** (0.073)	0.821*** (0.081)		$\alpha_1 + \alpha_2 = 1$ 0.527	0.338	0.331	1.931
	(2)		0.170** (0.085)	0.830*** (0.085)		$\alpha_1 = 0.25$ 0.870	0.335	0.335	1.940
	(3)	0.939*** (0.185)	0.114** (0.056)	0.567*** (0.100)			0.429	0.417	1.754
	(4)		0.108 (0.068)	0.773*** (0.060)	0.108* (0.055)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 0.847	0.368	0.354	1.873
	(5)	1.471*** (0.126)	-0.055 (0.061)	0.318*** (0.088)	0.239*** (0.050)		0.548	0.533	1.628
Y44	(1)		0.386*** (0.128)	0.573*** (0.148)		$\alpha_1 + \alpha_2 = 1$ 2.434	0.325	0.318	1.801
	(2)		0.362*** (0.123)	0.638*** (0.123)		$\alpha_1 = 0.25$ 0.829	0.298	0.298	1.849
	(3)	0.876*** (0.129)	0.283*** (0.076)	0.383*** (0.075)			0.406	0.394	1.731
	(4)		0.309*** (0.102)	0.434*** (0.085)	0.204** (0.084)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 4.934**	0.383	0.379	1.591
	(5)	1.358*** (0.323)	0.097 (0.085)	0.042 (0.092)	0.347*** (0.085)		0.550	0.535	1.554

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.26. Epidemiological Tests – Income Disaggregated Michigan Survey Forecasts – Stable Sample Period

Testing Equation:

$$E_{H,t}[\pi_{t+h}] = \alpha_0 + \alpha_1 E_{P,t}[\pi_{t+h}] + \alpha_2 E_{H,t-1}[\pi_{t+h-1}] + \alpha_3 \pi_t + \epsilon_t$$

		α_0	α_1	α_2		Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
Period: Stable 1990Q1 – 2006Q2									
Y14	(1)		0.293*** (0.073)	0.741*** (0.066)		$\alpha_1 + \alpha_2 = 1$ 3.338*	0.125	0.112	2.457
	(2)		0.199*** (0.066)	0.801*** (0.066)		$\alpha_1 = 0.25$ 0.584	0.101	0.101	2.555
	(3)	1.444*** (0.511)	0.157* (0.094)	0.439*** (0.113)			0.274	0.251	2.124
	(4)		0.207*** (0.072)	0.636*** (0.146)	0.203 (0.167)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 1.916	0.184	0.158	2.250
	(5)	2.664*** (0.475)	-0.177 (0.132)	-0.083 (0.114)	0.517*** (0.103)		0.548	0.526	1.684
Y24	(1)		0.217* (0.110)	0.789*** (0.113)		$\alpha_1 + \alpha_2 = 1$ 0.182	0.313	0.303	1.959
	(2)		0.208* (0.116)	0.792*** (0.116)		$\alpha_1 = 0.25$ 0.132	0.312	0.312	1.962
	(3)	1.008*** (0.304)	0.166 (0.163)	0.513*** (0.104)			0.411	0.392	1.744
	(4)		0.158* (0.082)	0.678*** (0.080)	0.171*** (0.047)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 0.210	0.374	0.354	1.793
	(5)	2.109*** (0.157)	-0.038 (0.075)	-0.063 (0.046)	0.424*** (0.037)		0.667	0.651	1.572
Y34	(1)		0.302 (0.185)	0.682*** (0.198)		$\alpha_1 + \alpha_2 = 1$ 0.645	0.385	0.375	2.087
	(2)		0.297* (0.161)	0.703*** (0.161)		$\alpha_1 = 0.25$ 0.087	0.377	0.377	2.106
	(3)	0.831*** (0.299)	0.221 (0.153)	0.481*** (0.159)			0.462	0.445	1.929
	(4)		0.269* (0.138)	0.531*** (0.187)	0.177*** (0.064)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 1.225	0.433	0.415	1.878
	(5)	1.544*** (0.176)	0.078 (0.084)	-0.021 (0.116)	0.386*** (0.069)		0.632	0.614	1.632
Y44	(1)		0.448*** (0.168)	0.507** (0.192)		$\alpha_1 + \alpha_2 = 1$ 2.267	0.343	0.333	1.961
	(2)		0.384** (0.152)	0.616*** (0.152)		$\alpha_1 = 0.25$ 0.782	0.296	0.296	2.082
	(3)	0.824*** (0.202)	0.327* (0.166)	0.342** (0.147)			0.421	0.403	1.885
	(4)		0.374*** (0.103)	0.337** (0.157)	0.228** (0.089)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 3.587*	0.421	0.403	1.691
	(5)	1.147** (0.487)	0.175 (0.134)	0.042 (0.166)	0.317*** (0.087)		0.562	0.541	1.623

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.27. Epidemiological Tests – Income Disaggregated Michigan Survey Forecasts – Volatile Sample Period

Testing Equation:

$$E_{H,t}[\pi_{t+h}] = \alpha_0 + \alpha_1 E_{P,t}[\pi_{t+h}] + \alpha_2 E_{H,t-1}[\pi_{t+h-1}] + \alpha_3 \pi_t + \epsilon_t$$

		α_0	α_1	α_2		Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
				Period: Volatile 2006Q3 – 2011Q1					
Y14	(1)		1.153*** (0.368)	0.380* (0.207)		$\alpha_1 + \alpha_2 = 1$ 9.766***	0.352	0.314	1.569
	(2)		0.069 (0.089)	0.931*** (0.089)		$\alpha_1 = 0.25$ 4.161**	0.074	0.074	2.282
	(3)	0.178 (1.665)	1.078 (0.847)	0.376* (0.214)			0.352	0.271	1.575
	(4)		1.150*** (0.388)	0.318 (0.194)	0.119** (0.053)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 11.179***	0.411	0.338	1.583
	(5)	1.680 (1.254)	0.442 (0.578)	0.252 (0.164)	0.181** (0.070)		0.448	0.338	1.744
Y24	(1)		1.330*** (0.291)	0.167 (0.205)		$\alpha_1 + \alpha_2 = 1$ 23.962***	0.335	0.295	1.734
	(2)		0.152 (0.126)	0.848*** (0.126)		$\alpha_1 = 0.25$ 0.604	0.007	0.007	1.994
	(3)	-0.723 (1.448)	1.718** (0.775)	0.131 (0.214)			0.343	0.261	1.757
	(4)		1.462*** (0.286)	-0.078 (0.153)	0.260** (0.091)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 28.674***	0.569	0.515	1.693
	(5)	1.275 (1.219)	0.796 (0.691)	-0.050 (0.137)	0.298** (0.109)		0.589	0.507	1.747
Y34	(1)		0.798*** (0.150)	0.441*** (0.125)		$\alpha_1 + \alpha_2 = 1$ 20.434***	0.396	0.360	1.264
	(2)		0.174 (0.191)	0.826*** (0.191)		$\alpha_1 = 0.25$ 0.158	0.218	0.218	1.356
	(3)	-0.332 (1.432)	0.949 (0.813)	0.442** (0.163)			0.398	0.323	1.256
	(4)		0.857*** (0.260)	0.263 (0.177)	0.194*** (0.061)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 5.537**	0.556	0.501	1.220
	(5)	1.698* (0.926)	0.106 (0.569)	0.198* (0.097)	0.260*** (0.051)		0.599	0.518	1.472
Y44	(1)		0.875*** (0.195)	0.279 (0.180)		$\alpha_1 + \alpha_2 = 1$ 2.980*	0.256	0.213	1.524
	(2)		0.571** (0.207)	0.429* (0.207)		$\alpha_1 = 0.25$ 2.394	0.176	0.176	1.511
	(3)	-1.780 (1.796)	1.779* (0.842)	0.204*** (0.039)			0.284	0.194	1.508
	(4)		1.010*** (0.038)	-0.159 (0.274)	0.399 (0.304)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 24.466***	0.481	0.416	1.615
	(5)	0.197 (1.740)	0.913 (0.819)	-0.157 (0.325)	0.405 (0.405)		0.481	0.377	1.627

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.28. Epidemiological Tests – Regionally Disaggregated Michigan Survey Forecasts – Whole Sample Period

Testing Equation:

$$E_{H,t}[\pi_{t+h}] = \alpha_0 + \alpha_1 E_{P,t}[\pi_{t+h}] + \alpha_2 E_{H,t-1}[\pi_{t+h-1}] + \alpha_3 \pi_t + \epsilon_t$$

		α_0	α_1	α_2		Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
				Period: Whole 1982Q3 – 2011Q1					
NC	(1)		0.126*** (0.044)	0.857*** (0.053)		$\alpha_1 + \alpha_2 = 1$ 1.513	0.218	0.211	2.137
	(2)		0.118*** (0.038)	0.882*** (0.038)		$\alpha_1 = 0.25$ 12.308***	0.209	0.209	2.168
	(3)	1.201*** (0.217)	0.092* (0.053)	0.513*** (0.104)			0.358	0.347	1.826
	(4)		0.069 (0.046)	0.802*** (0.041)	0.116** (0.047)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 0.930	0.255	0.242	2.062
	(5)	1.543*** (0.181)	-0.018 (0.054)	0.319*** (0.115)	0.206*** (0.037)		0.465	0.450	1.677
NE	(1)		0.256*** (0.070)	0.715*** (0.086)		$\alpha_1 + \alpha_2 = 1$ 2.040	0.290	0.284	2.261
	(2)		0.248*** (0.079)	0.752*** (0.079)		$\alpha_1 = 0.25$ 0.001	0.274	0.274	2.301
	(3)	1.136*** (0.210)	0.200** (0.081)	0.430*** (0.123)			0.412	0.402	2.018
	(4)		0.180** (0.072)	0.587*** (0.122)	0.213** (0.098)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 0.702	0.355	0.344	2.030
	(5)	1.412*** (0.264)	0.080 (0.092)	0.181* (0.101)	0.299*** (0.063)		0.533	0.521	1.728
S	(1)		0.115*** (0.042)	0.866*** (0.050)		$\alpha_1 + \alpha_2 = 1$ 2.012	0.256	0.250	2.093
	(2)		0.109** (0.045)	0.891*** (0.045)		$\alpha_1 = 0.25$ 10.033***	0.245	0.245	2.117
	(3)	1.191*** (0.188)	0.094** (0.041)	0.519*** (0.082)			0.402	0.391	1.841
	(4)		0.060 (0.036)	0.811*** (0.032)	0.116*** (0.043)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 1.520	0.296	0.283	2.034
	(5)	1.526*** (0.153)	-0.010 (0.057)	0.324*** (0.066)	0.204*** (0.040)		0.513	0.499	1.745
W	(1)		0.225*** (0.061)	0.746*** (0.075)		$\alpha_1 + \alpha_2 = 1$ 2.504	0.272	0.265	2.372
	(2)		0.212*** (0.062)	0.788*** (0.062)		$\alpha_1 = 0.25$ 0.375	0.251	0.251	2.418
	(3)	1.253*** (0.289)	0.206*** (0.071)	0.382** (0.148)			0.434	0.424	2.035
	(4)		0.158*** (0.057)	0.639*** (0.096)	0.181*** (0.060)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 1.091	0.340	0.328	2.240
	(5)	1.648*** (0.175)	0.092 (0.076)	0.094 (0.107)	0.292*** (0.036)		0.595	0.584	1.866

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.29. Epidemiological Tests – Regionally Disaggregated Michigan Survey Forecasts – Greenspan-Bernanke Sample Period

Testing Equation:

$$E_{H,t}[\pi_{t+h}] = \alpha_0 + \alpha_1 E_{P,t}[\pi_{t+h}] + \alpha_2 E_{H,t-1}[\pi_{t+h-1}] + \alpha_3 \pi_t + \epsilon_t$$

		α_0	α_1	α_2		Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
Period: Greenspan-Bernanke 1987Q2 – 2011Q1									
NC	(1)		0.161*** (0.060)	0.838*** (0.067)		$\alpha_1 + \alpha_2 = 1$ 0.005	0.341	0.334	1.937
	(2)		0.162** (0.063)	0.838*** (0.063)		$\alpha_1 = 0.25$ 1.937	0.341	0.341	1.938
	(3)	0.956*** (0.161)	0.110* (0.059)	0.581*** (0.090)			0.430	0.417	1.756
	(4)		0.103 (0.063)	0.807*** (0.043)	0.089* (0.049)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 0.003	0.362	0.349	1.890
	(5)	1.328*** (0.121)	-0.030 (0.074)	0.422*** (0.077)	0.183*** (0.043)		0.506	0.490	1.643
NE	(1)		0.264*** (0.085)	0.734*** (0.092)		$\alpha_1 + \alpha_2 = 1$ 0.020	0.380	0.374	2.022
	(2)		0.266** (0.115)	0.734*** (0.115)		$\alpha_1 = 0.25$ 0.018	0.380	0.380	2.023
	(3)	0.867*** (0.197)	0.178* (0.091)	0.546*** (0.115)			0.447	0.435	1.875
	(4)		0.190** (0.080)	0.649*** (0.090)	0.158** (0.067)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 0.010	0.416	0.403	1.871
	(5)	1.339*** (0.285)	-0.005 (0.108)	0.287*** (0.070)	0.292*** (0.073)		0.549	0.534	1.615
S	(1)		0.159*** (0.054)	0.841*** (0.059)		$\alpha_1 + \alpha_2 = 1$ 0.000	0.300	0.293	1.993
	(2)		0.159*** (0.059)	0.841*** (0.059)		$\alpha_1 = 0.25$ 2.414	0.300	0.300	1.993
	(3)	1.063*** (0.172)	0.114** (0.051)	0.548*** (0.085)			0.409	0.397	1.776
	(4)		0.092* (0.048)	0.808*** (0.030)	0.100** (0.047)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 0.004	0.331	0.317	1.942
	(5)	1.527*** (0.204)	-0.044 (0.068)	0.352*** (0.051)	0.208*** (0.043)		0.521	0.505	1.650
W	(1)		0.217*** (0.076)	0.781*** (0.081)		$\alpha_1 + \alpha_2 = 1$ 0.034	0.418	0.412	2.060
	(2)		0.219*** (0.079)	0.781*** (0.079)		$\alpha_1 = 0.25$ 0.156	0.418	0.418	2.061
	(3)	0.897*** (0.112)	0.182*** (0.067)	0.532*** (0.081)			0.499	0.489	1.864
	(4)		0.147** (0.063)	0.715*** (0.050)	0.136*** (0.049)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 0.020	0.461	0.450	1.969
	(5)	1.468*** (0.181)	0.020 (0.074)	0.242*** (0.055)	0.271*** (0.043)		0.636	0.624	1.701

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.30. Epidemiological Tests – Regionally Disaggregated Michigan Survey Forecasts – Stable Sample Period

Testing Equation:

$$E_{H,t}[\pi_{t+h}] = \alpha_0 + \alpha_1 E_{P,t}[\pi_{t+h}] + \alpha_2 E_{H,t-1}[\pi_{t+h-1}] + \alpha_3 \pi_t + \epsilon_t$$

		α_0	α_1	α_2		Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
				Period: Stable 1990Q1 – 2006Q2					
NC	**(1)**		0.303** (0.134)	0.693*** (0.141)		$\alpha_1 + \alpha_2 = 1$ 0.055	0.364	0.355	1.997
	(2)		0.306** (0.143)	0.694*** (0.143)		$\alpha_1 = 0.25$ 0.152	0.364	0.364	1.998
	(3)	0.917*** (0.214)	0.237** (0.118)	0.453*** (0.091)			0.454	0.437	1.815
	(4)		0.258** (0.100)	0.589*** (0.136)	0.147** (0.064)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 0.113	0.405	0.386	1.823
	(5)	1.544*** (0.220)	0.093 (0.065)	0.063 (0.068)	0.320*** (0.056)		0.604	0.584	1.533
NE	**(1)**		0.336* (0.186)	0.650*** (0.202)		$\alpha_1 + \alpha_2 = 1$ 0.219	0.384	0.375	2.099
	(2)		0.341* (0.174)	0.659*** (0.174)		$\alpha_1 = 0.25$ 0.273	0.379	0.379	2.103
	(3)	0.780*** (0.270)	0.204 (0.141)	0.520*** (0.151)			0.440	0.423	2.019
	(4)		0.271* (0.139)	0.426* (0.225)	0.280** (0.115)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 0.774	0.459	0.442	1.742
	(5)	1.435*** (0.146)	-0.014 (0.084)	0.034 (0.151)	0.472*** (0.092)		0.614	0.595	1.617
S	**(1)**		0.199*** (0.068)	0.798*** (0.078)		$\alpha_1 + \alpha_2 = 1$ 0.036	0.398	0.389	2.052
	(2)		0.202*** (0.069)	0.798*** (0.069)		$\alpha_1 = 0.25$ 0.482	0.398	0.398	2.050
	(3)	0.929*** (0.175)	0.171 (0.144)	0.519*** (0.113)			0.495	0.479	1.845
	(4)		0.168* (0.090)	0.717*** (0.092)	0.112*** (0.038)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 0.074	0.427	0.409	1.873
	(5)	1.701*** (0.179)	0.061 (0.095)	0.059 (0.113)	0.314*** (0.069)		0.657	0.641	1.414
W	**(1)**		0.309* (0.165)	0.689*** (0.170)		$\alpha_1 + \alpha_2 = 1$ 0.027	0.426	0.417	2.051
	(2)		0.310* (0.169)	0.690*** (0.169)		$\alpha_1 = 0.25$ 0.129	0.426	0.426	2.051
	(3)	0.853*** (0.227)	0.258* (0.134)	0.457*** (0.141)			0.505	0.489	1.863
	(4)		0.265* (0.133)	0.536*** (0.139)	0.194*** (0.061)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 0.080	0.493	0.477	1.870
	(5)	1.596*** (0.155)	0.128* (0.069)	-0.046 (0.097)	0.383*** (0.059)		0.706	0.692	1.759

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.31. Epidemiological Tests – Regionally Disaggregated Michigan Survey Forecasts – Volatile Sample Period

Testing Equation:

$$E_{H,t}[\pi_{t+h}] = \alpha_0 + \alpha_1 E_{P,t}[\pi_{t+h}] + \alpha_2 E_{H,t-1}[\pi_{t+h-1}] + \alpha_3 \pi_t + \epsilon_t$$

		α_0	α_1	α_2		Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
Period: Volatile 2006Q3 – 2011Q1									
NC	**(1)**		0.856*** (0.137)	0.438*** (0.094)		$\alpha_1 + \alpha_2 = 1$ 22.396***	0.391	0.355	1.224
	(2)		0.102 (0.156)	0.898*** (0.156)		$\alpha_1 = 0.25$ 0.903	0.187	0.187	1.403
	(3)	-0.168 (1.350)	0.929 (0.671)	0.441* (0.219)			0.391	0.315	1.216
	(4)		0.868*** (0.208)	0.329** (0.140)	0.150* (0.075)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 8.733***	0.504	0.442	1.224
	(5)	1.490 (0.927)	0.220 (0.426)	0.271*** (0.077)	0.206** (0.078)		0.540	0.448	1.453
NE	**(1)**		1.074*** (0.199)	0.279 (0.165)		$\alpha_1 + \alpha_2 = 1$ 58.555***	0.309	0.268	1.485
	(2)		0.206 (0.284)	0.794** (0.284)		$\alpha_1 = 0.25$ 0.024	0.040	0.040	1.686
	(3)	-0.709 (1.689)	1.421 (0.897)	0.263* (0.136)			0.316	0.231	1.462
	(4)		1.254*** (0.227)	-0.037 (0.140)	0.282*** (0.065)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 17.754***	0.526	0.466	1.424
	(5)	1.609 (0.971)	0.506 (0.484)	-0.068 (0.115)	0.343*** (0.053)		0.555	0.465	1.659
S	**(1)**		0.943*** (0.178)	0.374*** (0.117)		$\alpha_1 + \alpha_2 = 1$ 16.747***	0.299	0.257	1.403
	(2)		0.149 (0.105)	0.851*** (0.105)		$\alpha_1 = 0.25$ 0.922	0.033	0.033	1.614
	(3)	0.136 (1.304)	0.886 (0.714)	0.371*** (0.111)			0.299	0.212	1.408
	(4)		0.930*** (0.254)	0.278* (0.156)	0.157*** (0.049)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 7.851***	0.425	0.353	1.390
	(5)	2.163* (1.101)	0.016 (0.683)	0.175* (0.095)	0.239*** (0.067)		0.497	0.397	1.705
W	**(1)**		0.923*** (0.138)	0.350** (0.139)		$\alpha_1 + \alpha_2 = 1$ 44.428***	0.366	0.329	1.605
	(2)		0.203 (0.186)	0.797*** (0.186)		$\alpha_1 = 0.25$ 0.065	0.169	0.169	1.746
	(3)	-0.366 (1.517)	1.106 (1.122)	0.339 (0.549)			0.368	0.290	1.617
	(4)		1.086*** (0.144)	0.065 (0.103)	0.254*** (0.065)	$\alpha_1 + \alpha_2 + \alpha_3 = 1$ 18.675***	0.592	0.541	1.556
	(5)	1.690** (0.788)	0.282 (0.367)	0.046 (0.083)	0.304*** (0.072)		0.635	0.562	1.695

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.32. Naïve Sticky Information Model – Age Disaggregated Forecasts – Whole Sample Period

Testing Equation:

$$(1).\ E_t^H[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + \beta_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

$$(2).\ E_{t,H}[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + (1-\beta_1)E_{t-j,H}[\pi_{t+h-j}] + \epsilon_t$$

$$(3).\ E_t^H[\pi_{t+h}] = \beta_0 + \beta_1(\beta_2\pi_{t-1} + (1-\beta_2)E_t^P[\pi_{t+h}]) + (1-\beta_1)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

		β_0	β_1	$(1-\beta_1)$	β_2	$(1-\beta_2)$	Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
					Period: Whole 1982Q3 – 2011Q1					
A1834	**(1)**		0.210*** (0.058)		0.779*** (0.063)		$\beta_1+\beta_2=1$ 1.114	0.356	0.351	2.605
	(2)		0.216*** (0.055)	0.784*** (0.055)			$\beta_1=0.18$ 0.415	0.354	0.354	2.610
	(3)		0.375*** (0.083)	0.625*** (0.083)	0.457*** (0.131)	0.543*** (0.131)	$\beta_1=0.25$ 2.283 $\beta_1*(1-\beta_2)=0.25$ 0.719	0.402	0.397	2.329
A3445	**(1)**		0.239*** (0.070)		0.750*** (0.072)		$\beta_1+\beta_2=1$ 0.884	0.401	0.395	2.258
	(2)		0.244*** (0.071)	0.756*** (0.071)			$\beta_1=0.18$ 0.815	0.398	0.398	2.261
	(3)		0.360*** (0.062)	0.640*** (0.062)	0.564*** (0.149)	0.436*** (0.149)	$\beta_1=0.25$ 3.148* $\beta_1*(1-\beta_2)=0.25$ 3.117*	0.433	0.428	2.085
A4554	**(1)**		0.182*** (0.049)		0.807*** (0.052)		$\beta_1+\beta_2=1$ 0.766	0.198	0.191	2.272
	(2)		0.184*** (0.051)	0.816*** (0.051)			$\beta_1=0.18$ 0.005	0.195	0.195	2.286
	(3)		0.230*** (0.030)	0.770*** (0.030)	0.650*** (0.180)	0.350* (0.180)	$\beta_1=0.25$ 0.463 $\beta_1*(1-\beta_2)=0.25$ 15.533***	0.211	0.204	2.217
A5564	**(1)**		0.190*** (0.052)		0.790*** (0.056)		$\beta_1+\beta_2=1$ 2.106	0.099	0.091	2.074
	(2)		0.187*** (0.047)	0.813*** (0.047)			$\beta_1=0.18$ 0.022	0.088	0.088	2.106
	(3)		0.205*** (0.036)	0.795*** (0.036)	0.787*** (0.206)	0.213 (0.206)	$\beta_1=0.25$ 1.574 $\beta_1*(1-\beta_2)=0.25$ 23.186***	0.093	0.085	2.078
A6597	**(1)**		0.185*** (0.043)		0.800*** (0.052)		$\beta_1+\beta_2=1$ 0.859	0.114	0.106	2.214
	(2)		0.185*** (0.041)	0.815*** (0.041)			$\beta_1=0.18$ 0.017	0.109	0.109	2.239
	(3)		0.201*** (0.032)	0.799*** (0.032)	0.748*** (0.184)	0.252 (0.184)	$\beta_1=0.25$ 2.400 $\beta_1*(1-\beta_2)=0.25$ 26.588***	0.115	0.108	2.234

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.33. Naïve Sticky Information Model – Age Disaggregated Forecasts – Greenspan-Bernanke Sample Period

Testing Equation:

$$(1).\ E_t^H[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + \beta_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

$$(2).\ E_{t,H}[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + (1-\beta_1)E_{t-j,H}[\pi_{t+h-j}] + \epsilon_t$$

$$(3).\ E_t^H[\pi_{t+h}] = \beta_0 + \beta_1(\beta_2\pi_{t-1} + (1-\beta_2)E_t^P[\pi_{t+h}]) + (1-\beta_1)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

		β_0	β_1	$(1-\beta_1)$	β_2	$(1-\beta_2)$	Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
					Period: Greenspan-Bernanke 1987Q2 – 2011Q1					
A1834	(1)		0.176*** (0.062)		0.818*** (0.063)		$\beta_1+\beta_2=1$ 0.335	0.440	0.434	2.294
	(2)		0.178*** (0.045)	0.822*** (0.045)			$\beta_1=0.18$ 0.002	0.439	0.439	2.301
	(3)		0.313*** (0.073)	0.687*** (0.073)	0.407** (0.156)	0.593*** (0.156)	$\beta_1=0.25$ 0.740 $\beta_1*(1-\beta_2)=0.25$	0.474	0.468	2.124
A3445	(1)		0.201*** (0.068)		0.791*** (0.068)		$\beta_1+\beta_2=1$ 0.379	0.393	0.386	1.973
	(2)		0.204*** (0.066)	0.796*** (0.066)			$\beta_1=0.18$ 0.131	0.391	0.391	1.979
	(3)		0.312*** (0.057)	0.688*** (0.057)	0.491** (0.223)	0.509** (0.223)	$\beta_1=0.25$ 1.182 $\beta_1*(1-\beta_2)=0.25$ 1.178	0.423	0.417	1.868
A4554	(1)		0.148*** (0.050)		0.846*** (0.052)		$\beta_1+\beta_2=1$ 0.204	0.301	0.293	2.260
	(2)		0.150** (0.062)	0.850*** (0.062)			$\beta_1=0.18$ 0.230	0.300	0.300	2.266
	(3)		0.228*** (0.029)	0.772*** (0.029)	0.461** (0.212)	0.539** (0.212)	$\beta_1=0.25$ 0.547 $\beta_1*(1-\beta_2)=0.25$ 5.596	0.324	0.316	2.168
A5564	(1)		0.170*** (0.049)		0.819*** (0.051)		$\beta_1+\beta_2=1$ 0.677	0.203	0.195	2.098
	(2)		0.170*** (0.047)	0.830*** (0.047)			$\beta_1=0.18$ 0.044	0.200	0.200	2.114
	(3)		0.227*** (0.039)	0.773*** (0.039)	0.539** (0.246)	0.461* (0.246)	$\beta_1=0.25$ 0.349 $\beta_1*(1-\beta_2)=0.25$ 5.417**	0.219	0.210	2.041
A6597	(1)		0.168*** (0.044)		0.827*** (0.052)		$\beta_1+\beta_2=1$ 0.082	0.126	0.117	2.295
	(2)		0.170*** (0.046)	0.830*** (0.046)			$\beta_1=0.18$ 0.051	0.126	0.126	2.301
	(3)		0.245*** (0.051)	0.755*** (0.051)	0.445* (0.262)	0.555** (0.262)	$\beta_1=0.25$ 0.008 $\beta_1*(1-\beta_2)=0.25$ 2.224	0.154	0.145	2.197

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.34. Naïve Sticky Information Model – Age Disaggregated Forecasts – Stable Sample Period

Testing Equation:

$$(1).\ E_t^H[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + \beta_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

$$(2).\ E_{t,H}[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + (1-\beta_1)E_{t-j,H}[\pi_{t+h-j}] + \epsilon_t$$

$$(3).\ E_t^H[\pi_{t+h}] = \beta_0 + \beta_1(\beta_2\pi_{t-1} + (1-\beta_2)E_t^P[\pi_{t+h}]) + (1-\beta_1)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

		β_0	β_1	$(1-\beta_1)$	β_2	$(1-\beta_2)$	Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
					Period: Stable 1990Q1 – 2006Q2					
A1834	**(1)**		0.242*** (0.079)		0.745*** (0.082)		$\beta_1+\beta_2=1$ 0.642	0.524	0.517	2.174
	(2)		0.241*** (0.077)	0.759*** (0.077)			$\beta_1=0.18$ 0.632	0.519	0.519	2.186
	(3)		0.642*** (0.216)	0.358 (0.216)	0.366*** (0.096)	0.634*** (0.096)	$\beta_1=0.25$ 3.300* $\beta_1*(1-\beta_2)=0.25$ 0.732	0.623	0.617	1.743
A3445	**(1)**		0.261*** (0.097)		0.727*** (0.102)		$\beta_1+\beta_2=1$ 0.476	0.395	0.385	1.994
	(2)		0.263*** (0.097)	0.737*** (0.097)			$\beta_1=0.18$ 0.725	0.391	0.391	2.003
	(3)		0.557*** (0.179)	0.443** (0.179)	0.410*** (0.096)	0.590*** (0.096)	$\beta_1=0.25$ 2.946* $\beta_1*(1-\beta_2)=0.25$ 0.320	0.485	0.477	1.679
A4554	**(1)**		0.130** (0.061)		0.856*** (0.063)		$\beta_1+\beta_2=1$ 0.862	0.265	0.254	2.145
	(2)		0.129*** (0.040)	0.871*** (0.040)			$\beta_1=0.18$ 1.607	0.256	0.256	2.155
	(3)		0.271*** (0.100)	0.729*** (0.100)	0.383** (0.152)	0.617*** (0.152)	$\beta_1=0.25$ 0.042 $\beta_1*(1-\beta_2)=0.25$ 0.890	0.293	0.282	1.928
A5564	**(1)**		0.233*** (0.079)		0.747*** (0.077)		$\beta_1+\beta_2=1$ 1.021	0.130	0.116	2.064
	(2)		0.222** (0.093)	0.778*** (0.093)			$\beta_1=0.18$ 0.206	0.117	0.117	2.110
	(3)		0.337*** (0.099)	0.663*** (0.099)	0.482 (0.296)	0.518* (0.296)	$\beta_1=0.25$ 0.780 $\beta_1*(1-\beta_2)=0.25$ 0.437	0.157	0.144	1.937
A6597	**(1)**		0.277*** (0.077)		0.702*** (0.081)		$\beta_1+\beta_2=1$ 0.849	-0.060	-0.077	2.327
	(2)		0.274*** (0.082)	0.726*** (0.082)			$\beta_1=0.18$ 1.318	-0.076	-0.076	2.364
	(3)		0.468*** (0.093)	0.532*** (0.093)	0.360** (0.173)	0.640*** (0.173)	$\beta_1=0.25$ 5.527 $\beta_1*(1-\beta_2)=0.25$ 0.204	0.047	0.032	2.070

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.35. Naïve Sticky Information Model – Age Disaggregated Forecasts – Volatile Sample Period

Testing Equation:

$$(1).\ E_t^H[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + \beta_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

$$(2).\ E_{t,H}[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + (1-\beta_1)E_{t-j,H}[\pi_{t+h-j}] + \epsilon_t$$

$$(3).\ E_t^H[\pi_{t+h}] = \beta_0 + \beta_1(\beta_2\pi_{t-1} + (1-\beta_2)E_t^P[\pi_{t+h}]) + (1-\beta_1)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

		β_0	β_1	$(1-\beta_1)$	β_2	$(1-\beta_2)$	Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
					Period: Volatile 2006Q3 – 2011Q1					
A1834	**(1)**		0.167** (0.071)		0.869*** (0.060)		$\beta_1+\beta_2=1$ 2.693	0.194	0.147	2.124
	(2)		0.136 (0.082)	0.864*** (0.082)			$\beta_1=0.18$ 0.290	0.175	0.175	2.041
	(3)		0.190*** (0.050)	0.810*** (0.050)	0.592 (0.342)	0.408 (0.342)	$\beta_1=0.25$ 1.405 $\beta_1*(1-\beta_2)=0.25$ 6.282**	0.186	0.138	1.944
A3445	**(1)**		0.205** (0.092)		0.827*** (0.062)		$\beta_1+\beta_2=1$ 0.950	0.353	0.315	1.464
	(2)		0.174* (0.091)	0.826*** (0.091)			$\beta_1=0.18$ 0.005	0.341	0.341	1.444
	(3)		0.251*** (0.057)	0.749*** (0.057)	0.565 (0.520)	0.435 (0.520)	$\beta_1=0.25$ 0.000 $\beta_1*(1-\beta_2)=0.25$ 0.844	0.361	0.323	1.378
A4554	**(1)**		0.168* (0.084)		0.859*** (0.060)		$\beta_1+\beta_2=1$ 0.530	0.164	0.115	1.683
	(2)		0.138 (0.100)	0.862*** (0.100)			$\beta_1=0.18$ 0.172	0.156	0.156	1.667
	(3)		0.209*** (0.069)	0.791*** (0.069)	0.486 (0.527)	0.514 (0.527)	$\beta_1=0.25$ 0.350 $\beta_1*(1-\beta_2)=0.25$ 1.044	0.178	0.130	1.593
A5564	**(1)**		0.168** (0.075)		0.857*** (0.062)		$\beta_1+\beta_2=1$ 0.580	0.136	0.085	1.593
	(2)		0.142 (0.086)	0.858*** (0.086)			$\beta_1=0.18$ 0.197	0.128	0.128	1.576
	(3)		0.213** (0.095)	0.787*** (0.095)	0.487 (0.554)	0.513 (0.554)	$\beta_1=0.25$ 0.152 $\beta_1*(1-\beta_2)=0.25$ 0.776	0.153	0.104	1.490
A6597	**(1)**		0.157** (0.055)		0.897*** (0.043)		$\beta_1+\beta_2=1$ 5.085**	0.114	0.061	1.544
	(2)		0.101 (0.086)	0.899*** (0.086)			$\beta_1=0.18$ 0.842	0.066	0.066	1.496
	(3)		0.092 (0.067)	0.908*** (0.067)	1.148 (1.220)	-0.148 (1.220)	$\beta_1=0.25$ 5.509*** $\beta_1*(1-\beta_2)=0.25$ 6.424**	0.066	0.012	1.506

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.36. Naïve Sticky Information Model – Education Disaggregated Forecasts – Whole Sample Period

Testing Equation:

$$(1).\ E_t^H[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + \beta_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

$$(2).\ E_{t,H}[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + (1-\beta_1)E_{t-j,H}[\pi_{t+h-j}] + \epsilon_t$$

$$(3).\ E_t^H[\pi_{t+h}] = \beta_0 + \beta_1(\beta_2\pi_{t-1} + (1-\beta_2)E_t^P[\pi_{t+h}]) + (1-\beta_1)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

		β_0	β_1	$(1-\beta_1)$	β_2	$(1-\beta_2)$	Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
					Period: Whole 1982Q3 – 2011Q1					
ELHS	(1)		0.181*** (0.058)		0.827*** (0.050)		$\beta_1+\beta_2=1$ 0.252	0.088	0.080	2.415
	(2)		0.173*** (0.058)	0.827*** (0.058)			$\beta_1=0.18$ 0.016	0.087	0.087	2.414
	(3)		0.196*** (0.043)	0.804*** (0.043)	0.649** (0.313)	0.351 (0.313)	$\beta_1=0.25$ 1.566 $\beta_1*(1-\beta_2)=0.25$ 8.438***	0.095	0.087	2.382
EHSD	(1)		0.124*** (0.037)		0.870*** (0.042)		$\beta_1+\beta_2=1$ 0.292	0.133	0.125	2.357
	(2)		0.127*** (0.041)	0.873*** (0.041)			$\beta_1=0.18$ 1.654	0.132	0.132	2.360
	(3)		0.146*** (0.034)	0.854*** (0.034)	0.743*** (0.214)	0.257 (0.214)	$\beta_1=0.25$ 9.473*** $\beta_1*(1-\beta_2)=0.25$ 36.195***	0.136	0.128	2.321
ESC	(1)		0.142*** (0.053)		0.844*** (0.055)		$\beta_1+\beta_2=1$ 1.962	0.222	0.215	2.296
	(2)		0.145** (0.054)	0.855*** (0.054			$\beta_1=0.18$ 0.413	0.216	0.216	2.307
	(3)		0.184*** (0.041)	0.816*** (0.041)	0.629*** (0.226)	0.371 (0.226)	$\beta_1=0.25$ 2.623 $\beta_1*(1-\beta_2)=0.25$ 20.053***	0.227	0.220	2.236
ECD	(1)		0.360*** (0.074)		0.606*** (0.082)		$\beta_1+\beta_2=1$ 2.850*	0.260	0.254	2.211
	(2)		0.357*** (0.070)	0.643*** (0.070)			$\beta_1=0.18$ 6.323**	0.240	0.240	2.249
	(3)		0.514*** (0.122)	0.486*** (0.122)	0.569*** (0.092)	0.431*** (0.092)	$\beta_1=0.25$ 4.720** $\beta_1*(1-\beta_2)=0.25$ 0.134	0.305	0.299	1.997
EGS	(1)		0.303*** (0.064)		0.687*** (0.067)		$\beta_1+\beta_2=1$ 0.466	0.535	0.531	2.097
	(2)		0.309*** (0.068)	0.691*** (0.068)			$\beta_1=0.18$ 3.627*	0.534	0.534	2.101
	(3)		0.617*** (0.070)	0.383*** (0.070)	0.436*** (0.082)	0.564*** (0.082)	$\beta_1=0.25$ 27.127*** $\beta_1*(1-\beta_2)=0.25$ 1.884	0.616	0.613	1.753

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.37. Naïve Sticky Information Model – Education Disaggregated Forecasts – Greenspan-Bernanke Sample Period

Testing Equation:

$$(1).\ E_t^H[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + \beta_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

$$(2).\ E_{t,H}[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + (1-\beta_1)E_{t-j,H}[\pi_{t+h-j}] + \epsilon_t$$

$$(3).\ E_t^H[\pi_{t+h}] = \beta_0 + \beta_1(\beta_2\pi_{t-1} + (1-\beta_2)E_t^P[\pi_{t+h}]) + (1-\beta_1)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

		β_0	β_1	$(1-\beta_1)$	β_2	$(1-\beta_2)$	Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
					Period: Greenspan-Bernanke 1987Q2 – 2011Q1					
ELHS	**(1)**		0.183*** (0.066)		0.833*** (0.053)		$\beta_1+\beta_2=1$ 0.652	0.063	0.053	2.488
	(2)		0.164*** (0.060)	0.836*** (0.060)			$\beta_1=0.18$ 0.073	0.059	0.059	2.489
	(3)		0.203*** (0.051)	0.797*** (0.051)	0.432 (0.427)	0.568 (0.427)	$\beta_1=0.25$ 0.827 $\beta_1*(1-\beta_2)=0.25$ 1.822	0.076	0.066	2.445
EHSD	**(1)**		0.122*** (0.038)		0.880*** (0.041)		$\beta_1+\beta_2=1$ 0.053	0.130	0.121	2.320
	(2)		0.121*** (0.045)	0.879*** (0.045)			$\beta_1=0.18$ 1.709	0.130	0.130	2.318
	(3)		0.163*** (0.042)	0.837*** (0.042)	0.513** (0.243)	0.487** (0.243)	$\beta_1=0.25$ 4.355** $\beta_1*(1-\beta_2)=0.25$ 10.849***	0.142	0.133	2.253
ESC	**(1)**		0.120*** (0.045)		0.877*** (0.044)		$\beta_1+\beta_2=1$ 0.107	0.389	0.383	2.070
	(2)		0.121** (0.053)	0.879*** (0.053)			$\beta_1=0.18$ 1.247	0.389	0.389	2.074
	(3)		0.172*** (0.033)	0.828*** (0.033)	0.495* (0.297)	0.505* (0.297)	$\beta_1=0.25$ 5.565** $\beta_1*(1-\beta_2)=0.25$ 9.009***	0.401	0.395	2.016
ECD	**(1)**		0.300*** (0.059)		0.671*** (0.068)		$\beta_1+\beta_2=1$ 2.457	0.295	0.288	1.922
	(2)		0.292*** (0.065)	0.708*** (0.065)			$\beta_1=0.18$ 2.933*	0.280	0.280	1.965
	(3)		0.455*** (0.107)	0.545*** (0.107)	0.476*** (0.089)	0.524*** (0.089)	$\beta_1=0.25$ 3.634* $\beta_1*(1-\beta_2)=0.25$ 0.022	0.342	0.335	1.788
EGS	**(1)**		0.347*** (0.075)		0.632*** (0.077)		$\beta_1+\beta_2=1$ 1.645	0.445	0.439	2.014
	(2)		0.349*** (0.065)	0.651*** (0.065)			$\beta_1=0.18$ 6.726***	0.439	0.439	2.033
	(3)		0.646*** (0.066)	0.354*** (0.066)	0.420*** (0.109)	0.580*** (0.109)	$\beta_1=0.25$ 35.738*** $\beta_1*(1-\beta_2)=0.25$ 1.998	0.539	0.534	1.713

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.38. Naïve Sticky Information Model – Education Disaggregated Forecasts – Stable Sample Period

Testing Equation:

$$(1).\ E_t^H[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + \beta_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

$$(2).\ E_{t,H}[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + (1-\beta_1)E_{t-j,H}[\pi_{t+h-j}] + \epsilon_t$$

$$(3).\ E_t^H[\pi_{t+h}] = \beta_0 + \beta_1(\beta_2\pi_{t-1} + (1-\beta_2)E_t^P[\pi_{t+h}]) + (1-\beta_1)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

		β_0	β_1	$(1-\beta_1)$	β_2	$(1-\beta_2)$	Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
					Period: Stable 1990Q1 – 2006Q2					
ELHS	**(1)**		0.316*** (0.114)		0.714*** (0.085)		$\beta_1 + \beta_2 = 1$ 0.692	0.075	0.061	2.473
	(2)		0.264*** (0.061)	0.736*** (0.061)			$\beta_1 = 0.18$ 1.895	0.058	0.058	2.504
	(3)		0.298*** (0.082)	0.702*** (0.082)	0.649 (0.394)	0.351 (0.394)	$\beta_1 = 0.25$ 0.343 $\beta_1 * (1-\beta_2) = 0.25$ 1.143	0.069	0.054	2.462
EHSD	**(1)**		0.198*** (0.060)		0.799*** (0.062)		$\beta_1 + \beta_2 = 1$ 0.034	0.024	0.008	2.419
	(2)		0.200*** (0.050)	0.800*** (0.050)			$\beta_1 = 0.18$ 0.155	0.023	0.023	2.421
	(3)		0.324*** (0.074)	0.676*** (0.074)	0.410** (0.193)	0.590*** (0.193)	$\beta_1 = 0.25$ 0.990 $\beta_1 * (1-\beta_2) = 0.25$ 0.361	0.085	0.071	2.222
ESC	**(1)**		0.199** (0.079)		0.787*** (0.078)		$\beta_1 + \beta_2 = 1$ 0.610	0.351	0.341	2.055
	(2)		0.196*** (0.073)	0.804*** (0.073)			$\beta_1 = 0.18$ 0.050	0.345	0.345	2.073
	(3)		0.364*** (0.111)	0.636*** (0.111)	0.453** (0.172)	0.547*** (0.172)	$\beta_1 = 0.25$ 1.057 $\beta_1 * (1-\beta_2) = 0.25$ 0.247	0.387	0.377	1.860
ECD	**(1)**		0.322*** (0.085)		0.640*** (0.100)		$\beta_1 + \beta_2 = 1$ 2.279	0.331	0.321	2.039
	(2)		0.286*** (0.082)	0.714*** (0.082)			$\beta_1 = 0.18$ 1.662	0.296	0.296	2.125
	(3)		0.606*** (0.166)	0.394** (0.166)	0.359*** (0.117)	0.641*** (0.117)	$\beta_1 = 0.25$ 4.585** $\beta_1 * (1-\beta_2) = 0.25$ 0.875	0.423	0.414	1.715
EGS	**(1)**		0.360*** (0.118)		0.613*** (0.126)		$\beta_1 + \beta_2 = 1$ 1.146	0.483	0.475	1.914
	(2)		0.339*** (0.121)	0.661*** (0.121)			$\beta_1 = 0.18$ 1.728	0.469	0.469	1.971
	(3)		0.682*** (0.147)	0.318** (0.147)	0.454*** (0.113)	0.546*** (0.113)	$\beta_1 = 0.25$ 8.584*** $\beta_1 * (1-\beta_2) = 0.25$ 1.133	0.565	0.558	1.564

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.39. Naïve Sticky Information Model – Education Disaggregated Forecasts – Volatile Sample Period

Testing Equation:

$$(1).\ E_t^H[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + \beta_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

$$(2).\ E_{t,H}[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + (1-\beta_1)E_{t-j,H}[\pi_{t+h-j}] + \epsilon_t$$

$$(3).\ E_t^H[\pi_{t+h}] = \beta_0 + \beta_1(\beta_2\pi_{t-1} + (1-\beta_2)E_t^P[\pi_{t+h}]) + (1-\beta_1)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

		β_0	β_1	$(1-\beta_1)$	β_2	$(1-\beta_2)$	Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
					Period: Volatile 2006Q3 – 2011Q1					
ELHS	**(1)**		0.105 (0.191)		0.910*** (0.133)		$\beta_1 + \beta_2 = 1$ 0.035	-0.200	-0.270	1.980
	(2)		0.085 (0.118)	0.914*** (0.118)			$\beta_1 = 0.18$ 0.645	-0.202	-0.202	1.979
	(3)		0.131 (0.120)	0.869*** (0.120)	0.141 (1.352)	0.859 (1.351)	$\beta_1 = 0.25$ 0.985 $\beta_1 * (1-\beta_2) = 0.25$ 0.497	-0.172	-0.240	1.916
EHSD	**(1)**		0.131*** (0.042)		0.917*** (0.040)		$\beta_1 + \beta_2 = 1$ 4.074**	0.006	-0.052	1.926
	(2)		0.077 (0.061)	0.923*** (0.061)			$\beta_1 = 0.18$ 2.881	-0.032	-0.032	1.857
	(3)		0.068 (0.070)	0.932*** (0.070)	1.229 (1.337)	-0.229 (1.337)	$\beta_1 = 0.25$ 6.809*** $\beta_1 * (1-\beta_2) = 0.25$ 11.997	-0.032	-0.092	1.873
ESC	**(1)**		0.110 (0.087)		0.914*** (0.062)		$\beta_1 + \beta_2 = 1$ 0.514	0.253	0.209	1.538
	(2)		0.084 (0.093)	0.916*** (0.093)			$\beta_1 = 0.18$ 1.073	0.243	0.243	1.503
	(3)		0.110* (0.055)	0.890*** (0.055)	0.603 (0.740)	0.397 (0.740)	$\beta_1 = 0.25$ 6.374** $\beta_1 * (1-\beta_2) = 0.25$ 5.109	0.248	0.204	1.461
ECD	**(1)**		0.347*** (0.071)		0.688*** (0.081)		$\beta_1 + \beta_2 = 1$ 1.214	0.096	0.043	1.842
	(2)		0.317** (0.144)	0.683*** (0.144)			$\beta_1 = 0.18$ 0.906	0.086	0.086	1.810
	(3)		0.555*** (0.160)	0.444** (0.160)	0.452* (0.252)	0.548** (0.252)	$\beta_1 = 0.25$ 3.656* $\beta_1 * (1-\beta_2) = 0.25$ 0.061	0.194	0.147	1.561
EGS	**(1)**		0.337*** (0.078)		0.673*** (0.071)		$\beta_1 + \beta_2 = 1$ 0.070	0.123	0.071	1.949
	(2)		0.329*** (0.110)	0.671*** (0.110)			$\beta_1 = 0.18$ 1.833	0.122	0.122	1.942
	(3)		0.611*** (0.164)	0.389** (0.164)	0.398 (0.306)	0.602* (0.306)	$\beta_1 = 0.25$ 4.863** $\beta_1 * (1-\beta_2) = 0.25$ 0.175	0.278	0.236	1.684

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.40. Naïve Sticky Information Model – Gender Disaggregated Forecasts – Whole Sample Period

Testing Equation:

$$(1).\ E_t^H[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + \beta_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

$$(2).\ E_{t,H}[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + (1-\beta_1)E_{t-j,H}[\pi_{t+h-j}] + \epsilon_t$$

$$(3).\ E_t^H[\pi_{t+h}] = \beta_0 + \beta_1(\beta_2\pi_{t-1} + (1-\beta_2)E_t^P[\pi_{t+h}]) + (1-\beta_1)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

		β_0	β_1	$(1-\beta_1)$	β_2	$(1-\beta_2)$	Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
					Period: Whole 1982Q3 – 2011Q1					
MALE	(1)		0.188*** (0.054)		0.786*** (0.061)		$\beta_1 + \beta_2 = 1$ 4.154**	0.237	0.230	1.982
	(2)		0.178*** (0.047)	0.822*** (0.047)			$\beta_1 = 0.18$ 0.011	0.219	0.219	2.018
	(3)		0.222*** (0.058)	0.778*** (0.058)	0.671*** (0.180)	0.329* (0.180)	$\beta_1 = 0.25$ 0.225 $\beta_1 * (1-\beta_2) = 0.25$ 10.671***	0.232	0.225	1.960
FEMALE	(1)		0.151*** (0.054)		0.850*** (0.053)		$\beta_1 + \beta_2 = 1$ 0.002	0.371	0.365	2.298
	(2)		0.150*** (0.049)	0.850*** (0.049)			$\beta_1 = 0.18$ 0.369	0.371	0.371	2.298
	(3)		0.203*** (0.067)	0.797*** (0.067)	0.595*** (0.176)	0.405** (0.176)	$\beta_1 = 0.25$ 0.487 $\beta_1 * (1-\beta_2) = 0.25$ 11.270***	0.383	0.377	2.195

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.41. Naïve Sticky Information Model – Gender Disaggregated Forecasts – Greenspan-Bernanke Sample Period

Testing Equation:

$$(1).\ E_t^H[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + \beta_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

$$(2).\ E_{t,H}[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + (1-\beta_1)E_{t-j,H}[\pi_{t+h-j}] + \epsilon_t$$

$$(3).\ E_t^H[\pi_{t+h}] = \beta_0 + \beta_1(\beta_2\pi_{t-1} + (1-\beta_2)E_t^P[\pi_{t+h}]) + (1-\beta_1)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

		β_0	β_1	$(1-\beta_1)$	β_2	$(1-\beta_2)$	Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
					Period: Greenspan-Bernanke 1987Q2 – 2011Q1					
MALE	(1)		0.181*** (0.059)		0.797*** (0.065)		$\beta_1 + \beta_2 = 1$ 2.480	0.240	0.232	1.975
	(2)		0.175*** (0.053)	0.825*** (0.053)			$\beta_1 = 0.18$ 0.009	0.228	0.228	2.007
	(3)		0.277*** (0.070)	0.723*** (0.070)	0.438*** (0.151)	0.562*** (0.151)	$\beta_1 = 0.25$ 0.151 $\beta_1 * (1-\beta_2) = 0.25$ 2.213	0.266	0.258	1.899
FEMALE	(1)		0.122** (0.047)		0.886*** (0.043)		$\beta_1 + \beta_2 = 1$ 0.351	0.530	0.525	1.809
	(2)		0.115*** (0.039)	0.885*** (0.039)			$\beta_1 = 0.18$ 2.821*	0.529	0.529	1.805
	(3)		0.152*** (0.048)	0.848*** (0.048)	0.596* (0.314)	0.404 (0.314)	$\beta_1 = 0.25$ 4.200** $\beta_1 * (1-\beta_2) = 0.25$ 9.658***	0.534	0.529	1.761

***,**,* indicate significance at 1, 5 and 10 percent levels

Appendix 5.42. Naïve Sticky Information Model – Gender Disaggregated Forecasts – Stable Sample Period

Testing Equation:

$$(1). E_t^H[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + \beta_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

$$(2). E_{t,H}[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + (1-\beta_1)E_{t-j,H}[\pi_{t+h-j}] + \epsilon_t$$

$$(3). E_t^H[\pi_{t+h}] = \beta_0 + \beta_1(\beta_2\pi_{t-1} + (1-\beta_2)E_t^P[\pi_{t+h}]) + (1-\beta_1)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

		β_0	β_1	$(1-\beta_1)$	β_2	$(1-\beta_2)$	Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
					Period: Stable 1990Q1 – 2006Q2					
MALE	(1)		0.193*** (0.057)		0.783*** (0.067)		$\beta_1+\beta_2=1$ 1.720	0.346	0.336	2.108
	(2)		0.167*** (0.056)	0.833*** (0.056)			$\beta_1=0.18$ 0.055	0.328	0.328	2.177
	(3)		0.335** (0.131)	0.665*** (0.131)	0.388** (0.162)	0.612*** (0.162)	$\beta_1=0.25$ 0.417 $\beta_1*(1-\beta_2)=0.25$ 0.142	0.377	0.367	1.947
FEMALE	(1)		0.182** (0.087)		0.819*** (0.083)		$\beta_1+\beta_2=1$ 0.008	0.487	0.478	2.069
	(2)		0.181** (0.070)	0.819*** (0.070)			$\beta_1=0.18$ 0.000	0.486	0.486	2.070
	(3)		0.327** (0.138)	0.672*** (0.138)	0.458** (0.196)	0.542*** (0.196)	$\beta_1=0.25$ 0.313 $\beta_1*(1-\beta_2)=0.25$ 0.332	0.521	0.513	1.856

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.43. Naïve Sticky Information Model – Gender Disaggregated Forecasts – Volatile Sample Period

Testing Equation:

$$(1). E_t^H[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + \beta_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

$$(2). E_{t,H}[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + (1-\beta_1)E_{t-j,H}[\pi_{t+h-j}] + \epsilon_t$$

$$(3). E_t^H[\pi_{t+h}] = \beta_0 + \beta_1(\beta_2\pi_{t-1} + (1-\beta_2)E_t^P[\pi_{t+h}]) + (1-\beta_1)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

		β_0	β_1	$(1-\beta_1)$	β_2	$(1-\beta_2)$	Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
					Period: Volatile 2006Q3 – 2011Q1					
MALE	(1)		0.219** (0.091)		0.794*** (0.073)		$\beta_1+\beta_2=1$ 0.142	0.005	-0.053	1.815
	(2)		0.207 (0.123)	0.793*** (0.123)			$\beta_1=0.18$ 0.048	0.004	0.004	1.807
	(3)		0.411*** (0.105)	0.589*** (0.105)	0.352 (0.287)	0.648** (0.287)	$\beta_1=0.25$ 2.330 $\beta_1*(1-\beta_2)=0.25$ 0.009	0.110	0.058	1.611
FEMALE	(1)		0.144*** (0.049)		0.907*** (0.045)		$\beta_1+\beta_2=1$ 2.831*	0.336	0.297	1.231
	(2)		0.087 (0.073)	0.913*** (0.073)			$\beta_1=0.18$ 1.660	0.299	0.299	1.189
	(3)		0.069 (0.071)	0.931*** (0.071)	1.431 (1.795)	-0.431 (1.795)	$\beta_1=0.25$ 6.446** $\beta_1*(1-\beta_2)=0.25$ 8.325***	0.302	0.260	1.210

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.44. Naïve Sticky Information Model – Income Disaggregated Forecasts – Whole Sample Period

Testing Equation:

$$(1).\ E_t^H[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + \beta_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

$$(2).\ E_{t,H}[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + (1-\beta_1)E_{t-j,H}[\pi_{t+h-j}] + \epsilon_t$$

$$(3).\ E_t^H[\pi_{t+h}] = \beta_0 + \beta_1(\beta_2\pi_{t-1} + (1-\beta_2)E_t^P[\pi_{t+h}]) + (1-\beta_1)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

		β_0	β_1	$(1-\beta_1)$	β_2	$(1-\beta_2)$	Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
					Period: Whole 1982Q3 – 2011Q1					
Y14	**(1)**		0.133*** (0.044)		0.873*** (0.040)		$\beta_1+\beta_2=1$ 0.315	0.266	0.260	2.651
	(2)		0.125*** (0.040)	0.875*** (0.040)			$\beta_1=0.18$ 1.943	0.265	0.265	2.653
	(3)		0.145*** (0.037)	0.855*** (0.037)	0.666*** (0.238)	0.334 (0.238)	$\beta_1=0.25$ 7.889*** $\beta_1*(1-\beta_2)=0.25$ 24.603***	0.270	0.263	2.609
Y24	**(1)**		0.192*** (0.047)		0.804*** (0.049)		$\beta_1+\beta_2=1$ 0.142	0.256	0.249	2.168
	(2)		0.194*** (0.049)	0.806*** (0.049)			$\beta_1=0.18$ 0.085	0.255	0.255	2.170
	(3)		0.230*** (0.026)	0.770*** (0.026)	0.731*** (0.162)	0.269* (0.162)	$\beta_1=0.25$ 0.558 $\beta_1*(1-\beta_2)=0.25$ 22.329***	0.263	0.257	2.114
Y34	**(1)**		0.185*** (0.065)		0.792*** (0.070)		$\beta_1+\beta_2=1$ 4.654**	0.206	0.199	2.291
	(2)		0.182*** (0.065)	0.818*** (0.065)			$\beta_1=0.18$ 0.001	0.192	0.192	2.316
	(3)		0.236*** (0.057)	0.764*** (0.057)	0.624*** (0.171)	0.376** (0.171)	$\beta_1=0.25$ 0.063 $\beta_1*(1-\beta_2)=0.25$ 13.297***	0.209	0.202	2.210
Y44	**(1)**		0.303*** (0.073)		0.653*** (0.083)		$\beta_1+\beta_2=1$ 5.366**	0.306	0.299	1.820
	(2)		0.276*** (0.075)	0.724*** (0.075)			$\beta_1=0.18$ 1.634	0.274	0.274	1.889
	(3)		0.392*** (0.099)	0.608*** (0.099)	0.552*** (0.166)	0.448*** (0.166)	$\beta_1=0.25$ 2.058 $\beta_1*(1-\beta_2)=0.25$ 0.145	0.321	0.315	1.763

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.45. Naïve Sticky Information Model – Income Disaggregated Forecasts – Greenspan-Bernanke Sample Period

Testing Equation:

$$(1).\ E_t^H[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + \beta_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

$$(2).\ E_{t,H}[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + (1-\beta_1)E_{t-j,H}[\pi_{t+h-j}] + \epsilon_t$$

$$(3).\ E_t^H[\pi_{t+h}] = \beta_0 + \beta_1(\beta_2\pi_{t-1} + (1-\beta_2)E_t^P[\pi_{t+h}]) + (1-\beta_1)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

		β_0	β_1	$(1-\beta_1)$	β_2	$(1-\beta_2)$	Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
					Period: Greenspan-Bernanke 1987Q2 – 2011Q1					
Y14	(1)		0.139*** (0.048)		0.877*** (0.043)		$\beta_1 + \beta_2 = 1$ 1.445	0.318	0.311	2.686
	(2)		0.117*** (0.042)	0.883*** (0.042)			$\beta_1 = 0.18$ 2.270	0.312	0.312	2.686
	(3)		0.140*** (0.038)	0.860*** (0.038)	0.574* (0.330)	0.426 (0.330)	$\beta_1 = 0.25$ 8.571*** $\beta_1 * (1-\beta_2) = 0.25$ 3.820*	0.318	0.310	2.646
Y24	(1)		0.173*** (0.034)		0.830*** (0.036)		$\beta_1 + \beta_2 = 1$ 0.074	0.320	0.313	2.020
	(2)		0.171*** (0.046)	0.829*** (0.046)			$\beta_1 = 0.18$ 0.038	0.320	0.320	2.018
	(3)		0.216*** (0.027)	0.784*** (0.027)	0.635*** (0.220)	0.365 (0.220)	$\beta_1 = 0.25$ 1.513 $\beta_1 * (1-\beta_2) = 0.25$ 8.079***	0.329	0.322	1.969
Y34	(1)		0.146*** (0.054)		0.841*** (0.058)		$\beta_1 + \beta_2 = 1$ 1.199	0.349	0.342	1.951
	(2)		0.145*** (0.049)	0.855*** (0.049)			$\beta_1 = 0.18$ 0.515	0.345	0.345	1.967
	(3)		0.215*** (0.059)	0.785*** (0.059)	0.490** (0.235)	0.510** (0.235)	$\beta_1 = 0.25$ 0.344 $\beta_1 * (1-\beta_2) = 0.25$ 4.374**	0.364	0.357	1.885
Y44	(1)		0.288*** (0.078)		0.666*** (0.090)		$\beta_1 + \beta_2 = 1$ 4.592**	0.286	0.278	1.781
	(2)		0.256*** (0.088)	0.744*** (0.088)			$\beta_1 = 0.18$ 0.745	0.253	0.253	1.859
	(3)		0.464*** (0.128)	0.563*** (0.128)	0.370*** (0.124)	0.630*** (0.124)	$\beta_1 = 0.25$ 2.811 $\beta_1 * (1-\beta_2) = 0.25$ 0.802	0.341	0.334	1.672

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.46. Naïve Sticky Information Model – Income Disaggregated Forecasts – Stable Sample Period

Testing Equation:

$$(1).\ E_t^H[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + \beta_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

$$(2).\ E_{t,H}[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + (1-\beta_1)E_{t-j,H}[\pi_{t+h-j}] + \epsilon_t$$

$$(3).\ E_t^H[\pi_{t+h}] = \beta_0 + \beta_1(\beta_2\pi_{t-1} + (1-\beta_2)E_t^P[\pi_{t+h}]) + (1-\beta_1)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

		β_0	β_1	$(1-\beta_1)$	β_2	$(1-\beta_2)$	Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
					Period: Stable 1990Q1 – 2006Q2					
Y14	**(1)**		0.265* (0.159)		0.757*** (0.136)		$\beta_1+\beta_2=1$ 0.588	0.141	0.128	2.448
	(2)		0.220** (0.088)	0.780*** (0.088)			$\beta_1=0.18$ 0.207	0.128	0.128	2.488
	(3)		0.268*** (0.100)	0.732*** (0.100)	0.616* (0.317)	0.384 (0.317)	$\beta_1=0.25$ 0.032 $\beta_1*(1-\beta_2)=0.25$ 3.871**	0.142	0.129	2.410
Y24	**(1)**		0.203*** (0.058)		0.796*** (0.058)		$\beta_1+\beta_2=1$ 0.000	0.344	0.334	1.960
	(2)		0.204*** (0.044)	0.796*** (0.044)			$\beta_1=0.18$ 0.286	0.344	0.344	1.960
	(3)		0.318*** (0.089)	0.682*** (0.089)	0.538*** (0.191)	0.462** (0.191)	$\beta_1=0.25$ 0.577 $\beta_1*(1-\beta_2)=0.25$ 3.340*	0.372	0.362	1.797
Y34	**(1)**		0.211** (0.105)		0.766*** (0.115)		$\beta_1+\beta_2=1$ 1.337	0.359	0.349	2.154
	(2)		0.192* (0.096)	0.808*** (0.096)			$\beta_1=0.18$ 0.016	0.345	0.345	2.201
	(3)		0.423** (0.183)	0.577*** (0.183)	0.373*** (0.122)	0.627*** (0.122)	$\beta_1=0.25$ 0.896 $\beta_1*(1-\beta_2)=0.25$ 0.715	0.416	0.407	1.924
Y44	**(1)**		0.297*** (0.077)		0.657*** (0.095)		$\beta_1+\beta_2=1$ 3.029*	0.302	0.291	2.102
	(2)		0.241*** (0.077)	0.759*** (0.077)			$\beta_1=0.18$ 0.625	0.255	0.255	2.234
	(3)		0.481** (0.206)	0.519** (0.206)	0.350*** (0.075)	0.650*** (0.075)	$\beta_1=0.25$ 1.256 $\beta_1*(1-\beta_2)=0.25$ 0.254	0.342	0.332	1.892

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.47. Naïve Sticky Information Model – Income Disaggregated Forecasts – Volatile Sample Period

Testing Equation:

$$(1).\ E_t^H[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + \beta_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

$$(2).\ E_{t,H}[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + (1-\beta_1)E_{t-j,H}[\pi_{t+h-j}] + \epsilon_t$$

$$(3).\ E_t^H[\pi_{t+h}] = \beta_0 + \beta_1(\beta_2\pi_{t-1} + (1-\beta_2)E_t^P[\pi_{t+h}]) + (1-\beta_1)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

		β_0	β_1	$(1-\beta_1)$	β_2	$(1-\beta_2)$	Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
					Period: Volatile 2006Q3- 2011Q1					
Y14	**(1)**		0.121 (0.072)		0.920*** (0.060)		$\beta_1 + \beta_2 = 1$ 0.977	0.109	0.056	2.387
	(2)		0.068 (0.051)	0.932*** (0.051)			$\beta_1 = 0.18$ 4.870**	0.089	0.089	2.341
	(3)		0.073 (0.085)	0.927*** (0.085)	0.829 (1.045)	0.171 (1.045)	$\beta_1 = 0.25$ 4.366** $\beta_1 * (1-\beta_2) = 0.25$ 0.813	0.090	0.036	2.326
Y24	**(1)**		0.214** (0.100)		0.839*** (0.095)		$\beta_1 + \beta_2 = 1$ 1.461	0.106	0.054	1.997
	(2)		0.153* (0.085)	0.847*** (0.085)			$\beta_1 = 0.18$ 0.104	0.075	0.075	1.970
	(3)		0.174*** (0.045)	0.826*** (0.045)	0.779 (0.462)	0.221 (0.462)	$\beta_1 = 0.25$ 2.816* $\beta_1 * (1-\beta_2) = 0.25$ 3.034	0.078	0.024	1.945
Y34	**(1)**		0.172** (0.076)		0.861*** (0.055)		$\beta_1 + \beta_2 = 1$ 1.299	0.278	0.236	1.452
	(2)		0.142 (0.090)	0.858*** (0.090)			$\beta_1 = 0.18$ 0.181	0.264	0.264	1.414
	(3)		0.210*** (0.063)	0.790*** (0.063)	0.551 (0.493)	0.449 (0.493)	$\beta_1 = 0.25$ 0.411 $\beta_1 * (1-\beta_2) = 0.25$ 1.205	0.281	0.239	1.339
Y44	**(1)**		0.292 (0.324)		0.673* (0.344)		$\beta_1 + \beta_2 = 1$ 0.226	0.029	-0.028	1.514
	(2)		0.315 (0.328)	0.685* (0.328)			$\beta_1 = 0.18$ 0.170	0.021	0.021	1.528
	(3)		0.804*** (0.120)	0.196 (0.120)	0.337* (0.188)	0.663*** (0.188)	$\beta_1 = 0.25$ 21.385*** $\beta_1 * (1-\beta_2) = 0.25$ 1.228	0.293	0.252	1.345

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.48. Naïve Sticky Information Model – Regionally Disaggregated Forecasts – Whole Sample Period

Testing Equation:

$$(1).\ E_t^H[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + \beta_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

$$(2).\ E_{t,H}[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + (1-\beta_1)E_{t-j,H}[\pi_{t+h-j}] + \epsilon_t$$

$$(3).\ E_t^H[\pi_{t+h}] = \beta_0 + \beta_1(\beta_2\pi_{t-1} + (1-\beta_2)E_t^P[\pi_{t+h}]) + (1-\beta_1)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

		β_0	β_1	$(1-\beta_1)$	β_2	$(1-\beta_2)$	Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
					Period: Whole 1982Q3 – 2011Q1					
NC	(1)		0.146*** (0.041)		0.845*** (0.043)		$\beta_1+\beta_2=1$ 0.758	0.244	0.237	2.120
	(2)		0.147*** (0.040)	0.853*** (0.040)			$\beta_1=0.18$ 0.671	0.241	0.241	2.132
	(3)		0.182*** (0.033)	0.818*** (0.033)	0.666*** (0.202)	0.334 (0.202)	$\beta_1=0.25$ 4.167** $\beta_1*(1-\beta_2)=0.25$ 23.756***	0.250	0.244	2.084
NE	(1)		0.270*** (0.087)		0.716*** (0.091)		$\beta_1+\beta_2=1$ 0.896	0.313	0.307	2.210
	(2)		0.276*** (0.092)	0.724*** (0.092)			$\beta_1=0.18$ 1.077	0.309	0.309	2.218
	(3)		0.395*** (0.071)	0.605*** (0.071)	0.567*** (0.174)	0.433** (0.174)	$\beta_1=0.25$ 4.180** $\beta_1*(1-\beta_2)=0.25$ 1.438	0.348	0.342	2.048
S	(1)		0.140*** (0.040)		0.849*** (0.042)		$\beta_1+\beta_2=1$ 1.241	0.287	0.281	2.100
	(2)		0.143*** (0.039)	0.857*** (0.039)			$\beta_1=0.18$ 0.894	0.284	0.284	2.107
	(3)		0.175*** (0.031)	0.825*** (0.031)	0.703*** (0.183)	0.297 (0.183)	$\beta_1=0.25$ 5.870** $\beta_1*(1-\beta_2)=0.25$ 34.707***	0.290	0.284	2.050
W	(1)		0.229*** (0.071)		0.756*** (0.076)		$\beta_1+\beta_2=1$ 1.661	0.297	0.291	2.468
	(2)		0.234*** (0.072)	0.766*** (0.072)			$\beta_1=0.18$ 0.555	0.291	0.291	2.478
	(3)		0.336*** (0.068)	0.664*** (0.068)	0.569*** (0.125)	0.431*** (0.125)	$\beta_1=0.25$ 1.619 $\beta_1*(1-\beta_2)=0.25$ 4.942**	0.328	0.322	2.270

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.49. Naïve Sticky Information Model – Regionally Disaggregated Forecasts – Greenspan-Bernanke Sample Period

Testing Equation:

$$(1).\ E_t^H[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + \beta_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

$$(2).\ E_{t,H}[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + (1-\beta_1)E_{t-j,H}[\pi_{t+h-j}] + \epsilon_t$$

$$(3).\ E_t^H[\pi_{t+h}] = \beta_0 + \beta_1(\beta_2\pi_{t-1} + (1-\beta_2)E_t^P[\pi_{t+h}]) + (1-\beta_1)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

		β_0	β_1	$(1-\beta_1)$	β_2	$(1-\beta_2)$	Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
					Period: Greenspan-Bernanke 1987Q2 – 2011Q1					
NC	(1)		0.127*** (0.041)		0.869*** (0.041)		$\beta_1+\beta_2=1$ 0.116	0.347	0.340	1.964
	(2)		0.128*** (0.041)	0.872*** (0.041)			$\beta_1=0.18$ 1.577	0.346	0.346	1.968
	(3)		0.192*** (0.041)	0.808*** (0.041)	0.463* (0.278)	0.537* (0.278)	$\beta_1=0.25$ 1.974 $\beta_1*(1-\beta_2)=0.25$ 4.986**	0.362	0.356	1.891
NE	(1)		0.220*** (0.078)		0.770*** (0.081)		$\beta_1+\beta_2=1$ 0.416	0.380	0.373	2.004
	(2)		0.222*** (0.081)	0.778*** (0.081)			$\beta_1=0.18$ 0.275	0.378	0.378	2.014
	(3)		0.350*** (0.073)	0.650*** (0.073)	0.452** (0.210)	0.548** (0.210)	$\beta_1=0.25$ 1.900 $\beta_1*(1-\beta_2)=0.25$ 0.396	0.416	0.409	1.871
S	(1)		0.134*** (0.045)		0.863*** (0.045)		$\beta_1+\beta_2=1$ 0.071	0.316	0.309	2.004
	(2)		0.135*** (0.042)	0.865*** (0.042)			$\beta_1=0.18$ 1.154	0.316	0.316	2.007
	(3)		0.192*** (0.029)	0.808*** (0.029)	0.522** (0.240)	0.478** (0.240)	$\beta_1=0.25$ 3.862** $\beta_1*(1-\beta_2)=0.25$ 10.083	0.331	0.324	1.941
W	(1)		0.178*** (0.052)		0.815*** (0.054)		$\beta_1+\beta_2=1$ 0.435	0.433	0.427	2.093
	(2)		0.180*** (0.046)	0.820*** (0.046)			$\beta_1=0.18$ 0.000	0.432	0.432	2.100
	(3)		0.285*** (0.051)	0.715*** (0.051)	0.479*** (0.177)	0.521*** (0.177)	$\beta_1=0.25$ 0.473 $\beta_1*(1-\beta_2)=0.25$ 2.508	0.461	0.455	1.970

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.50. Naïve Sticky Information Model – Regionally Disaggregated Forecasts – Stable Sample Period

Testing Equation:

$$(1).\ E_t^H[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + \beta_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

$$(2).\ E_{t,H}[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + (1-\beta_1)E_{t-j,H}[\pi_{t+h-j}] + \epsilon_t$$

$$(3).\ E_t^H[\pi_{t+h}] = \beta_0 + \beta_1(\beta_2\pi_{t-1} + (1-\beta_2)E_t^P[\pi_{t+h}]) + (1-\beta_1)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

		β_0	β_1	$(1-\beta_1)$	β_2	$(1-\beta_2)$	Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
					Period: Stable 1990Q1 – 2006Q2					
NC	**(1)**		0.192**		0.796***		$\beta_1 + \beta_2 = 1$	0.335	0.324	2.080
			(0.075)		(0.079)		0.439			
	(2)		0.190***	0.810***			$\beta_1 = 0.18$	0.330	0.330	2.097
			(0.069)	(0.069)			0.020			
	(3)		0.407***	0.593***	0.356**	0.644***	$\beta_1 = 0.25$	0.403	0.394	1.827
			(0.126)	(0.126)	(0.144)	(0.144)	1.560			
							$\beta_1 * (1-\beta_2) = 0.25$			
							0.011			
NE	**(1)**		0.340**		0.632***		$\beta_1 + \beta_2 = 1$	0.392	0.382	1.988
			(0.162)		(0.168)		1.303			
	(2)		0.323**	0.677***			$\beta_1 = 0.18$	0.374	0.374	2.035
			(0.156)	(0.156)			0.846			
	(3)		0.547***	0.453**	0.483***	0.517***	$\beta_1 = 0.25$	0.448	0.439	1.763
			(0.200)	(0.200)	(0.136)	(0.136)	2.208			
							$\beta_1 * (1-\beta_2) = 0.25$			
							0.065			
S	**(1)**		0.135**		0.856***		$\beta_1 + \beta_2 = 1$	0.393	0.384	2.059
			(0.054)		(0.056)		0.444			
	(2)		0.136***	0.864***			$\beta_1 = 0.18$	0.390	0.390	2.066
			(0.035)	(0.035)			1.584			
	(3)		0.283***	0.717***	0.392**	0.608***	$\beta_1 = 0.25$	0.426	0.417	1.871
			(0.091)	(0.091)	(0.171)	(0.171)	0.135			
							$\beta_1 * (1-\beta_2) = 0.25$			
							0.682			
W	**(1)**		0.225***		0.764***		$\beta_1 + \beta_2 = 1$	0.428	0.419	2.184
			(0.058)		(0.059)		0.648			
	(2)		0.224***	0.776***			$\beta_1 = 0.18$	0.424	0.424	2.197
			(0.058)	(0.058)			0.575			
	(3)		0.463***	0.537***	0.418***	0.582***	$\beta_1 = 0.25$	0.493	0.485	1.871
			(0.139)	(0.139)	(0.150)	(0.150)	2.343			
							$\beta_1 * (1-\beta_2) = 0.25$			
							0.021			

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.51. Naïve Sticky Information Model – Regionally Disaggregated Forecasts – Volatile Sample Period

Testing Equation:

$$(1).\ E_t^H[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + \beta_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

$$(2).\ E_{t,H}[\pi_{t+h}] = \beta_0 + \beta_1\pi_{t-k} + (1-\beta_1)E_{t-j,H}[\pi_{t+h-j}] + \epsilon_t$$

$$(3).\ E_t^H[\pi_{t+h}] = \beta_0 + \beta_1(\beta_2\pi_{t-1} + (1-\beta_2)E_t^P[\pi_{t+h}]) + (1-\beta_1)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

		β_0	β_1	$(1-\beta_1)$	β_2	$(1-\beta_2)$	Wald χ^2 Test	R^2	$\bar{R}^2$	D.W. Stat
					Period: Volatile 2006Q3 – 2011Q1					
NC	(1)		0.146* (0.084)		0.896*** (0.068)		$\beta_1+\beta_2=1$ 2.156	0.262	0.218	1.529
	(2)		0.103 (0.091)	0.897*** (0.091)			$\beta_1=0.18$ 0.712	0.234	0.234	1.461
	(3)		0.118 (0.070)	0.882*** (0.070)	0.806 (0.764)	0.194 (0.764)	$\beta_1=0.25$ 3.527* $\beta_1*(1-\beta_2)=0.25$ 5.366**	0.235	0.190	1.439
NE	(1)		0.196** (0.074)		0.842*** (0.067)		$\beta_1+\beta_2=1$ 0.885	0.066	0.011	1.742
	(2)		0.156 (0.131)	0.844*** (0.131)			$\beta_1=0.18$ 0.034	0.051	0.051	1.719
	(3)		0.247* (0.122)	0.753*** (0.122)	0.455 (0.493)	0.545 (0.493)	$\beta_1=0.25$ 0.001 $\beta_1*(1-\beta_2)=0.25$ 0.404	0.081	0.081	1.622
S	(1)		0.163* (0.077)		0.875*** (0.062)		$\beta_1+\beta_2=1$ 1.798	0.101	0.049	1.762
	(2)		0.125 (0.100)	0.875*** (0.100)			$\beta_1=0.18$ 0.301	0.080	0.080	1.709
	(3)		0.165** (0.060)	0.835*** (0.060)	0.621 (0.560)	0.379 (0.560)	$\beta_1=0.25$ 1.999 $\beta_1*(1-\beta_2)=0.25$ 3.035*	0.089	0.035	1.645
W	(1)		0.185** (0.072)		0.840*** (0.059)		$\beta_1+\beta_2=1$ 1.122	0.224	0.178	1.824
	(2)		0.160 (0.116)	0.840*** (0.116)			$\beta_1=0.18$ 0.028	0.215	0.215	1.799
	(3)		0.247*** (0.063)	0.753*** (0.063)	0.517 (0.358)	0.483 (0.358)	$\beta_1=0.25$ 0.002 $\beta_1*(1-\beta_2)=0.25$ 1.428	0.241	0.197	1.701

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.52. Rational Updating Model – Age Disaggregated Forecasts – Whole Sample Period

Testing Equation:

$$(1).\ E_t^H[\pi_{t+h}] = \gamma_0 + \gamma_1\pi_{t+h} + \gamma_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

$$(2).\ E_{t,H}[\pi_{t+h}] = \gamma_0 + \gamma_1\pi_{t+h} + (1-\gamma_1)E_{t-j,H}[\pi_{t+h-j}] + \epsilon_t$$

$$(3).\ E_t^H[\pi_{t+h}] = \gamma_0 + \gamma_1(\gamma_2\pi_{t+h} + (1-\gamma_2)E_t^P[\pi_{t+h}]) + (1-\gamma_1)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

		γ_0	γ_1	$(1-\gamma_1)$	γ_2	$(1-\gamma_2)$	Wald χ^2 Test	J-Stat
				Period: Whole 1982Q3 – 2011Q1				
A1834	**(1)**		0.349*** (0.061)		0.662*** (0.052)		$\beta_1 + \beta_2 = 1$ 0.561	13.025
	(2)		0.327*** (0.044)		0.673*** (0.044)		$\beta_1 = 0.18$ 11.262***	12.843
	(3)		0.378*** (0.072)	0.622*** (0.072)	0.736*** (0.109)	0.264** (0.109)	$\beta_1 = 0.25$ 3.165*	12.341
A3445	**(1)**		0.255*** (0.055)		0.751*** (0.050)		$\beta_1 + \beta_2 = 1$ 0.332	12.366
	(2)		0.265*** (0.057)		0.735*** (0.057)		$\beta_1 = 0.18$ 2.177	12.403
	(3)		0.272*** (0.077)	0.728*** (0.077)	0.876*** (0.207)	0.124 (0.207)	$\beta_1 = 0.25$ 0.080	12.516
A4554	**(1)**		0.250*** (0.036)		0.760*** (0.033)		$\beta_1 + \beta_2 = 1$ 1.692	23.283
	(2)		0.235*** (0.039)		0.765*** (0.039)		$\beta_1 = 0.18$ 1.921	11.053
	(3)		0.237*** (0.047)	0.763*** (0.047)	1.171*** (0.179)	-0.171 (0.179)	$\beta_1 = 0.25$ 0.074	10.663
A5564	**(1)**		0.170*** (0.035)		0.821*** (0.040)		$\beta_1 + \beta_2 = 1$ 0.771	12.894
	(2)		0.168*** (0.036)		0.832*** (0.036)		$\beta_1 = 0.18$ 0.111	13.050
	(3)		0.148*** (0.054)	0.852*** (0.054)	0.693 (0.590)	0.307 (0.590)	$\beta_1 = 0.25$ 3.512*	13.707
A6597	**(1)**		0.161*** (0.045)		0.841*** (0.051)		$\beta_1 + \beta_2 = 1$ 0.055	14.207
	(2)		0.174*** (0.050)		0.826*** (0.050)		$\beta_1 = 0.18$ 0.012	14.416
	(3)		0.166** (0.065)	0.834*** (0.065)	0.707 (0.625)	0.293 (1.625)	$\beta_1 = 0.25$ 1.703	14.864

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.53. Rational Updating Model – Age Disaggregated Forecasts – Greenspan-Bernanke Sample Period

Testing Equation:

$$(1).\ E_t^H[\pi_{t+h}] = \gamma_0 + \gamma_1\pi_{t+h} + \gamma_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

$$(2).\ E_{t,H}[\pi_{t+h}] = \gamma_0 + \gamma_1\pi_{t+h} + (1-\gamma_1)E_{t-j,H}[\pi_{t+h-j}] + \epsilon_t$$

$$(3).\ E_t^H[\pi_{t+h}] = \gamma_0 + \gamma_1(\gamma_2\pi_{t+h} + (1-\gamma_2)E_t^P[\pi_{t+h}]) + (1-\gamma_1)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

		γ_0	γ_1	$(1-\gamma_1)$	γ_2	$(1-\gamma_2)$	Wald χ^2 Test	J-Stat
Period: Greenspan-Bernanke 1987Q2 – 2011Q1								
A1834	**(1)**		0.204*** (0.034)		0.805*** (0.032)		$\beta_1+\beta_2=1$ 3.435*	11.150
	(2)		0.200*** (0.035)		0.800*** (0.035)		$\beta_1=0.18$ 0.333	11.608
	(3)		0.195*** (0.065)	0.805*** (0.065)	0.891 (0.662)	0.109 (0.662)	$\beta_1=0.25$ 0.714	12.191
A3445	**(1)**		0.173*** (0.042)		0.836*** (0.043)		$\beta_1+\beta_2=1$ 2.895*	10.112
	(2)		0.184*** (0.042)		0.816*** (0.042)		$\beta_1=0.18$ 0.010	10.615
	(3)		0.158*** (0.059)	0.842*** (0.059)	1.070 (0.919)	-0.070 (0.919)	$\beta_1=0.25$ 2.458	10.999
A4554	**(1)**		0.147*** (0.016)		0.856*** (0.016)		$\beta_1+\beta_2=1$ 0.493	8.745
	(2)		0.175*** (0.027)		0.825*** (0.027)		$\beta_1=0.18$ 0.029	10.480
	(3)		0.168*** (0.024)	0.832*** (0.024)	1.017*** (0.322)	-0.017 (0.322)	$\beta_1=0.25$ 11.349***	10.855
A5564	**(1)**		0.133*** (0.042)		0.867*** (0.047)		$\beta_1+\beta_2=1$ 0.000	12.774
	(2)		0.137*** (0.038)		0.863*** (0.038)		$\beta_1=0.18$ 1.291	12.750
	(3)		0.074* (0.044)	0.926*** (0.044)	-1.710 (1.719)	2.710 (1.719)	$\beta_1=0.25$ 15.869***	14.509
A6597	**(1)**		0.098*** (0.025)		0.909*** (0.027)		$\beta_1+\beta_2=1$ 2.010	11.936
	(2)		0.104*** (0.032)		0.896*** (0.032)		$\beta_1=0.18$ 5.540**	12.519
	(3)		0.070 (0.086)	0.930*** (0.086)	-4.410 (5.898)	5.410 (4.898)	$\beta_1=0.25$ 4.399**	12.578

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.54. Rational Updating Model – Age Disaggregated Forecasts – Stable Sample Period

Testing Equation:

$$(1).\, E_t^H[\pi_{t+h}] = \gamma_0 + \gamma_1\pi_{t+h} + \gamma_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

$$(2).\, E_{t,H}[\pi_{t+h}] = \gamma_0 + \gamma_1\pi_{t+h} + (1-\gamma_1)E_{t-j,H}[\pi_{t+h-j}] + \epsilon_t$$

$$(3).\, E_t^H[\pi_{t+h}] = \gamma_0 + \gamma_1(\gamma_2\pi_{t+h} + (1-\gamma_2)E_t^P[\pi_{t+h}]) + (1-\gamma_1)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

		γ_0	γ_1	$(1-\gamma_1)$	γ_2	$(1-\gamma_2)$	Wald χ^2 Test	J-Stat
				Period: Stable 1990Q1 – 2006Q2				
A1834	**(1)**		0.815*** (0.192)		0.258 (0.181)		$\beta_1+\beta_2=1$ 11.094***	5.052
	(2)		0.507*** (0.069)		0.493*** (0.069)		$\beta_1=0.18$ 22.224***	8.013
	(3)		0.645*** (0.055)	0.355*** (0.055)	0.625*** (0.080)	0.375*** (0.080)	$\beta_1=0.25$ 51.341***	6.189
A3445	**(1)**		0.875*** (0.061)		0.200*** (0.055)		$\beta_1+\beta_2=1$ 15.607***	4.584
	(2)		0.620*** (0.052)		0.380*** (0.052)		$\beta_1=0.18$ 71.501***	7.848
	(3)		0.665*** (0.058)	0.335*** (0.058)	0.768*** (0.060)	0.232*** (0.060)	$\beta_1=0.25$ 51.955***	5.822
A4554	**(1)**		0.675*** (0.104)		0.372*** (0.111)		$\beta_1+\beta_2=1$ 6.243**	5.605
	(2)		0.487*** (0.033)		0.513*** (0.033)		$\beta_1=0.18$ 84.263***	7.672
	(3)		0.508** (0.034)	0.492*** (0.034)	0.956*** (0.137)	0.044 (0.137)	$\beta_1=0.25$ 58.384	7.240
A5564	**(1)**		0.863*** (0.105)		0.173** (0.082)		$\beta_1+\beta_2=1$ 1.244	6.106
	(2)		0.789 (44.345)		0.211 (44.345)		$\beta_1=0.18$ 0.000	7.009
	(3)		0.834*** (0.131)	0.166 (0.131)	0.933*** (0.176)	0.067 (0.176)	$\beta_1=0.25$ 19.981***	5.741
A6597	**(1)**		1.127*** (0.052)		-0.072 (0.055)		$\beta_1+\beta_2=1$ 2.316	4.550
	(2)		1.038*** (0.070)		-0.038 (0.070)		$\beta_1=0.18$ 148.524***	6.555
	(3)		1.046*** (0.156)	-0.046 (0.063)	0.926*** (0.150)	0.074*** (0.150)	$\beta_1=0.25$ 122.576***	5.714

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.55. Rational Updating Model – Age Disaggregated Forecasts – Volatile Sample Period

Testing Equation:

$$(1).\ E_t^H[\pi_{t+h}] = \gamma_0 + \gamma_1\pi_{t+h} + \gamma_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

$$(2).\ E_{t,H}[\pi_{t+h}] = \gamma_0 + \gamma_1\pi_{t+h} + (1-\gamma_1)E_{t-j,H}[\pi_{t+h-j}] + \epsilon_t$$

$$(3).\ E_t^H[\pi_{t+h}] = \gamma_0 + \gamma_1(\gamma_2\pi_{t+h} + (1-\gamma_2)E_t^P[\pi_{t+h}]) + (1-\gamma_1)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

		γ_0	γ_1	$(1-\gamma_1)$	γ_2	$(1-\gamma_2)$	Wald χ^2 Test	J-Stat
					Period: Volatile 2006Q3 – 2011Q1			
A1834	**(1)†**		-0.006 (0.034)		0.994*** (0.040)		$\beta_1 + \beta_2 = 1$ 1.066	4.706
	(2)†		-0.004 (0.026)		1.004*** (0.026)		$\beta_1 = 0.18$ 49.498***	5.289
	(3)†		0.212** (0.096)	0.788*** (0.096)	-0.575* (0.322)	1.575*** (0.322)	$\beta_1 = 0.25$ 0.158	6.240
A3445	**(1)†**		0.022 (0.029)		0.959*** (0.023)		$\beta_1 + \beta_2 = 1$ 1.299	6.235
	(2)†		0.036 (0.024)		0.964*** (0.024)		$\beta_1 = 0.18$ 35.344***	6.182
	(3)†		0.256*** (0.034)	0.744*** (0.034)	-0.382*** (0.103)	1.382*** (0.103)	$\beta_1 = 0.25$ 0.034	6.249
A4554	**(1)†**		0.032 (0.050)		0.955*** (0.048)		$\beta_1 + \beta_2 = 1$ 0.379	5.952
	(2)†		0.044 (0.044)		0.956*** (0.045)		$\beta_1 = 0.18$ 9.367***	5.932
	(3)†		0.194*** (0.029)	0.806*** (0.029)	-0.309 (0.388)	1.309*** (0.388)	$\beta_1 = 0.25$ 3.675*	6.132
A5564	**(1)†**		-0.000 (0.020)		0.979*** (0.023)		$\beta_1 + \beta_2 = 1$ 1.529	6.068
	(2)†		0.016 (0.020)		0.984*** (0.020)		$\beta_1 = 0.18$ 70.817***	5.982
	(3)		0.177** (0.074)	0.823*** (0.074)	-0.548 (0.328)	1.548*** (0.328)	$\beta_1 = 0.25$ 0.987	6.093
A6597	**(1)†**		-0.013 (0.026)		1.008*** (0.025)		$\beta_1 + \beta_2 = 1$ 0.239	6.308
	(2)†		-0.009 (0.025)		1.009*** (0.025)		$\beta_1 = 0.18$ 57.784***	6.286
	(3)†		0.105*** (0.034)	0.895*** (0.034)	-0.768* (0.393)	1.768*** (0.393)	$\beta_1 = 0.25$ 18.041***	6.320

***,**,* indicate significance at 1, 5 and 10 percent levels.

†Due to length of volatile period, no lag can be specified for the Newey-West covariance matrix

Appendix 5.56. Rational Updating Model – Education Disaggregated Forecasts – Whole Sample Period

Testing Equation:

$$(1). E_t^H[\pi_{t+h}] = \gamma_0 + \gamma_1\pi_{t+h} + \gamma_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

$$(2). E_{t,H}[\pi_{t+h}] = \gamma_0 + \gamma_1\pi_{t+h} + (1-\gamma_1)E_{t-j,H}[\pi_{t+h-j}] + \epsilon_t$$

$$(3). E_t^H[\pi_{t+h}] = \gamma_0 + \gamma_1(\gamma_2\pi_{t+h} + (1-\gamma_2)E_t^P[\pi_{t+h}]) + (1-\gamma_1)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

		γ_0	γ_1	$(1-\gamma_1)$	γ_2	$(1-\gamma_2)$	Wald χ^2 Test	J-Stat
				Period: Whole 1982Q3 – 2011Q1				
ELHS	**(1)**		0.204*** (0.058)		0.814*** (0.053)		$\beta_1 + \beta_2 = 1$ 1.588	13.620
	(2)		0.164*** (0.032)		0.836*** (0.032)		$\beta_1 = 0.18$ 0.240	14.077
	(3)		0.164*** (0.033)	0.836*** (0.033)	0.926*** (0.214)	0.074 (0.214)	$\beta_1 = 0.25$ 6.669***	14.251
EHSD	**(1)**		0.129*** (0.035)		0.873*** (0.037)		$\beta_1 + \beta_2 = 1$ 0.216	11.784
	(2)		0.130*** (0.031)		0.870*** (0.031)		$\beta_1 = 0.18$ 2.567	11.955
	(3)		0.128*** (0.034)	0.872*** (0.034)	0.945*** (0.204)	0.055 (0.204)	$\beta_1 = 0.25$ 12.620***	11.881
ESC	**(1)**		0.192*** (0.044)		0.809*** (0.045)		$\beta_1 + \beta_2 = 1$ 0.015	13.392
	(2)		0.195*** (0.047)		0.805*** (0.047)		$\beta_1 = 0.18$ 0.104	13.445
	(3)		0.194*** (0.051)	0.806*** (0.051)	1.143*** (0.189)	-0.143 (0.189)	$\beta_1 = 0.25$ 1.195	13.479
ECD	**(1)**		0.506*** (0.105)		0.471*** (0.105)		$\beta_1 + \beta_2 = 1$ 1.150	11.127
	(2)		0.495*** (0.090)		0.505*** (0.090)		$\beta_1 = 0.18$ 12.220	12.111
	(3)		0.496*** (0.095)	0.504*** (0.095)	0.870*** (0.173)	0.130 (0.173)	$\beta_1 = 0.25$ 6.646***	12.140
EGS	**(1)**		0.397*** (0.084)		0.615*** (0.083)		$\beta_1 + \beta_2 = 1$ 0.693	13.311
	(2)		0.383*** (0.089)		0.617*** (0.089)		$\beta_1 = 0.18$ 5.260	13.261
	(3)		0.477*** (0.077)	0.523*** (0.077)	0.428*** (0.071)	0.572*** (0.072)	$\beta_1 = 0.25$ 8.791***	14.070

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.57. Rational Updating Model – Education Disaggregated Forecasts – Greenspan-Bernanke Sample Period

Testing Equation:

$$(1).\ E_t^H[\pi_{t+h}] = \gamma_0 + \gamma_1\pi_{t+h} + \gamma_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

$$(2).\ E_{t,H}[\pi_{t+h}] = \gamma_0 + \gamma_1\pi_{t+h} + (1-\gamma_1)E_{t-j,H}[\pi_{t+h-j}] + \epsilon_t$$

$$(3).\ E_t^H[\pi_{t+h}] = \gamma_0 + \gamma_1(\gamma_2\pi_{t+h} + (1-\gamma_2)E_t^P[\pi_{t+h}]) + (1-\gamma_1)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

		γ_0	γ_1	$(1-\gamma_1)$	γ_2	$(1-\gamma_2)$	Wald χ^2 Test	J-Stat
				Period: Greenspan-Bernanke 1987Q2 – 2011Q1				
ELHS	**(1)**		0.213*** (0.059)		0.814*** (0.052)		$\beta_1+\beta_2=1$ 2.827*	13.451
	(2)		0.159*** (0.029)		0.841*** (0.029)		$\beta_1=0.18$ 0.513	14.540
	(3)		0.163*** (0.035)	0.837*** (0.035)	0.597 (1.356)	0.403 (1.356)	$\beta_1=0.25$ 6.220**	15.490*
EHSD	**(1)**		0.105** (0.040)		0.906*** (0.048)		$\beta_1+\beta_2=1$ 0.987	10.202
	(2)		0.093 (0.078)		0.907*** (0.078)		$\beta_1=0.18$ 1.242	11.434
	(3)		0.059 (0.055)	0.941*** (0.055)	-1.041 (1.136)	2.041* (1.136)	$\beta_1=0.25$ 158.907***	11.038
ESC	**(1)**		0.117*** (0.041)		0.891*** (0.046)		$\beta_1+\beta_2=1$ 1.015	13.053
	(2)		0.125*** (0.039)		0.875*** (0.039)		$\beta_1=0.18$ 1.976	13.596
	(3)		0.109** (0.049)	0.891*** (0.049)	0.987 (0.915)	0.013 (0.915)	$\beta_1=0.25$ 8.229***	12.239
ECD	**(1)**		0.285*** (0.077)		0.701*** (0.078)		$\beta_1+\beta_2=1$ 2.347	9.874
	(2)		0.260*** (0.084)		0.740*** (0.084)		$\beta_1=0.18$ 0.909	10.148
	(3)		0.243 (1.959)	0.757 (1.959)	0.210 (12.831)	0.790 (12.831)	$\beta_1=0.25$ 0.000	11.996
EGS	**(1)**		0.359*** (0.091)		0.642*** (0.095)		$\beta_1+\beta_2=1$ 0.001	10.936
	(2)		0.362*** (0.117)		0.638*** (0.117)		$\beta_1=0.18$ 2.417	10.943
	(3)		0.371** (0.172)	0.630*** (0.172)	-0.134 (1.181)	1.134 (1.181)	$\beta_1=0.25$ 0.495	14.497

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.58. Rational Updating Model – Education Disaggregated Forecasts – Stable Sample Period

Testing Equation:

$$(1).\ E_t^H[\pi_{t+h}] = \gamma_0 + \gamma_1\pi_{t+h} + \gamma_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

$$(2).\ E_{t,H}[\pi_{t+h}] = \gamma_0 + \gamma_1\pi_{t+h} + (1-\gamma_1)E_{t-j,H}[\pi_{t+h-j}] + \epsilon_t$$

$$(3).\ E_t^H[\pi_{t+h}] = \gamma_0 + \gamma_1(\gamma_2\pi_{t+h} + (1-\gamma_2)E_t^P[\pi_{t+h}]) + (1-\gamma_1)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

		γ_0	γ_1	$(1-\gamma_1)$	γ_2	$(1-\gamma_2)$	Wald χ^2 Test	J-Stat
					Period: Stable 1990Q1 – 2006Q2			
ELHS	**(1)**		1.016***		0.165		$\beta_1 + \beta_2 = 1$	8.373
			(0.220)		(0.178)		10.124***	
	(2)		0.315***		0.685***		$\beta_1 = 0.18$	12.568
			(0.029)		(0.029)		21.846***	
	(3)		0.273***	0.727***	1.434***	-0.434***	$\beta_1 = 0.25$	12.311
			(0.031)	(0.031)	(0.135)	(0.135)	0.585	
EHSD	**(1)**		1.004***		0.103		$\beta_1 + \beta_2 = 1$	5.113
			(0.130)		(0.168)		3.640**	
	(2)		0.516***		0.484***		$\beta_1 = 0.18$	9.774
			(0.075)		(0.075)		19.940***	
	(3)		0.522***	0.478***	0.825***	0.175	$\beta_1 = 0.25$	8.255
			(0.136)	(0.136)	(0.267)	(0.267)	3.976**	
ESC	**(1)**		0.837***		0.219***		$\beta_1 + \beta_2 = 1$	6.497
			(0.053)		(0.047)		8.476***	
	(2)		0.646***		0.354***		$\beta_1 = 0.18$	8.541
			(0.125)		(0.125)		13.924***	
	(3)		0.690***	0.310***	0.844***	0.156***	$\beta_1 = 0.25$	7.481
			(0.093)	(0.093)	(0.113)	(0.113)	22.324***	
ECD	**(1)**		0.833***		0.184***		$\beta_1 + \beta_2 = 1$	5.209
			(0.026)		(0.022)		0.718	
	(2)		0.804***		0.196***		$\beta_1 = 0.18$	5.581
			(0.028)		(0.028)		480.628***	
	(3)		0.860***	0.140***	0.834***	0.166	$\beta_1 = 0.25$	5.190
			(0.046)	(0.046)	(0.228)	(0.228)	176.915***	
EGS	**(1)**		0.700***		0.341***		$\beta_1 + \beta_2 = 1$	6.003
			(0.091)		(0.090)		3.080*	
	(2)		0.649***		0.351***		$\beta_1 = 0.18$	8.442
			(0.111)		(0.111)		17.919***	
	(3)		0.696***	0.304	0.692***	0.308*	$\beta_1 = 0.25$	5.739
			(0.209)	(0.209)	(0.175)	(0.175)	4.541**	

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.59. Rational Updating Model – Education Disaggregated Forecasts – Volatile Sample Period

Testing Equation:

$$(1).\ E_t^H[\pi_{t+h}] = \gamma_0 + \gamma_1\pi_{t+h} + \gamma_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

$$(2).\ E_{t,H}[\pi_{t+h}] = \gamma_0 + \gamma_1\pi_{t+h} + (1-\gamma_1)E_{t-j,H}[\pi_{t+h-j}] + \epsilon_t$$

$$(3).\ E_t^H[\pi_{t+h}] = \gamma_0 + \gamma_1(\gamma_2\pi_{t+h} + (1-\gamma_2)E_t^P[\pi_{t+h}]) + (1-\gamma_1)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

		γ_0	γ_1	$(1-\gamma_1)$	γ_2	$(1-\gamma_2)$	Wald χ^2 Test	J-Stat
					Period: Volatile 2006Q3 – 2011Q1			
ELHS	**(1)†**		0.135* (0.072)		0.903*** (0.060)		$\beta_1+\beta_2=1$ 1.844	5.703
	(2)†		0.082* (0.046)		0.918*** (0.046)		$\beta_1=0.18$ 4.481**	6.638
	(3)†		0.125** (0.051)	0.875*** (0.051)	0.540 (0.699)	0.460 (0.699)	$\beta_1=0.25$ 6.070**	6.190
EHSD	**(1)†**		0.031 (0.031)		0.981*** (0.022)		$\beta_1+\beta_2=1$ 0.646	5.884
	(2)†		0.018 (0.020)		0.982*** (0.020)		$\beta_1=0.18$ 65.613***	5.939
	(3)†		0.055 (0.041)	0.945*** (0.041)	-0.217 (0.596)	1.217* (0.596)	$\beta_1=0.25$ 22.360***	5.728
ESC	**(1)†**		0.028 (0.033)		0.963*** (0.032)		$\beta_1+\beta_2=1$ 1.079	5.577
	(2)†		0.035 (0.030)		0.965*** (0.030)		$\beta_1=0.18$ 23.190***	5.736
	(3)†		0.117*** (0.028)	0.883*** (0.028)	-0.379 (0.244)	1.379*** (0.244)	$\beta_1=0.25$ 22.436***	6.301
ECD	**(1)†**		-0.002 (0.034)		0.983*** (0.047)		$\beta_1+\beta_2=1$ 0.606	5.536
	(2)†		0.033 (0.022)		0.967*** (0.022)		$\beta_1=0.18$ 43.376***	5.774
	(3)†		0.448*** (0.116)	0.552*** (0.116)	-0.517*** (0.173)	1.517*** (0.173)	$\beta_1=0.25$ 2.886*	6.117
EGS	**(1)†**		0.026 (0.036)		0.931*** (0.047)		$\beta_1+\beta_2=1$ 4.108	5.252
	(2)†		0.063* (0.032)		0.937*** (0.032)		$\beta_1=0.18$ 13.060***	5.780
	(3)†		0.523*** (0.104)	0.477*** (0.104)	-0.360** (0.157)	1.360*** (0.158)	$\beta_1=0.25$ 6.923***	5.945

***,**,* indicate significance at 1, 5 and 10 percent levels.

†Due to length of volatile period, no lag can be specified for the Newey-West covariance matrix

Appendix 5.60. Rational Updating Model – Gender Disaggregated Forecasts – Whole Sample Period

Testing Equation:

$$(1).\ E_t^H[\pi_{t+h}] = \gamma_0 + \gamma_1\pi_{t+h} + \gamma_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

$$(2).\ E_{t,H}[\pi_{t+h}] = \gamma_0 + \gamma_1\pi_{t+h} + (1-\gamma_1)E_{t-j,H}[\pi_{t+h-j}] + \epsilon_t$$

$$(3).\ E_t^H[\pi_{t+h}] = \gamma_0 + \gamma_1(\gamma_2\pi_{t+h} + (1-\gamma_2)E_t^P[\pi_{t+h}]) + (1-\gamma_1)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

		γ_0	γ_1	$(1-\gamma_1)$	γ_2	$(1-\gamma_2)$	Wald χ^2 Test	J-Stat
				Period: Whole 1982Q3 – 2011Q1				
MALE	**(1)**		0.249***		0.733***		$\beta_1 + \beta_2 = 1$	12.098
			(0.057)		(0.058)		2.259	
	(2)		0.229***		0.771***		$\beta_1 = 0.18$	12.796
			(0.054)		(0.054)		0.820	
	(3)		0.230***	0.770***	1.158***	-0.158	$\beta_1 = 0.25$	12.494
			(0.061)	(0.060)	(0.255)	(0.255)	0.106	
FEMALE	**(1)**		0.173*		0.839***		$\beta_1 + \beta_2 = 1$	11.220
			(0.093)		(0.092)		3.069*	
	(2)		0.141		0.859***		$\beta_1 = 0.18$	11.849
			(0.265)		(0.265)		0.021	
	(3)		0.150	0.850***	0.830	0.170	$\beta_1 = 0.25$	12.005
			(0.266)	(0.266)	(0.629)	(0.629)	0.141	

***,**,* indicate significance at 1, 5 and 10 percent levels

Appendix 5.61. Rational Updating Model – Gender Disaggregated Forecasts – Greenspan-Bernanke Sample Period

Testing Equation:

$$(1).\ E_t^H[\pi_{t+h}] = \gamma_0 + \gamma_1\pi_{t+h} + \gamma_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

$$(2).\ E_{t,H}[\pi_{t+h}] = \gamma_0 + \gamma_1\pi_{t+h} + (1-\gamma_1)E_{t-j,H}[\pi_{t+h-j}] + \epsilon_t$$

$$(3).\ E_t^H[\pi_{t+h}] = \gamma_0 + \gamma_1(\gamma_2\pi_{t+h} + (1-\gamma_2)E_t^P[\pi_{t+h}]) + (1-\gamma_1)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

		γ_0	γ_1	$(1-\gamma_1)$	γ_2	$(1-\gamma_2)$	Wald χ^2 Test	J-Stat
				Period: Greenspan-Bernanke 1987Q2 – 2011Q1				
MALE	**(1)**		0.179***		0.817***		$\beta_1 + \beta_2 = 1$	10.757
			(0.042)		(0.045)		0.274	
	(2)		0.176***		0.824***		$\beta_1 = 0.18$	10.522
			(0.037)		(0.037)		0.010	
	(3)		0.150***	0.850***	0.815	0.185	$\beta_1 = 0.25$	10.794
			(0.045)	(0.589)	(0.589)	(0.589)	4.924**	
FEMALE	**(1)**		0.069***		0.943***		$\beta_1 + \beta_2 = 1$	9.571
			(0.017)		(0.022)		2.074	
	(2)		0.065**		0.935***		$\beta_1 = 0.18$	11.694
			(0.029)		(0.029)		15.598***	
	(3)		0.020	0.980***	-4.353	5.353	$\beta_1 = 0.25$	9.938
			(0.087)	(0.087)	(85.923)	(85.923)	7.003***	

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.62. Rational Updating Model – Gender Disaggregated Forecasts – Stable Sample Period

Testing Equation:

$$(1).\ E_t^H[\pi_{t+h}] = \gamma_0 + \gamma_1\pi_{t+h} + \gamma_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

$$(2).\ E_{t,H}[\pi_{t+h}] = \gamma_0 + \gamma_1\pi_{t+h} + (1-\gamma_1)E_{t-j,H}[\pi_{t+h-j}] + \epsilon_t$$

$$(3).\ E_t^H[\pi_{t+h}] = \gamma_0 + \gamma_1(\gamma_2\pi_{t+h} + (1-\gamma_2)E_t^P[\pi_{t+h}]) + (1-\gamma_1)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

		γ_0	γ_1	$(1-\gamma_1)$	γ_2	$(1-\gamma_2)$	Wald χ^2 Test	J-Stat
					Period: Stable 1990Q1 – 2006Q2			
MALE	(1)		0.744*** (0.033)		0.275*** (0.021)		$\beta_1+\beta_2=1$ 0.832	5.719
	(2)		0.725*** (0.020)		0.275*** (0.020)		$\beta_1=0.18$ 755.975***	6.177
	(3)		0.750*** (0.043)	0.250*** (0.043)	0.893*** (0.168)	0.107 (0.168)	$\beta_1=0.25$ 133.715***	5.475
FEMALE	(1)		0.877*** (0.031)		0.240*** (0.032)		$\beta_1+\beta_2=1$ 74.637***	4.787
	(2)		0.346*** (0.074)		0.654*** (0.074)		$\beta_1=0.18$ 5.029**	9.870
	(3)		0.364*** (0.057)	0.636*** (0.057)	0.933*** (0.071)	0.067 (0.071)	$\beta_1=0.25$ 3.942**	9.426

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.63. Rational Updating Model – Gender Disaggregated Forecasts – Volatile Sample Period

Testing Equation:

$$(1).\ E_t^H[\pi_{t+h}] = \gamma_0 + \gamma_1\pi_{t+h} + \gamma_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

$$(2).\ E_{t,H}[\pi_{t+h}] = \gamma_0 + \gamma_1\pi_{t+h} + (1-\gamma_1)E_{t-j,H}[\pi_{t+h-j}] + \epsilon_t$$

$$(3).\ E_t^H[\pi_{t+h}] = \gamma_0 + \gamma_1(\gamma_2\pi_{t+h} + (1-\gamma_2)E_t^P[\pi_{t+h}]) + (1-\gamma_1)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

		γ_0	γ_1	$(1-\gamma_1)$	γ_2	$(1-\gamma_2)$	Wald χ^2 Test	J-Stat
					Period: Volatile 2006Q3 – 2011Q1			
MALE	(1)		0.007 (0.034)		0.968*** (0.038)		$\beta_1+\beta_2=1$ 1.754	5.588
	(2)†		0.034 (0.031)		0.966*** (0.031)		$\beta_1=0.18$ 21.792***	5.962
	(3)		0.371*** (0.061)	0.629*** (0.061)	-0.399* (0.190)	1.399*** (0.192)	$\beta_1=0.25$ 3.698**	5.655
FEMALE	(1)†		-0.004 (0.019)		1.003*** (0.017)		$\beta_1+\beta_2=1$ 0.004	6.080
	(2)†		-0.004 (0.017)		1.004*** (0.017)		$\beta_1=0.18$ 122.180***	6.101
	(3)		0.049 (0.031)	0.951*** (0.031)	-1.033 (0.757)	2.033** (0.757)	$\beta_1=0.25$ 42.048***	6.095

†Due to length of volatile period, no lag can be specified for the Newey-West covariance matrix

Appendix 5.64. Rational Updating Model – Income Disaggregated Forecasts – Whole Sample Period

Testing Equation:

$$(1).\ E_t^H[\pi_{t+h}] = \gamma_0 + \gamma_1\pi_{t+h} + \gamma_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

$$(2).\ E_{t,H}[\pi_{t+h}] = \gamma_0 + \gamma_1\pi_{t+h} + (1-\gamma_1)E_{t-j,H}[\pi_{t+h-j}] + \epsilon_t$$

$$(3).\ E_t^H[\pi_{t+h}] = \gamma_0 + \gamma_1(\gamma_2\pi_{t+h} + (1-\gamma_2)E_t^P[\pi_{t+h}]) + (1-\gamma_1)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

		γ_0	γ_1	$(1-\gamma_1)$	γ_2	$(1-\gamma_2)$	Wald χ^2 Test	J-Stat
				Period: Whole 1982Q3 – 2011Q1				
Y14	(1)		0.126*** (0.034)		0.889*** (0.030)		$\beta_1+\beta_2=1$ 3.912**	15.166*
	(2)		0.092** (0.023)	0.908*** (0.023)			$\beta_1=0.18$ 14.550***	16.082*
	(3)		0.115*** (0.033)	0.885*** (0.033)	0.365 (0.350)	0.635* (0.350)	$\beta_1=0.25$ 17.052***	15.438*
Y24	(1)		0.214*** (0.041)		0.797*** (0.040)		$\beta_1+\beta_2=1$ 0.856	13.677
	(2)		0.205*** (0.043)	0.795*** (0.043)			$\beta_1=0.18$ 0.357	14.131
	(3)		0.206*** (0.042)	0.794*** (0.042)	0.967*** (0.150)	0.033 (0.150)	$\beta_1=0.25$ 1.114	14.171
Y34	(1)		0.226*** (0.074)		0.767*** (0.075)		$\beta_1+\beta_2=1$ 0.599	12.515
	(2)		0.224*** (0.069)	0.776*** (0.069)			$\beta_1=0.18$ 0.399	12.604
	(3)		0.223*** (0.070)	0.777*** (0.070)	1.171*** (0.293)	-0.171 (0.293)	$\beta_1=0.25$ 0.149	12.403
Y44	(1)		0.405*** (0.054)		0.567*** (0.058)		$\beta_1+\beta_2=1$ 2.880*	11.495
	(2)		0.361*** (0.045)	0.639*** (0.045)			$\beta_1=0.18$ 16.210***	12.120
	(3)		0.652*** (0.038)	0.348*** (0.038)	0.869*** (0.190)	0.131 (0.190)	$\beta_1=0.25$ 6.709***	12.618

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.65. Rational Updating Model – Income Disaggregated Forecasts – Greenspan-Bernanke Sample Period

Testing Equation:

$$(1).\ E_t^H[\pi_{t+h}] = \gamma_0 + \gamma_1\pi_{t+h} + \gamma_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

$$(2).\ E_{t,H}[\pi_{t+h}] = \gamma_0 + \gamma_1\pi_{t+h} + (1-\gamma_1)E_{t-j,H}[\pi_{t+h-j}] + \epsilon_t$$

$$(3).\ E_t^H[\pi_{t+h}] = \gamma_0 + \gamma_1(\gamma_2\pi_{t+h} + (1-\gamma_2)E_t^P[\pi_{t+h}]) + (1-\gamma_1)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

		γ_0	γ_1	$(1-\gamma_1)$	γ_2	$(1-\gamma_2)$	Wald χ^2 Test	J-Stat
				Period: Greenspan-Bernanke 1987Q2 – 2011Q1				
Y14	**(1)**		0.059**		0.954***		$\beta_1 + \beta_2 = 1$	13.283
			(0.026)		(0.023)		5.077**	
	(2)		0.037	0.963***			$\beta_1 = 0.18$	14.092
			(0.024)	(0.024)			34.576***	
	(3)		0.115***	0.885***	0.365	0.635*	$\beta_1 = 0.25$	15.438*
			(0.033)	(0.033)	(0.350)	(0.350)	17.052***	
Y24	**(1)**		0.171***		0.843***		$\beta_1 + \beta_2 = 1$	12.609
			(0.028)		(0.031)		2.189	
	(2)		0.158***	0.842***			$\beta_1 = 0.18$	13.981
			(0.051)	(0.051)			0.193	
	(3)		0.151***	0.849***	0.506	0.494	$\beta_1 = 0.25$	13.729
			(0.054)	(0.054)	(0.903)	(0.903)	3.340*	
Y34	**(1)**		0.095**		0.909***		$\beta_1 + \beta_2 = 1$	10.523
			(0.045)		(0.048)		0.594	
	(2)		0.107**	0.893***			$\beta_1 = 0.18$	10.715
			(0.041)	(0.041)			3.196**	
	(3)		0.095**	0.905***	1.310	-0.310	$\beta_1 = 0.25$	10.604
			(0.043)	(0.043)	(1.177)	(1.177)	13.012***	
Y44	**(1)**		0.286***		0.698***		$\beta_1 + \beta_2 = 1$	10.463
			(0.093)		(0.097)		1.716	
	(2)		0.270	0.730**			$\beta_1 = 0.18$	10.398
			(0.302)	(0.302)			0.088	
	(3)		0.294	0.706***	0.433	0.567	$\beta_1 = 0.25$	11.811
			(0.245)	(0.245)	(0.582)	(0.582)	0.032	

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.66. Rational Updating Model – Income Disaggregated Forecasts – Stable Sample Period

Testing Equation:

$$(1).\ E_t^H[\pi_{t+h}] = \gamma_0 + \gamma_1\pi_{t+h} + \gamma_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

$$(2).\ E_{t,H}[\pi_{t+h}] = \gamma_0 + \gamma_1\pi_{t+h} + (1-\gamma_1)E_{t-j,H}[\pi_{t+h-j}] + \epsilon_t$$

$$(3).\ E_t^H[\pi_{t+h}] = \gamma_0 + \gamma_1(\gamma_2\pi_{t+h} + (1-\gamma_2)E_t^P[\pi_{t+h}]) + (1-\gamma_1)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

		γ_0	γ_1	$(1-\gamma_1)$	γ_2	$(1-\gamma_2)$	Wald χ^2 Test	J-Stat
Period: Stable 1990Q1 – 2006Q2								
Y14	**(1)**		1.186* (0.596)		0.030 (0.542)		$\beta_1+\beta_2=1$	6.948
	(2)		0.160** (0.080)	0.840*** (0.080)			$\beta_1=0.18$ 0.062	11.903
	(3)		0.149 (0.180)	0.851*** (0.180)	0.948 (0.742)	0.052 (0.742)	$\beta_1=0.25$ 0.314	12.236
Y24	**(1)**		0.778*** (0.059)		0.302*** (0.067)		$\beta_1+\beta_2=1$ 11.361***	4.619
	(2)		0.526*** (0.037)	0.474*** (0.037)			$\beta_1=0.18$ 86.098***	8.985
	(3)		0.551*** (0.042)	0.449*** (0.042)	0.978*** (0.051)	0.022 (0.051)	$\beta_1=0.25$ 51.091***	8.350
Y34	**(1)**		0.741*** (0.055)		0.295*** (0.025)		$\beta_1+\beta_2=1$ 1.388	5.275
	(2)		0.680*** (0.041)	0.320*** (0.041)			$\beta_1=0.18$ 148.583***	6.831
	(3)		0.701*** (0.073)	0.299*** (0.073)	0.828*** (0.209)	0.172 (0.209)	$\beta_1=0.25$ 38.455***	5.777
Y44	**(1)**		0.713*** (0.037)		0.288*** (0.053)		$\beta_1+\beta_2=1$ 0.000	5.647
	(2)		0.715*** (0.039)	0.285*** (0.039)			$\beta_1=0.18$ 190.460***	5.496
	(3)		0.725*** (0.026)	0.275*** (0.026)	0.930*** (0.091)	0.070 (0.091)	$\beta_1=0.25$ 328.744***	5.268

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.67. Rational Updating Model – Income Disaggregated Forecasts – Volatile Sample Period

Testing Equation:

$$(1).\ E_t^H[\pi_{t+h}] = \gamma_0 + \gamma_1\pi_{t+h} + \gamma_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

$$(2).\ E_{t,H}[\pi_{t+h}] = \gamma_0 + \gamma_1\pi_{t+h} + (1-\gamma_1)E_{t-j,H}[\pi_{t+h-j}] + \epsilon_t$$

$$(3).\ E_t^H[\pi_{t+h}] = \gamma_0 + \gamma_1(\gamma_2\pi_{t+h} + (1-\gamma_2)E_t^P[\pi_{t+h}]) + (1-\gamma_1)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

		γ_0	γ_1	$(1-\gamma_1)$	γ_2	$(1-\gamma_2)$	Wald χ^2 Test	J-Stat
				Period: Volatile 2006Q3- 2011Q1				
Y14	**(1)**		0.032 (0.029)		0.972*** (0.024)		$\beta_1+\beta_2=1$ 0.077	5.774
	(2)		0.026 (0.022)	0.974*** (0.022)			$\beta_1=0.18$ 47.838***	5.845
	(3)		0.053** (0.021)	0.947*** (0.021)	-0.514 (0.933)	1.514 (0.933)	$\beta_1=0.25$ 86.904***	5.871
Y24	**(1)**		0.066 (0.038)		0.938*** (0.039)		$\beta_1+\beta_2=1$ 0.014	5.701
	(2)		0.070* (0.036)	0.930*** (0.036)			$\beta_1=0.18$	5.859
	(3)		0.167** (0.069)	0.834*** (0.069)	-0.130 (0.340)	1.130*** (0.340)	$\beta_1=0.25$ 1.455	6.010
Y34	**(1)**		-0.001 (0.021)		0.985*** (0.020)		$\beta_1+\beta_2=1$ 1.393	6.248
	(2)		0.012 (0.019)	0.988*** (0.019)			$\beta_1=0.18$ 82.618***	0.787
	(3)		0.206*** (0.054)	0.794*** (0.054)	-0.528*** (0.133)	1.528*** (0.133)	$\beta_1=0.25$ 0.655	5.753
Y44	**(1)**		0.065 (0.046)		0.900*** (0.060)		$\beta_1+\beta_2=1$ 2.110	5.017
	(2)		0.104** (0.044)	0.896*** (0.044)			$\beta_1=0.18$ 2.905*	5.828
	(3)		0.653*** (0.102)	0.347*** (0.102)	-0.321* (0.160)	1.321*** (0.160)	$\beta_1=0.25$ 15.591***	6.252

***,**,* indicate significance at 1, 5 and 10 percent levels.

†Due to length of volatile period, no lag can be specified for the Newey-West covariance matrix.

Appendix 5.68. Rational Updating Model – Regionally Disaggregated Forecasts – Whole Sample Period

Testing Equation:

$$(1).\ E_t^H[\pi_{t+h}] = \gamma_0 + \gamma_1\pi_{t+h} + \gamma_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

$$(2).\ E_{t,H}[\pi_{t+h}] = \gamma_0 + \gamma_1\pi_{t+h} + (1-\gamma_1)E_{t-j,H}[\pi_{t+h-j}] + \epsilon_t$$

$$(3).\ E_t^H[\pi_{t+h}] = \gamma_0 + \gamma_1(\gamma_2\pi_{t+h} + (1-\gamma_2)E_t^P[\pi_{t+h}]) + (1-\gamma_1)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

		γ_0	γ_1	$(1-\gamma_1)$	γ_2	$(1-\gamma_2)$	Wald χ^2 Test	J-Stat
				Period: Whole 1982Q3 – 2011Q1				
NC	**(1)**		0.198*** (0.065)		0.801*** (0.062)		$\beta_1 + \beta_2 = 1$ 0.013	13.831
	(2)		0.196*** (0.065)	0.804*** (0.065)			$\beta_1 = 0.18$ 0.059	13.871
	(3)		0.205** (0.084)	0.795*** (0.084)	1.284*** (0.286)	-0.284 (0.286)	$\beta_1 = 0.25$ 0.291	13.352
NE	**(1)**		0.270*** (0.061)		0.732*** (0.063)		$\beta_1 + \beta_2 = 1$ 0.050	11.236
	(2)		0.273*** (0.062)	0.727*** (0.062)			$\beta_1 = 0.18$ 2.265	11.256
	(3)		0.316*** (0.080)	0.684*** (0.080)	0.691*** (0.129)	0.309** (0.129)	$\beta_1 = 0.25$ 0.669	11.225
S	**(1)**		0.177*** (0.042)		0.823*** (0.040)		$\beta_1 + \beta_2 = 1$ 0.000	14.492
	(2)		0.182*** (0.048)	0.818*** (0.048)			$\beta_1 = 0.18$ 0.002	14.511
	(3)		0.185*** (0.070)	0.815*** (0.070)	0.964*** (0.367)	0.036 (0.367)	$\beta_1 = 0.25$ 0.857	14.549
W	**(1)**		0.215*** (0.038)		0.787*** (0.036)		$\beta_1 + \beta_2 = 1$ 0.048	10.486
	(2)		0.213*** (0.036)	0.787*** (0.036)			$\beta_1 = 0.18$ 0.870	10.479
	(3)		0.234*** (0.040)	0.766*** (0.040)	0.676*** (0.137)	0.324** (0.137)	$\beta_1 = 0.25$ 0.165	10.434

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.69. Rational Updating Model – Regionally Disaggregated Forecasts – Greenspan-Bernanke Sample Period

Testing Equation:

$$(1).\ E_t^H[\pi_{t+h}] = \gamma_0 + \gamma_1\pi_{t+h} + \gamma_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

$$(2).\ E_{t,H}[\pi_{t+h}] = \gamma_0 + \gamma_1\pi_{t+h} + (1-\gamma_1)E_{t-j,H}[\pi_{t+h-j}] + \epsilon_t$$

$$(3).\ E_t^H[\pi_{t+h}] = \gamma_0 + \gamma_1(\gamma_2\pi_{t+h} + (1-\gamma_2)E_t^P[\pi_{t+h}]) + (1-\gamma_1)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

		γ_0	γ_1	$(1-\gamma_1)$	γ_2	$(1-\gamma_2)$	Wald χ^2 Test	J-Stat
Period: Greenspan-Bernanke 1987Q2 – 2011Q1								
NC	**(1)**		0.091*** (0.024)		0.912*** (0.022)		$\beta_1 + \beta_2 = 1$ 0.238	12.159
	(2)		0.089*** (0.023)	0.911*** (0.023)			$\beta_1 = 0.18$ 16.179***	12.041
	(3)		0.099*** (0.031)	0.901*** (0.031)	0.432 (0.730)	0.568 (0.730)	$\beta_1 = 0.25$ 24.231***	12.005
NE	**(1)**		0.162*** (0.061)		0.845*** (0.067)		$\beta_1 + \beta_2 = 1$ 0.527	9.890
	(2)		0.179*** (0.061)	0.821*** (0.061)			$\beta_1 = 0.18$ 0.000	10.205
	(3)		0.108*** (0.040)	0.892*** (0.040)	-0.394 (2.505)	1.394 (2.505)	$\beta_1 = 0.25$ 12.828***	10.028
S	**(1)**		0.141*** (0.022)		0.866*** (0.023)		$\beta_1 + \beta_2 = 1$ 1.060	12.861
	(2)		0.143*** (0.024)	0.857*** (0.024)			$\beta_1 = 0.18$ 2.294	13.612
	(3)		0.124*** (0.038)	0.876*** (0.038)	0.485 (1.116)	0.515 (1.116)	$\beta_1 = 0.25$ 10.853***	12.921
W	**(1)**		0.167*** (0.032)		0.837*** (0.033)		$\beta_1 + \beta_2 = 1$ 0.427	10.042
	(2)		0.168*** (0.033)	0.832*** (0.033)			$\beta_1 = 0.18$ 0.124	10.160
	(3)		0.119** (0.048)	0.881*** (0.048)	0.677 (0.451)	0.323 (0.451)	$\beta_1 = 0.25$ 7.343***	11.259

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.70. Rational Updating Model – Regionally Disaggregated Forecasts – Stable Sample Period

Testing Equation:

$$(1).\ E_t^H[\pi_{t+h}] = \gamma_0 + \gamma_1\pi_{t+h} + \gamma_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

$$(2).\ E_{t,H}[\pi_{t+h}] = \gamma_0 + \gamma_1\pi_{t+h} + (1-\gamma_1)E_{t-j,H}[\pi_{t+h-j}] + \epsilon_t$$

$$(3).\ E_t^H[\pi_{t+h}] = \gamma_0 + \gamma_1(\gamma_2\pi_{t+h} + (1-\gamma_2)E_t^P[\pi_{t+h}]) + (1-\gamma_1)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

		γ_0	γ_1	$(1-\gamma_1)$	γ_2	$(1-\gamma_2)$	Wald χ^2 Test	J-Stat
Period: Stable 1990Q1 – 2006Q2								
NC	(1)		0.728*** (0.030)		0.334*** (0.046)		$\beta_1 + \beta_2 = 1$ 11.946***	7.732
	(2)		0.608*** (0.050)	0.392*** (0.050)			$\beta_1 = 0.18$ 71.676***	11.153
	(3)		0.640*** (0.079)	0.360*** (0.079)	0.754*** (0.233)	0.246 (0.233)	$\beta_1 = 0.25$ 24.276***	9.253
NE	(1)		0.873*** (0.054)		0.163*** (0.055)		$\beta_1 + \beta_2 = 1$ 4.457**	4.982
	(2)		0.808*** (0.047)	0.192*** (0.047)			$\beta_1 = 0.18$ 179.488***	5.757
	(3)		0.823*** (0.050)	0.177*** (0.050)	0.903*** (0.064)	0.097 (0.064)	$\beta_1 = 0.25$ 132.560***	4.972
S	(1)		0.713*** (0.024)		0.345*** (0.022)		$\beta_1 + \beta_2 = 1$ 9.081***	5.608
	(2)		0.501*** (0.053)	0.499*** (0.053)			$\beta_1 = 0.18$ 37.064***	8.547
	(3)		0.523*** (0.084)	0.477*** (0.084)	0.911*** (0.113)	0.089 (0.113)	$\beta_1 = 0.25$ 10.505***	8.142
W	(1)		0.786*** (0.062)		0.280*** (0.041)		$\beta_1 + \beta_2 = 1$ 6.443**	5.417
	(2)		0.572*** (0.015)	0.428*** (0.015)			$\beta_1 = 0.18$ 703.038***	8.743
	(3)		0.641*** (0.053)	0.359*** (0.053)	0.743*** (0.073)	0.257*** (0.073)	$\beta_1 = 0.25$ 53.455***	6.715

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.71. Rational Updating Model – Regionally Disaggregated Forecasts – Volatile Sample Period

Testing Equation:

$$(1).\ E_t^H[\pi_{t+h}] = \gamma_0 + \gamma_1\pi_{t+h} + \gamma_2 E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

$$(2).\ E_{t,H}[\pi_{t+h}] = \gamma_0 + \gamma_1\pi_{t+h} + (1-\gamma_1)E_{t-j,H}[\pi_{t+h-j}] + \epsilon_t$$

$$(3).\ E_t^H[\pi_{t+h}] = \gamma_0 + \gamma_1(\gamma_2\pi_{t+h} + (1-\gamma_2)E_t^P[\pi_{t+h}]) + (1-\gamma_1)E_{t-j}^H[\pi_{t+h-j}] + \epsilon_t$$

		γ_0	γ_1	$(1-\gamma_1)$	γ_2	$(1-\gamma_2)$	Wald χ^2 Test	J-Stat
				Period: Volatile 2006Q3 – 2011Q1				
NC	(1)		-0.006 (0.024)		0.998*** (0.026)		$\beta_1+\beta_2=1$ 0.803	5.895
	(2)		-0.005 (0.024)	1.005*** (0.024)			$\beta_1=0.18$ 57.690***	5.933
	(3)		0.122** (0.048)	0.878*** (0.048)	-0.676** (0.319)	1.676*** (0.319)	$\beta_1=0.25$ 7.036***	5.617
NE	(1)		0.036*** (0.012)		0.959*** (0.015)		$\beta_1+\beta_2=1$ 0.122	5.425
	(2)		0.040*** (0.010)	0.960*** (0.010)			$\beta_1=0.18$ 182.006***	5.524
	(3)		0.140** (0.058)	0.860*** (0.058)	-0.263 (0.265)	1.263*** (0.265)	$\beta_1=0.25$ 3.567*	4.757
S	(1)		-0.046 (0.036)		1.017*** (0.036)		$\beta_1+\beta_2=1$ 2.743	6.167
	(2)		-0.017 (0.029)	1.017*** (0.029)			$\beta_1=0.18$ 46.725***	6.281
	(3)		0.169*** (0.049)	0.831*** (0.049)	-0.896** (0.385)	1.896*** (0.385)	$\beta_1=0.25$ 2.746*	5.563
W	(1)		0.023 (0.018)		0.962*** (0.027)		$\beta_1+\beta_2=1$ 0.579	5.787
	(2)		0.029 (0.018)	0.971*** (0.018)			$\beta_1=0.18$ 67.510***	5.446
	(3)		0.225*** (0.038)	0.775*** (0.038)	-0.309 (0.236)	1.309*** (0.236)	$\beta_1=0.25$ 0.445	6.124

***,**,* indicate significance at 1, 5 and 10 percent levels.

†Due to length of volatile period, no lag can be specified for the Newey-West covariance matrix

Appendix 5.72. Heterogeneous Updating Model – Age Disaggregated Expectations – Whole Sample Period

Testing Equation:

$$(1) E_{i,t}[\pi_{t+h}] = \phi_1 E_{P,t}[\pi_{t+h}] + \phi_2 \pi_t + \phi_3 E_{RE,t}[\pi_{t+h}] + \phi_4 E_{i,t-1}[\pi_{t+h-1}] + \epsilon_t$$

$$(2) E_{i,t}[\pi_{t+h}] = \phi_1 E_{P,t}[\pi_{t+h}] + \phi_2 \pi_t + \phi_3 E_{RE,t}[\pi_{t+h}] + (1 - \phi_1 - \phi_2 - \phi_3) E_{i,t-1}[\pi_{t+h-1}] + \epsilon_t$$

$$(3)\ E_{t,H}[\pi_{t+h}] = \lambda\big(\phi_1 E_{t,P}[\pi_{t+h}] + \phi_2 \pi_{t-1} + (1 - \phi_1 + \phi_2) E_{RE,t}[\pi_{t+h}]\big) + (1 - \lambda) E_{t,H}[\pi_{t+h-1}] + \epsilon_t$$

		λ	ϕ_1	ϕ_2	ϕ_3	ϕ_4 $(1-\lambda)$	Wald χ^2 Test		J-Stat
					Period: Whole 1982Q3 – 2011Q1				
A1834	**(1)**		0.122**	0.076	0.201***	0.598***	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		10.042*
			(0.054)	(0.090)	(0.059)	(0.108)	0.087		
	(2)		0.114**	0.079	0.211***	0.596***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	10.173
			(0.057)	(0.080)	(0.046)	(0.102)	5.639**	4.516**	
	(3)	0.404***	0.281*	0.196	0.522***	0.596***	$\lambda = 0.25$		10.173
		(0.102)	(0.125)	(0.163)	(0.150)	(0.102)	2.283		
A3544	**(1)**		0.069	0.108***	0.136	0.690***	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		11.347**
			(0.103)	(0.035)	(0.102)	(0.087)	0.280		
	(2)		0.084	0.105***	0.134	0.678***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	11.482*
			(0.096)	(0.035)	(0.099)	(0.087)	2.997*	17.393***	
	(3)	0.322***	0.260	0.326***	0.415	0.678***	$\lambda = 0.25$		11.482
		(0.087)	(0.282)	(0.081)	(0.294)	(0.087)	0.688		
A4554	**(1)**		-0.054	0.045	0.263***	0.757***	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		9.475*
			(0.045)	(0.041)	(0.070)	(0.054)	0.539		
	(2)		-0.024	0.023	0.239***	0.762***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	9.886
			(0.051)	(0.043)	(0.064)	(0.054)	29.439***	27.996***	
	(3)	0.239***	-0.101	0.098	1.003***	0.761***	$\lambda = 0.25$		9.886
		(0.054)	(0.206)	(0.171)	(0.170)	(0.054)	0.045		
A5564	**(1)**		0.012	0.104	0.108	0.760***	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		10.071*
			(0.090)	(0.092)	(0.119)	(0.129)	1.098		
	(2)		-0.030	0.135*	0.134	0.761***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	10.243
			(0.100)	(0.074)	(0.074)	(0.092)	7.886***	2.395	
	(3)	0.239**	-0.125	0.565***	0.560*	0.761***	$\lambda = 0.25$		10.243
		(0.092)	(0.382)	(0.174)	(0.337)	(0.092)	0.014		
A6597	**(1)**		-0.065	0.109	0.210	0.750***	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		12.653**
			(0.285)	(0.173)	(0.373)	(0.251)	0.005		
	(2)		-0.070	0.116	0.218	0.736**	$\phi_1 = 0.25$	$\phi_2 = 0.25$	12.605**
			(0.308)	(0.201)	(0.403)	(0.290)	1.078	0.447	
	(3)	0.264	-0.266	0.439	0.827	0.736**	$\lambda = 0.25$		12.605**
		(0.290)	(0.881)	(0.319)	(0.634)	(0.290)	0.002		

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.73. Heterogeneous Updating Model – Age Disaggregated Expectations – Greenspan-Bernanke Sample Period

Testing Equation:

$$(1) E_{i,t}[\pi_{t+h}] = \phi_1 E_{P,t}[\pi_{t+h}] + \phi_2 \pi_t + \phi_3 E_{RE,t}[\pi_{t+h}] + \phi_4 E_{i,t-1}[\pi_{t+h-1}] + \epsilon_t$$

$$(2) E_{i,t}[\pi_{t+h}] = \phi_1 E_{P,t}[\pi_{t+h}] + \phi_2 \pi_t + \phi_3 E_{RE,t}[\pi_{t+h}] + (1 - \phi_1 - \phi_2 - \phi_3) E_{i,t-1}[\pi_{t+h-1}] + \epsilon_t$$

$$(3) E_{t,H}[\pi_{t+h}] = \lambda\left(\phi_1 E_{t,P}[\pi_{t+h}] + \phi_2 \pi_{t-1} + (1 - \phi_1 + \phi_2) E_{RE,t}[\pi_{t+h}]\right) + (1 - \lambda) E_{t,H}[\pi_{t+h-1}] + \epsilon_t$$

		λ	ϕ_1	ϕ_2	ϕ_3	ϕ_4 $(1-\lambda)$	Wald χ^2 Test		J-Stat
Period: Greenspan-Bernanke 1987Q2 – 2011Q1									
A1834	**(1)**		0.109	-0.010	0.076	0.832***	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		10.181*
			(0.091)	(0.044)	(0.073)	(0.050)	0.821		
	(2)		0.118	-0.017	0.067	0.832***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	10.733*
			(0.087)	(0.043)	(0.067)	(0.050)	2.313	38.405***	
	(3)	0.168***	0.700	-0.099	0.399	0.832***	$\lambda = 0.25$		10.733*
		(0.050)	(0.432)	(0.273)	(0.454)	(0.050)	2.686		
A3544	**(1)**		0.199	0.034	-0.067	0.833***	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		8.494
			(2.958)	(1.284)	(1.866)	(0.215)	0.001		
	(2)		0.217	0.031	-0.076	0.828***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	8.484
			(0.536)	(0.264)	(0.341)	(0.082)	0.004	0.687	
	(3)	0.172**	1.260	0.180	-0.441	0.828***	$\lambda = 0.25$		8.484
		(0.082)	(3.472)	(1.471)	(2.102)	(0.082)	0.904		
A4554	**(1)**		0.084	-0.052	0.091	0.889***	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		7.607
			(0.098)	(0.046)	(0.086)	(0.048)	2.154		
	(2)		0.096	-0.069	0.112	0.860***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	8.985
			(0.089)	(0.058)	(0.071)	(0.054)	3.012*	30.769***	
	(3)	0.140**	0.690	-0.495	0.805*	0.860***	$\lambda = 0.25$		8.985
		(0.054)	(0.757)	(0.559)	(0.414)	(0.054)	4.165**		
A5564	**(1)**		0.166	0.022	-0.034	0.841***	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		9.175
			(0.120)	(0.071)	(0.104)	(0.130)	0.016		
	(2)		0.173	0.023	-0.040	0.844***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	9.080
			(0.119)	(0.077)	(0.101)	(0.057)	0.419	8.612***	
	(3)	0.156***	1.111	0.146	-0.258	0.844***	$\lambda = 0.25$		9.080
		(0.057)	(0.877)	(0.451)	(0.648)	(0.057)	2.775*		
A6597	**(1)**		0.223	-0.017	-0.070	0.874***	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		11.275**
			(0.247)	(0.052)	(0.220)	(0.068)	0.252		
	(2)		0.213	-0.019	-0.050	0.856***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	11.845*
			(0.169)	(0.047)	(0.157)	(0.052)	0.048	32.369***	
	(3)	0.144***	1.482	-0.135	-0.626	0.856***	$\lambda = 0.25$		11.845*
		(0.052)	(1.449)	(0.364)	(1.416)	(0.052)	4.133**		

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.74. Heterogeneous Updating Model – Age Disaggregated Expectations – Stable Sample Period

Testing Equation:

$$(1) E_{i,t}[\pi_{t+h}] = \phi_1 E_{P,t}[\pi_{t+h}] + \phi_2 \pi_t + \phi_3 E_{RE,t}[\pi_{t+h}] + \phi_4 E_{i,t-1}[\pi_{t+h-1}] + \epsilon_t$$

$$(2) E_{i,t}[\pi_{t+h}] = \phi_1 E_{P,t}[\pi_{t+h}] + \phi_2 \pi_t + \phi_3 E_{RE,t}[\pi_{t+h}] + (1 - \phi_1 - \phi_2 - \phi_3) E_{i,t-1}[\pi_{t+h-1}] + \epsilon_t$$

$$(3)\ E_{t,H}[\pi_{t+h}] = \lambda(\phi_1 E_{t,P}[\pi_{t+h}] + \phi_2 \pi_{t-1} + (1 - \phi_1 + \phi_2) E_{RE,t}[\pi_{t+h}]) + (1 - \lambda) E_{t,H}[\pi_{t+h-1}] + \epsilon_t$$

		λ	ϕ_1	ϕ_2	ϕ_3	ϕ_4 $(1-\lambda)$	Wald χ^2 Test		J-Stat
Period: Stable 1990Q1 – 2006Q2									
A1834	**(1)**		0.238	0.152**	0.414**	0.236***	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		5.582
			(0.191)	(0.060)	(0.195)	(0.067)	3.151*		
	(2)		0.246*	0.116***	0.149*	0.489***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	10.818*
			(0.142)	(0.044)	(0.080)	(0.092)	0.001	9.452***	
	(3)	0.511***	0.481**	0.227**	0.292	0.489***	$\lambda = 0.25$		10.818*
		(0.092)	(0.220)	(0.072)	(0.189)	(0.092)	3.297*		
A3544	**(1)**		0.159	0.093	0.432**	0.350***	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		4.664
			(0.096)	(0.076)	(0.164)	(0.102)	2.332		
	(2)		0.205***	0.022	0.221***	0.552***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	8.784
			(0.072)	(0.121)	(0.059)	(0.171)	0.390	3.567*	
	(3)	0.448**	0.458**	0.049	0.494***	0.552***	$\lambda = 0.25$		8.734
		(0.171)	(0.209)	(0.252)	(0.142)	(0.172)	1.340		
A4554	**(1)**		0.047	0.003	0.364***	0.608***	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		5.971
			(0.068)	(0.036)	(0.131)	(0.092)	1.361		
	(2)		0.100	-0.009	0.226***	0.684***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	7.252
			(0.152)	(0.054)	(0.067)	(0.047)	0.974	22.831***	
	(3)	0.316***	0.316	-0.028	0.316	0.713**	$\lambda = 0.25$		7.252
		(0.047)	(0.441)	(0.168)	(0.441)	(0.295)	1.990		
A5564	**(1)**		0.111	0.066	0.388*	0.446***	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		5.054
			(0.166)	(0.040)	(0.197)	(0.059)	0.429		
	(2)		0.135	0.058	0.338**	0.469***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	5.356
			(0.116)	(0.041)	(0.135)	(0.049)	0.978	21.884***	
	(3)	0.531***	0.254	0.109	0.637***	0.469***	$\lambda = 0.25$		5.356
		(0.049)	(0.238)	(0.075)	(0.202)	(0.049)	32.581***		
A6597	**(1)**		0.001	0.049	1.045***	-0.041	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		4.635
			(0.171)	(0.081)	(0.308)	(0.142)	1.486		
	(2)		0.078	0.080	0.788***	0.054	$\phi_1 = 0.25$	$\phi_2 = 0.25$	7.575
			(0.132)	(0.057)	(0.212)	(0.110)	1.705	8.851***	
	(3)	0.946***	0.082	0.085	0.833***	0.054	$\lambda = 0.25$		7.575
		(0.110)	(0.148)	(0.058)	(0.134)	(0.110)	40.117***		

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.75. Heterogeneous Updating Model – Age Disaggregated Expectations – Volatile Sample Period

Testing Equation:

$$(1) E_{i,t}[\pi_{t+h}] = \phi_1 E_{P,t}[\pi_{t+h}] + \phi_2 \pi_t + \phi_3 E_{RE,t}[\pi_{t+h}] + \phi_4 E_{i,t-1}[\pi_{t+h-1}] + \epsilon_t$$

$$(2) E_{i,t}[\pi_{t+h}] = \phi_1 E_{P,t}[\pi_{t+h}] + \phi_2 \pi_t + \phi_3 E_{RE,t}[\pi_{t+h}] + (1 - \phi_1 - \phi_2 - \phi_3) E_{i,t-1}[\pi_{t+h-1}] + \epsilon_t$$

$$(3)\ E_{t,H}[\pi_{t+h}] = \lambda\left(\phi_1 E_{t,P}[\pi_{t+h}] + \phi_2 \pi_{t-1} + (1 - \phi_1 + \phi_2) E_{RE,t}[\pi_{t+h}]\right) + (1 - \lambda) E_{t,H}[\pi_{t+h-1}] + \epsilon_t$$

		λ	ϕ_1	ϕ_2	ϕ_3	ϕ_4 $(1-\lambda)$	Wald χ^2 Test	J-Stat
				Period: Volatile 2006Q3 – 2011Q1				
A1834	**(1)†**		1.014** (0.402)	-0.005 (0.067)	-0.080 (0.109)	0.330 (0.209)	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$ 5.801**	3.554
	(2)†		-0.004 (0.192)	-0.021 (0.080)	0.141* (0.077)	0.884*** (0.105)	$\phi_1 = 0.25$: 1.753 $\phi_2 = 0.25$: 11.388***	2.100
	(3)†	0.116 (0.105)	-0.036 (1.685)	-0.179 (0.719)	1.215 (1.594)	0.884*** (0.105)	$\lambda = 0.25$ 1.635	2.100
A3544	**(1)†**		2.152*** (0.279)	0.147*** (0.040)	-0.371*** (0.072)	-0.350** (0.143)	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$ 43.238***	4.025
	(2)†		0.061 (0.165)	0.066 (0.083)	0.062 (0.059)	0.811*** (0.082)	$\phi_1 = 0.25$: 1.316 $\phi_2 = 0.25$: 4.870**	5.991
	(3)†	0.189** (0.082)	0.324 (0.773)	0.350 (0.525)	0.326 (0.356)	0.811*** (0.082)	$\lambda = 0.25$ 0.561	5.991
A4554	**(1)†**		0.728 (0.506)	0.031 (0.113)	0.065 (0.119)	0.445 (0.306)	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$ 2.347	2.954
	(2)†		-0.183 (0.189)	-0.026 (0.080)	0.231*** (0.077)	0.979*** (0.131)	$\phi_1 = 0.25$: 5.242** $\phi_2 = 0.25$: 11.799***	2.119
	(3)†	0.021 (0.130)	-8.560 (59.635)	-1.214 (8.037)	10.773 (66.599)	0.979*** (0.131)	$\lambda = 0.25$ 3.046**	2.119
A5564	**(1)†**		1.669*** (0.218)	0.078 (0.052)	-0.258*** (0.071)	-0.004 (0.131)	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$ 58.898***	4.009
	(2)†		0.013 (0.067)	0.036 (0.050)	0.073 (0.050)	0.878*** (0.075)	$\phi_1 = 0.25$: 12.523*** $\phi_2 = 0.25$: 18.195***	5.375
	(3)†	0.122 (0.075)	0.108 (0.522)	0.298 (0.370)	0.594 (0.405)	0.878*** (0.075)	$\lambda = 0.25$ 2.919*	5.375
A6597	**(1)†**		1.572*** (0.320)	0.032 (0.081)	-0.231** (0.087)	0.096 (0.154)	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$ 22.072***	3.607
	(2)†		0.014 (0.079)	0.019 (0.055)	0.030 (0.048)	0.938*** (0.042)	$\phi_1 = 0.25$: 9.007*** $\phi_2 = 0.25$: 17.390	5.859
	(3)†	0.062 (0.042)	0.225 (1.280)	0.300 (0.837)	0.474 (0.631)	0.938*** (0.042)	$\lambda = 0.25$ 20.335	5.859

***,**,* indicate significance at 1, 5 and 10 percent levels.

†Due to length of volatile period, no lag can be specified for the Newey-West covariance matrix

Appendix 5.76. Heterogeneous Updating Model – Education Disaggregated Expectations – Whole Sample Period

Testing Equation:

$$(1)E_{i,t}[\pi_{t+h}] = \phi_1 E_{P,t}[\pi_{t+h}] + \phi_2 \pi_t + \phi_3 E_{RE,t}[\pi_{t+h}] + \phi_4 E_{i,t-1}[\pi_{t+h-1}] + \epsilon_t$$

$$(2)E_{i,t}[\pi_{t+h}] = \phi_1 E_{P,t}[\pi_{t+h}] + \phi_2 \pi_t + \phi_3 E_{RE,t}[\pi_{t+h}] + (1-\phi_1-\phi_2-\phi_3)E_{i,t-1}[\pi_{t+h-1}] + \epsilon_t$$

$$(3)E_{t,H}[\pi_{t+h}] = \lambda\big(\phi_1 E_{t,P}[\pi_{t+h}] + \phi_2 \pi_{t-1} + (1-\phi_1+\phi_2)E_{RE,t}[\pi_{t+h}]\big) + (1-\lambda)E_{t,H}[\pi_{t+h-1}] + \epsilon_t$$

		λ	ϕ_1	ϕ_2	ϕ_3	ϕ_4 $(1-\lambda)$	Wald χ^2 Test		J-Stat
					Period: Whole 1982Q3 – 2011Q1				
ELHS	(1)		-0.001	0.046	0.179	0.783***	$\phi_1+\phi_2+\phi_3+\phi_4=1$		6.958
			(0.416)	(0.274)	(0.364)	(0.152)	0.013		
	(2)		0.003	0.051	0.123**	0.823***	$\phi_1=0.25$	$\phi_2=0.25$	7.731
			(0.078)	(0.082)	(0.057)	(0.052)	10.069***	5.913**	
	(3)	0.177***	0.017	0.288	0.696***	0.823***	$\lambda=0.25$		7.730
		(0.052)	(0.443)	(0.397)	(0.196)	(0.196)	0.161		
EHSD	(1)		-0.049	0.036	0.200***	0.818***	$\phi_1+\phi_2+\phi_3+\phi_4=1$		8.582
			(0.054)	(0.058)	(0.057)	(0.050)	0.236		
	(2)		-0.038	0.028	0.193***	0.818***	$\phi_1=0.25$	$\phi_2=0.25$	8.619
			(0.049)	(0.053)	(0.055)	(0.048)	34.535***	17.425***	
	(3)	0.182***	-0.209	0.151	1.058***	0.818***	$\lambda=0.25$		8.619
		(0.048)	(0.246)	(0.270)	(0.213)	(0.048)	1.983		
ESC	(1)		0.011	-0.001	0.178**	0.804***	$\phi_1+\phi_2+\phi_3+\phi_4=1$		10.428*
			(0.044)	(0.046)	(0.079)	(0.062)	0.469		
	(2)		-0.008	0.017	0.184**	0.807***	$\phi_1=0.25$	$\phi_2=0.25$	10.690*
			(0.046)	(0.038)	(0.080)	(0.061)	31.312***	36.602***	
	(3)	0.193***	-0.044	0.089	0.955***	0.807***	$\lambda=0.25$		10.690*
		(0.061)	(0.237)	(0.198)	(0.240)	(0.061)	0.878		
ECD	(1)		0.113	0.227	0.245	0.384	$\phi_1+\phi_2+\phi_3+\phi_4=1$		8.444
			(0.140)	(0.152)	(0.301)	(0.324)	1.015		
	(2)		0.030	0.297**	0.311	0.363	$\phi_1=0.25$	$\phi_2=0.25$	8.441
			(0.171)	(0.119)	(0.257)	(0.269)	1.655	0.155	
	(3)	0.637**	0.046	0.466***	0.488*	0.363	$\lambda=0.25$		8.441
		(0.268)	(0.276)	(0.093)	(0.256)	(0.268)	2.081		
EGS	(1)		0.346***	0.183*	0.002	0.451***	$\phi_1+\phi_2+\phi_3+\phi_4=1$		10.924
			(0.110)	(0.105)	(0.087)	(0.138)	0.443		
	(2)		0.279***	0.219***	0.054	0.448***	$\phi_1=0.25$	$\phi_2=0.25$	11.669*
			(0.061)	(0.063)	(0.084)	(0.065)	0.228	0.252	
	(3)	0.552***	0.506***	0.396***	0.098	0.448***	$\lambda=0.25$		11.669*
		(0.065)	(0.121)	(0.107)	(0.147)	(0.147)	21.458***		

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.77. Heterogeneous Updating Model – Education Disaggregated Expectations – Greenspan-Bernanke Sample Period

Testing Equation:

$$(1) E_{i,t}[\pi_{t+h}] = \phi_1 E_{P,t}[\pi_{t+h}] + \phi_2 \pi_t + \phi_3 E_{RE,t}[\pi_{t+h}] + \phi_4 E_{i,t-1}[\pi_{t+h-1}] + \epsilon_t$$

$$(2) E_{i,t}[\pi_{t+h}] = \phi_1 E_{P,t}[\pi_{t+h}] + \phi_2 \pi_t + \phi_3 E_{RE,t}[\pi_{t+h}] + (1 - \phi_1 - \phi_2 - \phi_3) E_{i,t-1}[\pi_{t+h-1}] + \epsilon_t$$

$$(3) E_{t,H}[\pi_{t+h}] = \lambda(\phi_1 E_{t,P}[\pi_{t+h}] + \phi_2 \pi_{t-1} + (1 - \phi_1 + \phi_2) E_{RE,t}[\pi_{t+h}]) + (1 - \lambda) E_{t,H}[\pi_{t+h-1}] + \epsilon_t$$

		λ	ϕ_1	ϕ_2	ϕ_3	ϕ_4 $(1-\lambda)$	Wald χ^2 Test		J-Stat
Period: Greenspan-Bernanke 1987Q2 – 2011Q1									
ELHS	**(1)**		0.195	-0.106*	0.085	0.838***	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		8.882
			(0.167)	(0.056)	(0.169)	(0.041)	0.877		
	(2)		0.204	-0.093*	0.024	0.865***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	9.170
			(0.142)	(0.048)	(0.139)	(0.038)	0.104	50.606***	
	(3)	0.135***	1.507	-0.684*	0.177	0.865***	$\lambda = 0.25$		9.170
		(0.038)	(0.981)	(0.359)	(1.026)	(0.038)	8.938***		
EHSD	**(1)**		0.039	-0.032	0.121	0.881***	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		8.257
			(0.071)	(0.038)	(0.077)	(0.034)	1.297		
	(2)		0.023	-0.033	0.128	0.882***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	8.712
			(0.080)	(0.041)	(0.083)	(0.042)	8.136***	47.117***	
	(3)	0.118***	0.195	-0.281	1.086*	0.882***	$\lambda = 0.25$		8.712
		(0.042)	(0.652)	(0.292)	(0.605)	(0.042)	9.847***		
ESC	**(1)**		0.144	-0.047*	-0.010	0.916***	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		7.776
			(0.117)	(0.024)	(0.103)	(0.032)	0.042		
	(2)		0.149	-0.048**	-0.013	0.912***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	7.820
			(0.113)	(0.023)	(0.101)	(0.033)	0.789	165.727***	
	(3)	0.088***	1.705*	-0.553	-0.152	0.912***	$\lambda = 0.25$		7.820
		(0.033)	(1.000)	(0.386)	(1.132)	(0.033)	24.812***		
ECD	**(1)**		0.448*	0.042	-0.209	0.699***	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		7.624
			(0.238)	(0.040)	(0.188)	(0.099)	0.353		
	(2)		0.417*	0.042	-0.180	0.722***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	7.664
			(0.238)	(0.036)	(0.183)	(0.082)	0.491	34.407***	
	(3)	0.278***	1.496**	0.150	-0.646	0.722***	$\lambda = 0.25$		7.664
		(0.082)	(0.603)	(0.133)	(0.580)	(0.082)	0.119		
EGS	**(1)**		0.460**	0.200***	-0.135	0.461***	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		6.998
			(0.195)	(0.049)	(0.155)	(0.120)	0.192		
	(2)		0.450**	0.196***	-0.131	0.485***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	7.380
			(0.223)	(0.066)	(0.179)	(0.067)	0.804	0.672	
	(3)	0.515***	0.874**	0.381***	-0.255	0.485***	$\lambda = 0.25$		7.380
		(0.067)	(0.421)	(0.123)	(0.349)	(0.067)	15.384***		

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.78. Heterogeneous Updating Model – Education Disaggregated Expectations – Stable Sample Period

Testing Equation:

$$(1) E_{i,t}[\pi_{t+h}] = \phi_1 E_{P,t}[\pi_{t+h}] + \phi_2 \pi_t + \phi_3 E_{RE,t}[\pi_{t+h}] + \phi_4 E_{i,t-1}[\pi_{t+h-1}] + \epsilon_t$$

$$(2) E_{i,t}[\pi_{t+h}] = \phi_1 E_{P,t}[\pi_{t+h}] + \phi_2 \pi_t + \phi_3 E_{RE,t}[\pi_{t+h}] + (1 - \phi_1 - \phi_2 - \phi_3) E_{i,t-1}[\pi_{t+h-1}] + \epsilon_t$$

$$(3) E_{t,H}[\pi_{t+h}] = \lambda(\phi_1 E_{t,P}[\pi_{t+h}] + \phi_2 \pi_{t-1} + (1 - \phi_1 + \phi_2) E_{RE,t}[\pi_{t+h}]) + (1 - \lambda) E_{t,H}[\pi_{t+h-1}] + \epsilon_t$$

		λ	ϕ_1	ϕ_2	ϕ_3	ϕ_4 $(1-\lambda)$	Wald χ^2 Test		J-Stat
					Period: Stable 1990Q1 – 2006Q2				
ELHS	**(1)**		-0.336*	0.232**	0.963*	0.294	$\phi_1+\phi_2+\phi_3+\phi_4=1$		3.939
			(0.191)	(0.100)	(0.506)	(0.216)	1.895		
	(2)		0.088*	0.040	0.115*	0.756***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	9.786
			(0.050)	(0.030)	(0.067)	(0.036)	10.612***	47.433***	
	(3)	0.244***	0.363*	0.165	0.472*	0.756***	$\lambda = 0.25$		9.786
		(0.036)	(0.213)	(0.121)	(0.250)	(0.036)	0.031		
EHSD	**(1)**		0.057	0.071	0.641***	0.301***	$\phi_1+\phi_2+\phi_3+\phi_4=1$		4.648
			(0.109)	(0.076)	(0.167)	(0.085)	9.630***		
	(2)		0.118**	0.019	0.190***	0.673***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	11.126*
			(0.049)	(0.100)	(0.042)	(0.129)	7.353***	5.333**	
	(3)	0.327**	0.361**	0.058	0.581**	0.673***	$\lambda = 0.25$		11.126
		(0.129)	(0.144)	(0.286)	(0.222)	(0.129)	0.352		
ESC	**(1)**		0.168	0.048	0.258	0.544***	$\phi_1+\phi_2+\phi_3+\phi_4=1$		6.373
			(0.231)	(0.030)	(0.394)	(0.148)	1.048		
	(2)		0.187	0.014	0.143	0.657***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	7.529
			(0.456)	(0.115)	(0.340)	(0.236)	0.019	4.241**	
	(3)	0.343	0.543	0.039	0.418	0.657***	$\lambda = 0.25$		7.529
		(0.236)	(0.979)	(0.308)	(1.258)	(0.236)	0.157		
ECD	**(1)**		0.210	0.102**	0.455**	0.223***	$\phi_1+\phi_2+\phi_3+\phi_4=1$		5.368
			(0.138)	(0.039)	(0.213)	(0.081)	0.156		
	(2)		0.174*	0.102**	0.519***	0.205***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	5.218
			(0.095)	(0.039)	(0.117)	(0.064)	0.641	14.364***	
	(3)	0.795***	0.219*	0.128**	0.653***	0.205***	$\lambda = 0.25$		5.218
		(0.064)	(0.125)	(0.051)	(0.111)	(0.064)	72.882***		
EGS	**(1)**		0.231**	0.159	0.293*	0.325***	$\phi_1+\phi_2+\phi_3+\phi_4=1$		6.351
			(0.113)	(0.159)	(0.147)	(0.069)	0.127		
	(2)		0.259	0.163	0.253	0.326	$\phi_1 = 0.25$	$\phi_2 = 0.25$	6.631
			(0.554)	(2.922)	(1.441)	(0.930)	0.000	0.001	
	(3)	0.674	0.384	0.241	0.375	0.326	$\lambda = 0.25$		6.631
		(0.930)	(1.349)	(4.002)	(2.665)	(0.930)	0.208		

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.79. Heterogeneous Updating Model – Education Disaggregated Expectations – Volatile Sample Period

Testing Equation:

$$(1) E_{i,t}[\pi_{t+h}] = \phi_1 E_{P,t}[\pi_{t+h}] + \phi_2 \pi_t + \phi_3 E_{RE,t}[\pi_{t+h}] + \phi_4 E_{i,t-1}[\pi_{t+h-1}] + \epsilon_t$$

$$(2) E_{i,t}[\pi_{t+h}] = \phi_1 E_{P,t}[\pi_{t+h}] + \phi_2 \pi_t + \phi_3 E_{RE,t}[\pi_{t+h}] + (1 - \phi_1 - \phi_2 - \phi_3) E_{i,t-1}[\pi_{t+h-1}] + \epsilon_t$$

$$(3) E_{t,H}[\pi_{t+h}] = \lambda(\phi_1 E_{t,P}[\pi_{t+h}] + \phi_2 \pi_{t-1} + (1 - \phi_1 + \phi_2) E_{RE,t}[\pi_{t+h}]) + (1 - \lambda) E_{t,H}[\pi_{t+h-1}] + \epsilon_t$$

		λ	ϕ_1	ϕ_2	ϕ_3	ϕ_4 $(1-\lambda)$	Wald χ^2 Test		J-Stat
					Period: Volatile 2006Q3 – 2011Q1				
ELHS	**(1)†**		0.929*	-0.021	0.091	0.456**	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		3.995
			(0.456)	(0.070	(0.135)	(0.201)	5.553**		
	(2)†		-0.289*	-0.002	0.350***	0.940***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	4.240
			(0.142)	(0.090)	(0.078)	(0.111)	14.300***	7.820***	
	(3)†	0.060	-4.840	-0.026	5.866	0.940***	$\lambda = 0.25$		4.240
		(0.111)	(10.819)	(1.488)	(10.156)	(0.111)	2.937*		
EHSD	**(1)†**		0.286	0.036	0.180	0.692**	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		3.003
			(0.617)	(0.049)	(0.108)	(0.308)	0.826		
	(2)†		-0.293*	0.052	0.260***	0.981***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	3.445
			(0.143)	(0.046)	(0.069)	(0.068)	14.497***	18.850***	
	(3)†	0.019	-15.082	2.691	13.391	0.981***	$\lambda = 0.25$		3.445
		(0.068)	(59.454)	(10.036)	(49.661)	(0.068)	11.585***		
ESC	**(1)†**		1.295**	0.021	-0.182	0.252	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		3.954
			(0.478)	(0.039)	(0.120)	(0.233)	6.380**		
	(2)†		-0.012	-0.001	0.095*	0.918***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	4.639
			(0.095)	(0.068)	(0.052)	(0.044)	7.563***	13.612***	
	(3)†	0.082*	-0.143	-0.018	1.160*	0.918***	$\lambda = 0.25$		4.639
		(0.044)	(1.160)	(0.834)	(0.660)	(0.044)	14.491***		
ECD	**(1)†**		1.348***	0.264***	-0.127**	-0.116**	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		4.061
			(0.154)	(0.060)	(0.053)	(0.052)	80.161***		
	(2)†		0.241	0.080	0.064	0.616***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	5.338
			(0.161)	(0.113)	(0.071)	(0.128)	0.003	2.271	
	(3)†	0.384***	0.626	0.207	0.167	0.616***	$\lambda = 0.25$		5.338
		(0.128)	(0.369)	(0.296)	(0.158)	(0.128)	1.097		
EGS	**(1)†**		1.405***	0.259***	-0.128*	-0.151	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		3.971
			(0.217)	(0.043)	(0.069)	(0.101)	37.648***		
	(2)†		0.252*	0.116	0.099	0.533***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	5.225
			(0.142)	(0.075)	(0.061)	(0.098)	0.000	3.206*	
	(3)†	0.467***	0.540**	0.249	0.211*	0.533***	$\lambda = 0.25$		5.225
		(0.098)	(0.241)	(0.188)	(0.115)	(0.098)	4.915**		

***,**,* indicate significance at 1, 5 and 10 percent levels.

†Due to length of volatile period, no lag can be specified for the Newey-West covariance matrix

Appendix 5.80. Heterogeneous Updating Model – Gender Disaggregated Expectations – Whole Sample Period

Testing Equation:

$$(1)E_{i,t}[\pi_{t+h}] = \phi_1 E_{P,t}[\pi_{t+h}] + \phi_2 \pi_t + \phi_3 E_{RE,t}[\pi_{t+h}] + \phi_4 E_{i,t-1}[\pi_{t+h-1}] + \epsilon_t$$

$$(2)E_{i,t}[\pi_{t+h}] = \phi_1 E_{P,t}[\pi_{t+h}] + \phi_2 \pi_t + \phi_3 E_{RE,t}[\pi_{t+h}] + (1-\phi_1-\phi_2-\phi_3) E_{i,t-1}[\pi_{t+h-1}] + \epsilon_t$$

$$(3)E_{t,H}[\pi_{t+h}] = \lambda(\phi_1 E_{t,P}[\pi_{t+h}] + \phi_2 \pi_{t-1} + (1-\phi_1+\phi_2) E_{RE,t}[\pi_{t+h}]) + (1-\lambda) E_{t,H}[\pi_{t+h-1}] + \epsilon_t$$

		λ	ϕ_1	ϕ_2	ϕ_3	ϕ_4 $(1-\lambda)$	Wald χ^2 Test		J-Stat
					Period: Whole 1982Q3 – 2011Q1				
MALE	(1)		0.004	0.067**	0.158**	0.750***	$\phi_1+\phi_2+\phi_3+\phi_4=1$		11.022*
			(0.041)	(0.032)	(0.073)	(0.068)	4.364**		
	(2)		-0.029	0.091**	0.166**	0.773***	$\phi_1=0.25$	$\phi_2=0.25$	11.632
			(0.054)	(0.037)	(0.073)	(0.067)	26.983***	18.604***	
	(3)	0.227***	-0.130	0.399***	0.730***	0.773***	$\lambda=0.25$		11.632
		(0.067)	(0.248)	(0.150)	(0.277)	(0.067)	0.114		
FEMALE	(1)		0.020	0.014	0.193	0.781***	$\phi_1+\phi_2+\phi_3+\phi_4=1$		8.704
			(0.056)	(0.107)	(0.215)	(0.269)	0.251		
	(2)		0.042	-0.007	0.165	0.801*	$\phi_1=0.25$	$\phi_2=0.25$	9.229
			(0.033)	(0.105)	(0.383)	(0.470)	40.145***	5.979**	
	(3)	0.199	0.210	-0.037	0.827***	0.801*	$\lambda=0.25$		9.229
		(0.470)	(0.572)	(0.611)	(0.132)	(0.470)	0.012		

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.81. Heterogeneous Updating Model – Gender Disaggregated Expectations – Greenspan-Bernanke Sample Period

Testing Equation:

$$(1)E_{i,t}[\pi_{t+h}] = \phi_1 E_{P,t}[\pi_{t+h}] + \phi_2 \pi_t + \phi_3 E_{RE,t}[\pi_{t+h}] + \phi_4 E_{i,t-1}[\pi_{t+h-1}] + \epsilon_t$$

$$(2)E_{i,t}[\pi_{t+h}] = \phi_1 E_{P,t}[\pi_{t+h}] + \phi_2 \pi_t + \phi_3 E_{RE,t}[\pi_{t+h}] + (1-\phi_1-\phi_2-\phi_3) E_{i,t-1}[\pi_{t+h-1}] + \epsilon_t$$

$$(3)E_{t,H}[\pi_{t+h}] = \lambda(\phi_1 E_{t,P}[\pi_{t+h}] + \phi_2 \pi_{t-1} + (1-\phi_1+\phi_2) E_{RE,t}[\pi_{t+h}]) + (1-\lambda) E_{t,H}[\pi_{t+h-1}] + \epsilon_t$$

		λ	ϕ_1	ϕ_2	ϕ_3	ϕ_4 $(1-\lambda)$	Wald χ^2 Test		J-Stat
					Period: Greenspan-Bernanke 1987Q2 – 2011Q1				
MALE	(1)		0.170	-0.006	-0.022	0.847***	$\phi_1+\phi_2+\phi_3+\phi_4=1$		9.319*
			(0.151)	(0.031)	(0.101)	(0.067)	0.450		
	(2)		0.151	-0.006	-0.011	0.867***	$\phi_1=0.25$	$\phi_2=0.25$	9.503
			(0.135)	(0.028)	(0.087)	(0.058)	0.537	82.430***	
	(3)	0.133**	1.134	-0.048	-0.086	0.867***	$\lambda=0.25$		9.503
		(0.058)	(0.683)	(0.210)	(0.638)	(0.058)	4.007**		
FEMALE	(1)		0.132	-0.001	-0.061	0.941***	$\phi_1+\phi_2+\phi_3+\phi_4=1$		8.364
			(0.138)	(0.036)	(0.093)	(0.065)	0.989		
	(2)		0.147	-0.007	-0.078	0.938***	$\phi_1=0.25$	$\phi_2=0.25$	8.906
			(0.137)	(0.034)	(0.098)	(0.075)	0.564	55.715***	
	(3)	0.062	2.370	-0.109	-1.261	0.938***	$\lambda=0.25$		8.906
		(0.075)	(2.683)	(0.596)	(2.243)	(0.075)	6.309**		

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.82. Heterogeneous Updating Model – Gender Disaggregated Expectations – Stable Sample Period

Testing Equation:

$$(1)E_{i,t}[\pi_{t+h}] = \phi_1 E_{P,t}[\pi_{t+h}] + \phi_2 \pi_t + \phi_3 E_{RE,t}[\pi_{t+h}] + \phi_4 E_{i,t-1}[\pi_{t+h-1}] + \epsilon_t$$

$$(2)E_{i,t}[\pi_{t+h}] = \phi_1 E_{P,t}[\pi_{t+h}] + \phi_2 \pi_t + \phi_3 E_{RE,t}[\pi_{t+h}] + (1 - \phi_1 - \phi_2 - \phi_3)E_{i,t-1}[\pi_{t+h-1}] + \epsilon_t$$

$$(3)E_{t,H}[\pi_{t+h}] = \lambda(\phi_1 E_{t,P}[\pi_{t+h}] + \phi_2 \pi_{t-1} + (1 - \phi_1 + \phi_2)E_{RE,t}[\pi_{t+h}]) + (1 - \lambda)E_{t,H}[\pi_{t+h-1}] + \epsilon_t$$

		λ	ϕ_1	ϕ_2	ϕ_3	ϕ_4 $(1-\lambda)$	Wald χ^2 Test		J-Stat
					Period: Stable 1990Q1 – 2006Q2				
MALE	(1)		0.109	0.053	0.390	0.450***	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		6.632
			(0.209)	(0.063)	(0.295)	(0.122)	0.003		
	(2)		0.119	0.054	0.384**	0.443***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	6.464
			(0.116)	(0.059)	(0.155)	(0.122)	1.270	11.005***	
	(3)	0.557***	0.214	0.097	0.690***	0.443***	$\lambda = 0.25$		6.464
		(0.122)	(0.235)	(0.095)	(0.157)	(0.122)	6.341**		
FEMALE	(1)		0.127	0.088	0.513**	0.348*	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		5.095
			(0.113)	(0.074)	(0.251)	(0.188)	5.534**		
	(2)		0.127	-0.035	0.054	0.854***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	10.538
			(0.091)	(0.025)	(0.041)	(0.053)	1.817	127.095***	
	(3)	0.146***	0.868**	-0.238	0.370	0.854***	$\lambda = 0.25$		10.538
		(0.053)	(0.336)	(0.182)	(0.394)	(0.053)	3.905**		

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.83. Heterogeneous Updating Model – Gender Disaggregated Expectations – Volatile Sample Period

Testing Equation:

$$(1)E_{i,t}[\pi_{t+h}] = \phi_1 E_{P,t}[\pi_{t+h}] + \phi_2 \pi_t + \phi_3 E_{RE,t}[\pi_{t+h}] + \phi_4 E_{i,t-1}[\pi_{t+h-1}] + \epsilon_t$$

$$(2)E_{i,t}[\pi_{t+h}] = \phi_1 E_{P,t}[\pi_{t+h}] + \phi_2 \pi_t + \phi_3 E_{RE,t}[\pi_{t+h}] + (1 - \phi_1 - \phi_2 - \phi_3)E_{i,t-1}[\pi_{t+h-1}] + \epsilon_t$$

$$(3)E_{t,H}[\pi_{t+h}] = \lambda(\phi_1 E_{t,P}[\pi_{t+h}] + \phi_2 \pi_{t-1} + (1 - \phi_1 + \phi_2)E_{RE,t}[\pi_{t+h}]) + (1 - \lambda)E_{t,H}[\pi_{t+h-1}] + \epsilon_t$$

		λ	ϕ_1	ϕ_2	ϕ_3	ϕ_4 $(1-\lambda)$	Wald χ^2 Test		J-Stat
					Period: Volatile 2006Q3 – 2011Q1				
MALE	(1)†		1.436***	0.090	-0.141*	0.001	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		4.995
			(0.213)	(0.057)	(0.070)	(0.132)	32.322***		
	(2)†		0.158	0.052	0.060	0.730***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	5.269
			(0.134)	(0.066)	(0.067)	(0.116)	0.465	9.053***	
	(3)†	0.270**	0.586	0.192	0.222	0.730***	$\lambda = 0.25$		5.269
		(0.116)	(0.386)	(0.256)	(0.227)	(0.116)	0.031		
FEMALE	(1)†		1.562**	0.075	-0.227*	0.095	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		2.745
			(0.549)	(0.076)	(0.127)	(0.232)	10.277***		
	(2)†		-0.095	0.024	0.076*	0.995***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	5.116
			(0.091)	(0.074)	(0.043)	(0.041)	14.551***	9.288***	
	(3)†	0.005	-18.134	4.638	14.496	0.995***	$\lambda = 0.25$		5.116
		(0.041)	(138.723)	(29.982)	(110.292)	(0.041)	36.518***		

***,**,* indicate significance at 1, 5 and 10 percent levels.

†Due to length of volatile period, no lag can be specified for the Newey-West covariance matrix

Appendix 5.84. Heterogeneous Updating Model – Income Disaggregated Expectations – Whole Sample Period

Testing Equation:

$$(1) E_{i,t}[\pi_{t+h}] = \phi_1 E_{P,t}[\pi_{t+h}] + \phi_2 \pi_t + \phi_3 E_{RE,t}[\pi_{t+h}] + \phi_4 E_{i,t-1}[\pi_{t+h-1}] + \epsilon_t$$

$$(2) E_{i,t}[\pi_{t+h}] = \phi_1 E_{P,t}[\pi_{t+h}] + \phi_2 \pi_t + \phi_3 E_{RE,t}[\pi_{t+h}] + (1 - \phi_1 - \phi_2 - \phi_3) E_{i,t-1}[\pi_{t+h-1}] + \epsilon_t$$

$$(3) E_{t,H}[\pi_{t+h}] = \lambda(\phi_1 E_{t,P}[\pi_{t+h}] + \phi_2 \pi_{t-1} + (1 - \phi_1 + \phi_2) E_{RE,t}[\pi_{t+h}]) + (1 - \lambda) E_{t,H}[\pi_{t+h-1}] + \epsilon_t$$

		λ	ϕ_1	ϕ_2	ϕ_3	ϕ_4 $(1-\lambda)$	Wald χ^2 Test		J-Stat
Period: Whole 1982Q3 – 2011Q1									
Y14	**(1)**		-0.065	0.019	0.232***	0.839***	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		7.285
			(0.070)	(0.074)	(0.067)	(0.048)	1.435		
	(2)		0.029	-0.032	0.144	0.859***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	8.883
			(0.110)	(0.251)	(0.169)	(0.034)	3.986**	1.264	
	(3)	0.141***	0.209	-0.227	1.019	0.859***	$\lambda = 0.25$		8.883
		(0.034)	(0.750)	(1.742)	(1.043)	(0.034)	10.151***		
Y24	**(1)**		-0.008	0.057	0.181**	0.774***	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		8.746
			(0.040)	(0.061)	(0.078)	(0.069)	0.130		
	(2)		0.008	0.047	0.169**	0.776***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	8.789
			(0.048)	(0.058)	(0.058)	(0.064)	25.646***	12.151***	
	(3)	0.224***	0.036	0.209	0.755***	0.776***	$\lambda = 0.25$		8.789
		(0.064)	(0.218)	(0.238)	(0.243)	(0.064)	0.165		
Y34	**(1)**		0.016	0.041	0.154	0.775***	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		11.810
			(0.073)	(0.039)	(0.115)	(0.089)	1.779		
	(2)		-0.013	0.053*	0.175	0.785***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	11.911*
			(0.073)	(0.029)	(0.111)	(0.085)	13.064	44.581***	
	(3)	0.215**	-0.059	0.247**	0.812**	0.785***	$\lambda = 0.25$		11.911*
		(0.085)	(0.334)	(0.109)	(0.360)	(0.085	0.164		
Y44	**(1)**		0.274	0.108**	-0.019	0.590***	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		10.338*
			(0.250)	(0.050)	(0.332)	(0.085)	0.500		
	(2)		0.096	0.150**	0.144	0.610***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	11.779*
			(0.197)	(0.072)	(0.199)	(0.080)	0.610	1.918	
	(3)	0.390***	0.246	0.385***	0.369	0.610***	$\lambda = 0.25$		11.779*
		(0.080)	(0.537)	(0.121)	(0.463)	(0.080	3.089*		

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.85. Heterogeneous Updating Model – Income Disaggregated Expectations – Greenspan-Bernanke Sample Period

Testing Equation:

$$(1) E_{i,t}[\pi_{t+h}] = \phi_1 E_{P,t}[\pi_{t+h}] + \phi_2 \pi_t + \phi_3 E_{RE,t}[\pi_{t+h}] + \phi_4 E_{i,t-1}[\pi_{t+h-1}] + \epsilon_t$$

$$(2) E_{i,t}[\pi_{t+h}] = \phi_1 E_{P,t}[\pi_{t+h}] + \phi_2 \pi_t + \phi_3 E_{RE,t}[\pi_{t+h}] + (1 - \phi_1 - \phi_2 - \phi_3) E_{i,t-1}[\pi_{t+h-1}] + \epsilon_t$$

$$(3) E_{t,H}[\pi_{t+h}] = \lambda(\phi_1 E_{t,P}[\pi_{t+h}] + \phi_2 \pi_{t-1} + (1 - \phi_1 + \phi_2) E_{RE,t}[\pi_{t+h}]) + (1 - \lambda) E_{t,H}[\pi_{t+h-1}] + \epsilon_t$$

		λ	ϕ_1	ϕ_2	ϕ_3	ϕ_4 $(1-\lambda)$	Wald χ^2 Test		J-Stat
Period: Greenspan-Bernanke 1987Q2 – 2011Q1									
Y14	**(1)**		0.078	0.016	0.033	0.892***	$\phi_1+\phi_2+\phi_3+\phi_4=1$		7.706
			(0.134)	(0.064)	(0.193)	(0.030)	5.087**		
	(2)		0.135	-0.003	-0.027	0.895***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	8.911
			(0.134)	(0.087)	(0.159)	(0.082)	0.738	8.435***	
	(3)	0.105	1.285	-0.029	-0.256	0.895***	$\lambda = 0.25$		8.911
		(0.082)	(1.358)	(0.845)	(1.491)	(0.082)	3.153*		
Y24	**(1)**		0.087	-0.044	0.109	0.858***	$\phi_1+\phi_2+\phi_3+\phi_4=1$		7.662
			(0.086)	(0.065)	(0.071)	(0.029)	0.958		
	(2)		0.095	-0.048	0.096	0.856***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	8.083
			(0.079)	(0.059)	(0.063)	(0.032)	3.810*	25.568***	
	(3)	0.144***	0.662	-0.332	0.670	0.856***	$\lambda = 0.25$		8.083
		(0.032)	(0.448)	(0.373)	(0.452)	(0.032)	11.195***		
Y34	**(1)**		0.168	-0.003	-0.109	0.945***	$\phi_1+\phi_2+\phi_3+\phi_4=1$		8.377
			(0.243)	(0.096)	(0.132)	(0.090)	0.001		
	(2)		0.174	-0.008	-0.108	0.942***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	8.638
			(0.181)	(0.121)	(0.108)	(0.071)	0.177	4.573**	
	(3)	0.058	3.017	-0.144	-1.873	0.942***	$\lambda = 0.25$		8.638
		(0.071)	(5.222)	(2.226)	(0.350)	(0.071)	7.283***		
Y44	**(1)**		0.717	0.020	-0.375	0.590	$\phi_1+\phi_2+\phi_3+\phi_4=1$		4.396
			(0.515)	(0.210)	(0.538)	(0.512)	0.037		
	(2)		0.616	-0.014	-0.312	0.710***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	5.896
			(0.416)	(0.099)	(0.254)	(0.105)	0.773	7.180***	
	(3)	0.290***	2.124**	-0.050	-1.075	0.710***	$\lambda = 0.25$		5.896
		(0.105)	(0.976)	(0.333)	(0.676)	(0.105)	0.145		

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.86. Heterogeneous Updating Model – Income Disaggregated Expectations – Stable Sample Period

Testing Equation:

$$(1) E_{i,t}[\pi_{t+h}] = \phi_1 E_{P,t}[\pi_{t+h}] + \phi_2 \pi_t + \phi_3 E_{RE,t}[\pi_{t+h}] + \phi_4 E_{i,t-1}[\pi_{t+h-1}] + \epsilon_t$$

$$(2) E_{i,t}[\pi_{t+h}] = \phi_1 E_{P,t}[\pi_{t+h}] + \phi_2 \pi_t + \phi_3 E_{RE,t}[\pi_{t+h}] + (1 - \phi_1 - \phi_2 - \phi_3) E_{i,t-1}[\pi_{t+h-1}] + \epsilon_t$$

$$(3) E_{t,H}[\pi_{t+h}] = \lambda(\phi_1 E_{t,P}[\pi_{t+h}] + \phi_2 \pi_{t-1} + (1 - \phi_1 + \phi_2) E_{RE,t}[\pi_{t+h}]) + (1 - \lambda) E_{t,H}[\pi_{t+h-1}] + \epsilon_t$$

		λ	ϕ_1	ϕ_2	ϕ_3	ϕ_4 $(1-\lambda)$	Wald χ^2 Test		J-Stat
					Period: Stable 1990Q1 – 2006Q2				
Y14	**(1)**		0.065 (0.173)	0.060 (0.100)	0.949 (0.682)	0.105 (0.441)	$\phi_1+\phi_2+\phi_3+\phi_4=1$ 6.002**		4.525
	(2)		0.165 (0.157)	-0.107 (0.165)	0.043 (0.144)	0.900*** (0.134)	$\phi_1 = 0.25$ 0.295	$\phi_2 = 0.25$ 4.693**	9.735
	(3)	0.100 (0.134)	1.659** (0.777)	-1.075* (0.589)	-0.256 (1.491)	0.895*** (0.082)	$\lambda = 0.25$ 1.259		9.735
Y24	**(1)**		0.092 (0.387)	0.061 (0.830)	0.356 (3.960)	0.531 (1.995)	$\phi_1+\phi_2+\phi_3+\phi_4=1$ 0.003		4.061
	(2)		0.129 (0.141)	0.004 (0.069)	0.123 (0.085)	0.744*** (0.032)	$\phi_1 = 0.25$ 0.735	$\phi_2 = 0.25$ 12.766***	9.403
	(3)	0.256*** (0.032)	0.504 (0.532)	0.015 (0.269)	0.481 (0.332)	0.744*** (0.032)	$\lambda = 0.25$ 0.040		9.403
Y34	**(1)**		0.092 (0.132)	0.089*** (0.032)	0.334** (0.151)	0.495*** (0.081)	$\phi_1+\phi_2+\phi_3+\phi_4=1$ 0.467		6.387
	(2)		0.132 (0.097)	0.086*** (0.032)	0.275** (0.115)	0.507*** (0.087)	$\phi_1 = 0.25$ 1.478	$\phi_2 = 0.25$ 25.418***	6.683
	(3)	0.493*** (0.087)	0.267 (0.198)	0.175** (0.075)	0.558*** (0.181)	0.507*** (0.087)	$\lambda = 0.25$ 7.735***		6.683
Y44	**(1)**		0.175** (0.079)	0.087** (0.042)	0.365*** (0.100)	0.355*** (0.037)	$\phi_1+\phi_2+\phi_3+\phi_4=1$ 0.744		5.694
	(2)		0.105* (0.056)	0.070* (0.037)	0.477*** (0.093)	0.348*** (0.053)	$\phi_1 = 0.25$ 6.854***	$\phi_2 = 0.25$ 24.129***	4.942
	(3)	0.652*** (0.053)	0.160* (0.087)	0.108* (0.061)	0.732*** (0.100)	0.348*** (0.053)	$\lambda = 0.25$ 56.869***		4.942

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.87. Heterogeneous Updating Model – Income Disaggregated Expectations – Volatile Sample Period

Testing Equation:

$$(1) E_{i,t}[\pi_{t+h}] = \phi_1 E_{P,t}[\pi_{t+h}] + \phi_2 \pi_t + \phi_3 E_{RE,t}[\pi_{t+h}] + \phi_4 E_{i,t-1}[\pi_{t+h-1}] + \epsilon_t$$

$$(2) E_{i,t}[\pi_{t+h}] = \phi_1 E_{P,t}[\pi_{t+h}] + \phi_2 \pi_t + \phi_3 E_{RE,t}[\pi_{t+h}] + (1 - \phi_1 - \phi_2 - \phi_3) E_{i,t-1}[\pi_{t+h-1}] + \epsilon_t$$

$$(3) E_{t,H}[\pi_{t+h}] = \lambda(\phi_1 E_{t,P}[\pi_{t+h}] + \phi_2 \pi_{t-1} + (1 - \phi_1 + \phi_2) E_{RE,t}[\pi_{t+h}]) + (1 - \lambda) E_{t,H}[\pi_{t+h-1}] + \epsilon_t$$

		λ	ϕ_1	ϕ_2	ϕ_3	ϕ_4 $(1-\lambda)$	Wald χ^2 Test		J-Stat
					Period: Volatile 2006Q3 – 2011Q1				
Y14	(1)†		1.944*** (0.548)	0.030 (0.049)	-0.248** (0.110)	0.073 (0.250)	$\phi_1+\phi_2+\phi_3+\phi_4=1$ 13.825***		1.945
	(2)†		-0.247* (0.126)	0.105 (0.064)	0.143*** (0.048)	0.999*** (0.048)	$\phi_1 = 0.25$ 15.621***	$\phi_2 = 0.25$ 5.125**	3.947
	(3)†	0.001 (0.048)	-227.865 (10267.23)	96.686 (4337.984)	130.458 (5776.105)	0.999*** (0.048)	$\lambda = 0.25$ 26.400***		3.947
Y24	(1)†		1.912*** (0.359)	0.144** (0.052)	-0.152 (0.093)	-0.204 (0.186)	$\phi_1+\phi_2+\phi_3+\phi_4=1$ 39.967***		4.818
	(2)†		-0.216 (0.283)	0.034 (0.085)	0.246** (0.115)	0.936*** (0.146)	$\phi_1 = 0.25$ 2.718*	$\phi_2 = 0.25$ 6.424**	4.394
	(3)†	0.064 (0.146)	-3.376 (11.830)	0.534 (2.070)	3.841 (10.107)	0.936*** (0.146)	$\lambda = 0.25$ 1.618		4.393
Y34	(1)†		1.497*** (0.324)	0.078 (0.046)	-0.245*** (0.083)	0.060 (0.177)	$\phi_1+\phi_2+\phi_3+\phi_4=1$ 18.770***		4.027
	(2)†		0.108 (0.068)	0.024 (0.063)	0.028 (0.041)	0.840*** (0.071)	$\phi_1 = 0.25$ 4.330**	$\phi_2 = 0.25$ 12.949***	6.024
	(3)†	0.160** (0.071)	0.675 (0.428)	0.148 (0.340)	0.177 (0.278)	0.840*** (0.071)	$\lambda = 0.25$ 1.600		6.024
Y44	(1)†		1.166*** (0.219)	0.223** (0.092)	-0.095 (0.082)	-0.033 (0.154)	$\phi_1+\phi_2+\phi_3+\phi_4=1$ 30.027***		3.279
	(2)†		0.461* (0.223)	0.143 (0.149)	0.037 (0.117)	0.359** (0.147)	$\phi_1 = 0.25$ 0.891	$\phi_2 = 0.25$ 0.511	5.481
	(3)†	0.641*** (0.147)	0.719* (0.365)	0.224 (0.220)	0.058 (0.108)	0.359** (0.147)	$\lambda = 0.25$ 7.062***		5.481

***,**,* indicate significance at 1, 5 and 10 percent levels.

†Due to length of volatile period, no lag can be specified for the Newey-West covariance matrix

Appendix 5.88. Heterogeneous Updating Model – Regionally Disaggregated Expectations – Whole Sample Period

Testing Equation:

$$(1)E_{i,t}[\pi_{t+h}] = \phi_1 E_{P,t}[\pi_{t+h}] + \phi_2 \pi_t + \phi_3 E_{RE,t}[\pi_{t+h}] + \phi_4 E_{i,t-1}[\pi_{t+h-1}] + \epsilon_t$$

$$(2)E_{i,t}[\pi_{t+h}] = \phi_1 E_{P,t}[\pi_{t+h}] + \phi_2 \pi_t + \phi_3 E_{RE,t}[\pi_{t+h}] + (1 - \phi_1 - \phi_2 - \phi_3)E_{i,t-1}[\pi_{t+h-1}] + \epsilon_t$$

$$(3)E_{t,H}[\pi_{t+h}] = \lambda(\phi_1 E_{t,P}[\pi_{t+h}] + \phi_2 \pi_{t-1} + (1 - \phi_1 + \phi_2)E_{RE,t}[\pi_{t+h}]) + (1 - \lambda)E_{t,H}[\pi_{t+h-1}] + \epsilon_t$$

		λ	ϕ_1	ϕ_2	ϕ_3	ϕ_4 $(1-\lambda)$	Wald χ^2 Test		J-Stat
					Period: Whole 1982Q3 – 2011Q1				
NC	**(1)**		0.052 (3.620)	0.040 (3.844)	0.061 (3.074)	0.841 (2.699)	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$ 0.000		11.536
	(2)		0.015 (0.088)	0.056 (0.068)	0.098 (0.144)	0.831*** (0.120)	$\phi_1 = 0.25$ 7.179***	$\phi_2 = 0.25$ 8.207***	11.840*
	(3)	0.169 (0.120)	0.087 (0.576)	0.331 (0.206)	0.583 (0.486)	0.831*** (0.120)	$\lambda = 0.25$ 0.459		11.840*
NE	**(1)**		0.042 (0.062)	0.176 (0.200)	0.280* (0.155)	0.502 (0.319)	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$ 0.000		9.087
	(2)		0.041 (0.050)	0.172 (0.171)	0.275* (0.150)	0.512* (0.308)	$\phi_1 = 0.25$ 17.596***	$\phi_2 = 0.25$ 0.207	9.203
	(3)	0.488 (0.308)	0.084 (0.106)	0.353** (0.157)	0.563*** (0.147)	0.512* (0.308)	$\lambda = 0.25$ 0.599		9.203
S	**(1)**		-0.003 (0.060)	0.048 (0.033)	0.158 (0.122)	0.795*** (0.074)	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$ 2.823*		12.677**
	(2)		-0.014 (0.058)	0.057* (0.033)	0.168 (0.119)	0.789*** (0.071)	$\phi_1 = 0.25$ 20.649***	$\phi_2 = 0.25$ 34.410***	12.764**
	(3)	0.211*** (0.072)	-0.066 (0.258)	0.269 (0.169)	0.797** (0.320)	0.789*** (0.072)	$\lambda = 0.25$ 0.294		12.764**
W	**(1)**		0.054 (0.058)	0.093 (0.069)	0.191** (0.073	0.657*** (0.091)	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$ 0.108		8.457
	(2)		0.044 (0.059)	0.098* (0.054)	0.200*** (0.069)	0.659*** (0.084)	$\phi_1 = 0.25$ 12.073***	$\phi_2 = 0.25$ 7.860***	8.562
	(3)	0.341*** (0.084)	0.128 (0.178)	0.286** (0.115)	0.587*** (0.151)	0.659*** (0.084)	$\lambda = 0.25$ 1.172		8.562

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.89. Heterogeneous Updating Model – Regionally Disaggregated Expectations – Greenspan-Bernanke Sample Period

Testing Equation:

$$(1) E_{i,t}[\pi_{t+h}] = \phi_1 E_{P,t}[\pi_{t+h}] + \phi_2 \pi_t + \phi_3 E_{RE,t}[\pi_{t+h}] + \phi_4 E_{i,t-1}[\pi_{t+h-1}] + \epsilon_t$$

$$(2) E_{i,t}[\pi_{t+h}] = \phi_1 E_{P,t}[\pi_{t+h}] + \phi_2 \pi_t + \phi_3 E_{RE,t}[\pi_{t+h}] + (1 - \phi_1 - \phi_2 - \phi_3) E_{i,t-1}[\pi_{t+h-1}] + \epsilon_t$$

$$(3) E_{t,H}[\pi_{t+h}] = \lambda(\phi_1 E_{t,P}[\pi_{t+h}] + \phi_2 \pi_{t-1} + (1 - \phi_1 + \phi_2) E_{RE,t}[\pi_{t+h}]) + (1 - \lambda) E_{t,H}[\pi_{t+h-1}] + \epsilon_t$$

		λ	ϕ_1	ϕ_2	ϕ_3	ϕ_4 $(1-\lambda)$	Wald χ^2 Test		J-Stat
					Period: Greenspan-Bernanke 1987Q2 – 2011Q1				
NC	(1)		0.272*	-0.003	-0.187**	0.918***	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		9.319*
			(0.160)	(0.067)	(0.086)	(0.100)	0.002		
	(2)		0.276*	-0.005	-0.185**	0.914***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	9.600
			(0.153)	(0.065)	(0.088)	(0.061)	0.029	15.279***	
	(3)	0.086	3.204	-0.057	-2.147	0.914***	$\lambda = 0.25$		9.600
		(0.061)	(2.216)	(0.749)	(1.939)	(0.061)	7.259***		
NE	(1)		0.075	0.009	0.138	0.786***	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		9.042
			(0.123)	(0.194)	(0.136)	(0.187)	0.551		
	(2)		0.088	0.002	0.148	0.762***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	9.394
			(0.125)	(0.200)	(0.129)	(0.191)	1.666	1.538	
	(3)	0.238	0.372	0.007	0.621	0.762***	$\lambda = 0.25$		9.394
		(0.191)	(0.772)	(0.837)	(0.381)	(0.191)	0.004		
S	(1)		0.160	0.000	-0.025	0.869***	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		10.547*
			(0.113)	(0.041)	(0.097)	(0.047)	0.048		
	(2)		0.163	-0.001	-0.027	0.865***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	10.702*
			(0.107)	(0.056)	(0.093)	(0.070)	0.669	20.116***	
	(3)	0.135*	1.201	-0.005	-0.196	0.865***	$\lambda = 0.25$		10.702*
		(0.070)	(0.844)	(0.415)	(0.685)	(0.070)	2.658		
W	(1)		0.084	0.014	0.087	0.819	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		8.544
			(0.183)	(0.101)	(0.110)	(0.073)	0.140		
	(2)		0.095	0.012	0.082	0.811***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	8.740
			(0.195)	(0.113)	(0.133)	(0.080)	0.633	4.444**	
	(3)	0.189**	0.503	0.062	0.436	0.811***	$\lambda = 0.25$		8.740
		(0.080)	(1.138)	(0.578)	(0.606)	(0.080)	0.576		

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.90. Heterogeneous Updating Model – Regionally Disaggregated Expectations – Stable Sample Period

Testing Equation:

$$(1) E_{i,t}[\pi_{t+h}] = \phi_1 E_{P,t}[\pi_{t+h}] + \phi_2 \pi_t + \phi_3 E_{RE,t}[\pi_{t+h}] + \phi_4 E_{i,t-1}[\pi_{t+h-1}] + \epsilon_t$$

$$(2) E_{i,t}[\pi_{t+h}] = \phi_1 E_{P,t}[\pi_{t+h}] + \phi_2 \pi_t + \phi_3 E_{RE,t}[\pi_{t+h}] + (1 - \phi_1 - \phi_2 - \phi_3) E_{i,t-1}[\pi_{t+h-1}] + \epsilon_t$$

$$(3) E_{t,H}[\pi_{t+h}] = \lambda\left(\phi_1 E_{t,P}[\pi_{t+h}] + \phi_2 \pi_{t-1} + (1 - \phi_1 + \phi_2) E_{RE,t}[\pi_{t+h}]\right) + (1 - \lambda) E_{t,H}[\pi_{t+h-1}] + \epsilon_t$$

		λ	ϕ_1	ϕ_2	ϕ_3	ϕ_4 $(1-\lambda)$	Wald χ^2 Test		J-Stat
Period: Stable 1990Q1 – 2006Q2									
NC	**(1)**		0.205	0.019	0.266	0.534***	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		9.619
			(0.184)	(0.051)	(0.252)	(0.095)	1.345		
	(2)		0.239**	0.016	0.126	0.619***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	0.429
			(0.093)	(0.081)	(0.168)	(0.171)	0.015	8.146***	
	(3)	0.382**	0.626	0.043	0.331	0.619***	$\lambda = 0.25$		11.213*
		(0.171)	(0.472)	(0.197)	(0.317)	(0.171)	0.590		
NE	**(1)**		-0.004	0.246***	0.620**	0.160	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		4.089
			(0.152)	(0.051)	(0.290)	(0.132)	0.595		
	(2)		0.055	0.247***	0.497***	0.201***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	5.414
			(0.065)	(0.043)	(0.111)	(0.070)	9.066***	0.004	
	(3)	0.799***	0.069	0.310***	0.622***	0.201***	$\lambda = 0.25$		5.414
		(0.070)	(0.084)	(0.052)	(0.107)	(0.070)	62.225***		
S	**(1)**		0.096	-0.005	0.363***	0.576***	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		6.511
			(0.077)	(0.048)	(0.127)	(0.082)	2.823*		
	(2)		0.112	-0.040	0.137**	0.792	$\phi_1 = 0.25$	$\phi_2 = 0.25$	9.181
			(0.068)	(0.070)	(0.063)	(0.047)	4.121**	17.256***	
	(3)	0.208***	0.538**	-0.194	0.656***	0.792***	$\lambda = 0.25$		9.181
		(0.047)	(0.237)	(0.307)	(0.238)	(0.047)	0.806		
W	**(1)**		0.155	0.112**	0.349	0.409**	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		5.118
			(0.151)	(0.049)	(0.271)	(0.161)	0.998		
	(2)		0.191**	0.098	0.202	0.509**	$\phi_1 = 0.25$	$\phi_2 = 0.25$	6.560
			(0.084)	(0.086)	(0.193)	(0.219)	0.504	2.954*	
	(3)	0.491**	0.388	0.199*	0.412*	0.509**	$\lambda = 0.25$		6.560
		(0.219)	(0.306)	(0.105)	(0.220)	(0.219)	1.207		

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 5.91. Heterogeneous Updating Model – Regionally Disaggregated Expectations – Volatile Sample Period

Testing Equation:

$$(1)E_{i,t}[\pi_{t+h}] = \phi_1 E_{P,t}[\pi_{t+h}] + \phi_2 \pi_t + \phi_3 E_{RE,t}[\pi_{t+h}] + \phi_4 E_{i,t-1}[\pi_{t+h-1}] + \epsilon_t$$

$$(2)E_{i,t}[\pi_{t+h}] = \phi_1 E_{P,t}[\pi_{t+h}] + \phi_2 \pi_t + \phi_3 E_{RE,t}[\pi_{t+h}] + (1 - \phi_1 - \phi_2 - \phi_3) E_{i,t-1}[\pi_{t+h-1}] + \epsilon_t$$

$$(3)E_{t,H}[\pi_{t+h}] = \lambda(\phi_1 E_{t,P}[\pi_{t+h}] + \phi_2 \pi_{t-1} + (1 - \phi_1 + \phi_2) E_{RE,t}[\pi_{t+h}]) + (1 - \lambda) E_{t,H}[\pi_{t+h-1}] + \epsilon_t$$

		λ	ϕ_1	ϕ_2	ϕ_3	ϕ_4 $(1-\lambda)$	Wald χ^2 Test		J-Stat
					Period: Volatile 2006Q3 – 2011Q1				
NC	**(1)†**		1.993***	0.024	-0.338***	-0.119	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		4.663
			(0.462)	(0.047)	(0.100)	(0.239)	16.535***		
	(2)†		0.033	0.029	0.022	0.916***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	5.465
			(0.115)	(0.048)	(0.046)	(0.063)	3.548*	21.418***	
	(3)†	0.084	0.392	0.349	0.259	0.916***	$\lambda = 0.25$		5.465
		(0.063)	(1.188)	(0.725)	(0.578)	(0.063)	6.888***		
NE	**(1)†**		1.548***	0.090	-0.138**	-0.001	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		3.172
			(0.228)	(0.064)	(0.049)	(0.146)	47.285***		
	(2)†		-0.051	0.036	0.142**	0.873***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	4.082
			(0.138)	(0.076)	(0.057)	(0.088)	4.722**	7.984***	
	(3)†	0.127	-0.401	0.284	1.117	0.873***	$\lambda = 0.25$		4.082
		(0.088)	(1.319)	(0.661)	(0.936)	(0.088)	1.944		
S	**(1)†**		1.463***	0.037	-0.220**	0.134	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		4.068
			(0.256)	(0.065)	(0.082)	(0.130)	29.913***		
	(2)†		0.094	0.006	0.025	0.875***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	6.152
			(0.094)	(0.059)	(0.062)	(0.059)	2.741*	17.340***	
	(3)†	0.125**	0.750	0.050	0.200	0.875***	$\lambda = 0.25$		6.152
		(0.059)	(0.687)	(0.457)	(0.508)	(0.059)	4.455**		
W	**(1)†**		0.948**	0.096	0.000	0.249	$\phi_1 + \phi_2 + \phi_3 + \phi_4 = 1$		3.365
			(0.381)	(0.070)	(0.083)	(0.232)	6.835***		
	(2)†		-0.058	0.057	0.161**	0.839***	$\phi_1 = 0.25$	$\phi_2 = 0.25$	4.834
			(0.152)	(0.060)	(0.058)	(0.091)	4.076**	10.266***	
	(3)†	0.161*	-0.358	0.353	1.005	0.839***	$\lambda = 0.25$		4.834
		(0.091)	(1.118)	(0.466)	(0.757)	(0.091)	0.961		

***,**,* indicate significance at 1, 5 and 10 percent levels.

†Due to length of volatile period, no lag can be specified for the Newey-West covariance matrix

APPENDICES FOR CHAPTER 6

Appendix 6.1. SPF Forecast Updates – Descriptive Statistics

	PANEL A				PANEL B			
	WHOLE	G-B	STABLE	VOLATILE	WHOLE	G-B	STABLE	VOLATILE
	$U_{t,t} = E_t[\pi_t] - E_{t-1}[\pi_{t-1}]$				$\lvert U_{t,t}\rvert = \lvert E_t[\pi_t] - E_{t-1}[\pi_{t-1}]\rvert$			
Mean	-0.008	-0.008	-0.009	-0.047	0.825***	0.753***	0.563***	1.488***
Median	0.015	0.008	-0.025	0.200	0.450	0.411	0.375	0.622
S.D.	1.399	1.306	0.835	2.475	1.127	1.064	0.613	1.947
Max.	4.100	3.420	2.000	3.420	7.900	7.900	0.380	7.900
Min.	-7.900	-7.900	-3.800	-7.900	0.000	0.000	0.000	0.015
	$U_{t,t+1} = E_t[\pi_{t+1}] - E_{t-1}[\pi_t]$				$\lvert U_{t,t+1}\rvert = \lvert E_t[\pi_{t+1}] - E_{t-1}[\pi_t]\rvert$			
Mean	-0.040	-0.023	-0.025	-0.066	0.297***	0.275***	0.229***	0.400***
Median	0.000	0.000	0.025	-0.093	0.200	0.200	0.150	0.219
S.D.	0.440	0.435	0.362	0.643	0.326	0.336	0.280	0.499
Max.	1.000	1.000	1.000	0.943	2.091	2.091	1.900	2.091
Min.	-2.091	-2.091	-1.900	-2.091	0.000	0.000	0.000	0.000
	$U_{t,t+2} = E_t[\pi_{t+2}] - E_{t-1}[\pi_{t+1}]$				$\lvert U_{t,t+2}\rvert = \lvert E_t[\pi_{t+2}] - E_{t-1}[\pi_{t+1}]\rvert$			
Mean	-0.037	-0.023	-0.027	-0.034	0.207***	0.183***	0.157***	0.210***
Median	0.000	0.000	0.000	-0.037	0.150	0.140	0.100	0.143
S.D.	0.284	0.248	0.215	0.295	0.198	0.167	0.149	0.203
Max.	0.550	0.550	0.500	0.514	1.200	0.800	0.600	0.800
Min.	-1.200	-0.800	-0.600	-0.800	0.000	0.000	0.000	0.000
	$U_{t,t+3} = E_t[\pi_{t+3}] - E_{t-1}[\pi_{t+2}]$				$\lvert U_{t,t+3}\rvert = \lvert E_t[\pi_{t+3}] - E_{t-1}[\pi_{t+2}]\rvert$			
Mean	-0.039	-0.024	-0.029	-0.027	0.199***	0.165***	0.155***	0.147***
Median	-0.024	0.000	0.000	-0.037	0.150	0.140	0.107	0.125
S.D.	0.255	0.208	0.197	0.193	0.161	0.129	0.838	0.123
Max.	0.600	0.450	0.418	0.387	0.900	0.490	0.490	0.400
Min.	-0.900	-0.490	-0.490	-0.400	0.000	0.000	0.000	0.006
	$U_{t,t+4} = E_t[\pi_{t+4}] - E_{t-1}[\pi_{t+3}]$				$\lvert U_{t,t+4}\rvert = \lvert E_t[\pi_{t+4}] - E_{t-1}[\pi_{t+3}]\rvert$			
Mean	-0.035	-0.021	-0.031	-0.013	0.165***	0.140***	0.135***	0.134***
Median	-0.050*	-0.018	-0.038	-0.050	0.100	0.100	0.100	0.133
S.D.	0.231	0.176	0.171	0.164	0.164	0.107	0.108	0.091
Max.	1.000	0.450	0.400	0.250	1.000	0.450	0.450	0.278
Min.	-1.000	-0.450	-0.450	-0.278	0.000	0.000	0.000	0.000

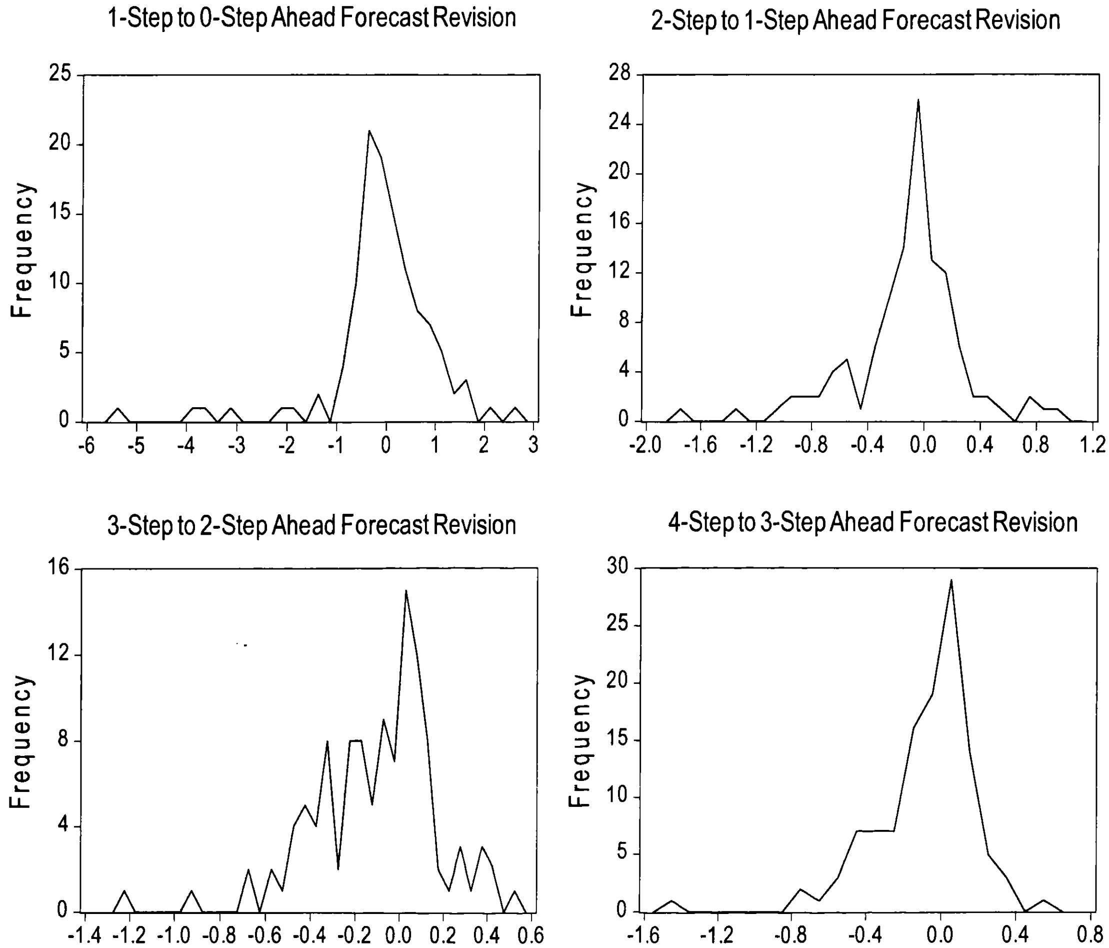
***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 6.2. SPF Forecast Revisions – Descriptive Statistics

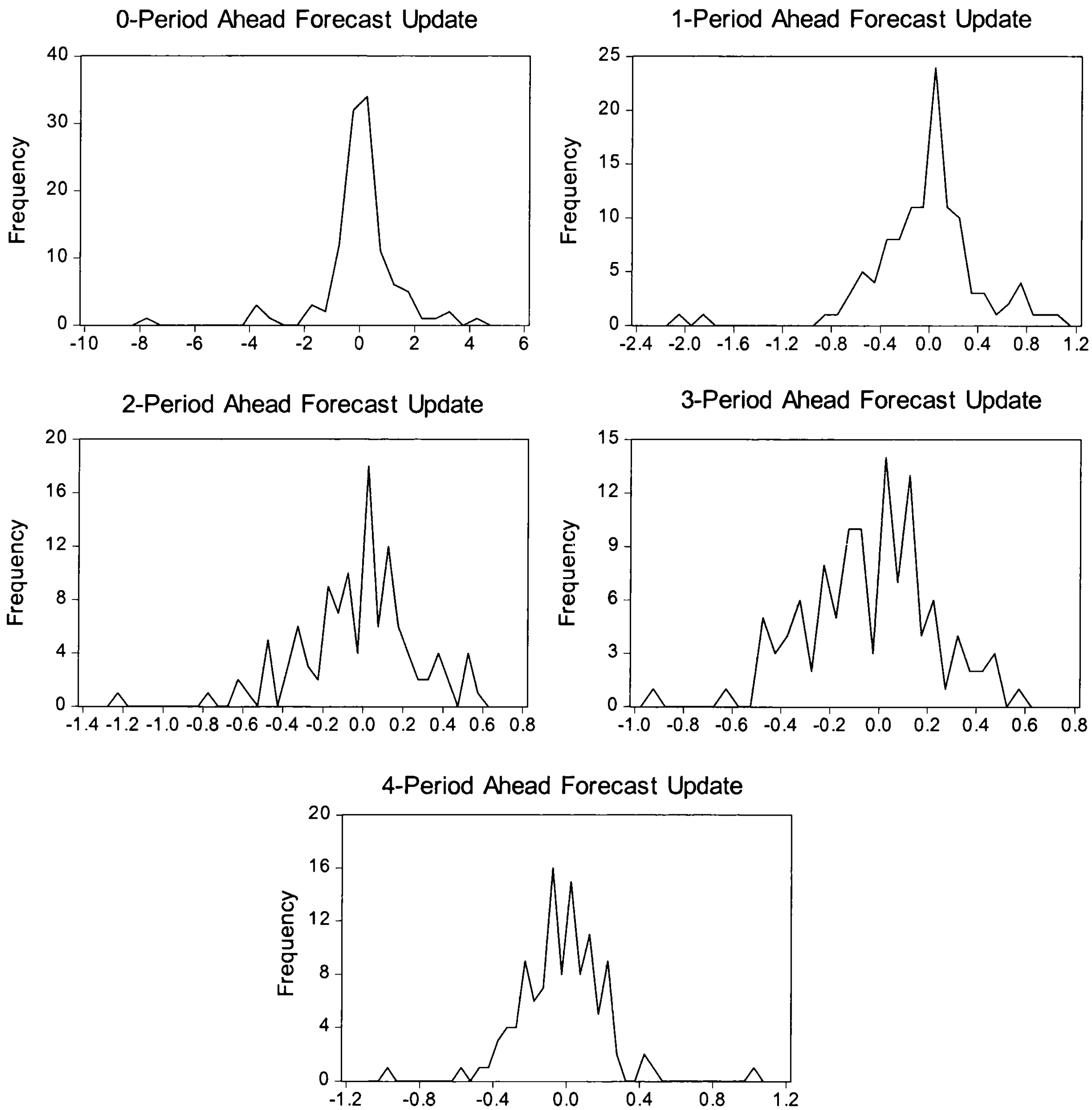
	PANEL A				PANEL B			
	WHOLE	G-B	STABLE	VOLATILE	WHOLE	G-B	STABLE	VOLATILE
	$R_t = E_t[\pi_t] - E_{t-1}[\pi_t]$				$\lvert R_t \rvert = \lvert E_t[\pi_t] - E_{t-1}[\pi_t] \rvert$			
Mean	-0.080	0.011	0.058	-0.126	0.663***	0.631***	0.481***	1.241***
Median	-0.100	-0.100	-0.100	0.454	0.400	0.400	0.375	0.800
S.D.	1.053	1.016	0.673	1.897	0.820	0.794	0.470	1.411
Max.	2.700	2.700	2.700	2.100	5.493	5.493	2.700	5.493
Min.	-5.493	-5.493	-1.450	-5.493	0.000	0.000	0.000	0.031
	$R_{t-1} = E_{t-1}[\pi_t] - E_{t-2}[\pi_t]$				$\lvert R_{t-1} \rvert = \lvert E_{t-1}[\pi_t] - E_{t-2}[\pi_t] \rvert$			
Mean	-0.108***	-0.051	-0.047	-0.083	0.272***	0.231***	0.200***	0.324***
Median	-0.050**	-0.001	0.000*	-0.025	0.157***	0.150***	0.125***	0.150***
S.D.	0.400	0.389	0.300	0.551	0.312	0.278	0.227	0.447
Max.	1.000	1.000	1.000	0.700	1.798	1.798	1.000	1.798
Min.	-1.798	-1.798	-0.750	-1.798	0.000	0.000	0.000	0.000
	$R_{t-2} = E_{t-2}[\pi_t] - E_{t-3}[\pi_t]$				$\lvert R_{t-2} \rvert = \lvert E_{t-2}[\pi_t] - E_{t-3}[\pi_t] \rvert$			
Mean	-0.114***	-0.084***	-0.098***	-0.079	0.218***	0.181***	0.159***	0.199***
Median	-0.090***	-0.050***	-0.050***	-0.041	0.157	0.102	0.100	0.114
S.D.	0.277	0.224	0.196	0.257	0.204	0.156	0.150	0.176
Max.	0.500	0.400	0.290	0.396	1.200	0.700	0.700	0.543
Min.	-1.200	-0.700	-0.700	-0.543	0.000	0.000	0.000	0.000
	$R_{t-3} = E_{t-3}[\pi_t] - E_{t-4}[\pi_t]$				$\lvert R_{t-3} \rvert = \lvert E_{t-3}[\pi_t] - E_{t-4}[\pi_t] \rvert$			
Mean	-0.095***	-0.055***	-0.057**	-0.073*	0.188***	0.146***	0.133***	0.155***
Median	-0.050***	-0.009**	-0.004**	-0.100	0.104	0.100	0.100	0.127
S.D.	0.262	0.192	0.181	0.184	0.205	0.134	0.134	0.119
Max.	0.600	0.400	0.328	0.300	1.400	0.650	0.650	0.428
Min.	-1.400	-0.650	-0.650	-0.428	0.000	0.000	0.000	0.000

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 6.3. Distribution of Forecast Revisions



Appendix 6.4. Distribution of Forecast Updates



Appendix 6.5. Efficiency of Forecast Revisions

PANEL A
Testing Equation:

$$R_{t-h} = c + \beta R_{t-h-1} + \epsilon_t$$

PANEL B
Testing Equation:

$$R_{t-h} = c + \sum_k \lambda_k R_{t-h-k} + u_t$$

	c	β	R^2	$\bar{R}^2$	c	λ_1	λ_2	λ_3	R^2	$\bar{R}^2$
Period: Whole 1982:3-2011:1										
$h = 0$	-0.024	0.485	0.035	0.026	-0.056	0.511**	-0.253	-0.030	0.040	0.014
	(0.072)	(0.182)			(0.107)	(0.214)	(0.360)	(0.367)		
$h = 1$	-0.092**	0.139	0.010	0.001	-0.080**	0.122	0.129		0.018	0.000
	(0.039)	(0.148)			(0.031)	(0.124)	(0.083)			
$h = 2$	-0.109***	0.049	0.002	-0.007						
	(0.033)	(0.105)								
Period: Greenspan-Bernanke 1987:2-2011:1										
$h = 0$	0.037	0.511*	0.033	0.022	-0.047	0.539	-0.918**	-0.274	0.076	0.046
	(0.080)	(0.278)			(0.108)	(0.325)	(0.400)	(0.415)		
$h = 1$	-0.044	0.084	0.003	-0.008	-0.047*	0.085	-0.061		0.004	-0.018
	(0.033)	(0.178)			(0.025)	(0.212)	(0.180)			
$h = 2$	-0.084	-0.005	0.000	-0.011						
	(0.027)	(0.139)								
Period: Stable 1990:1-2006:2										
$h = 0$	0.076	0.315	0.020	0.005	0.030	0.282	-0.443	0.093	0.039	-0.007
	(0.095)	(0.238)			(0.145)	(0.215)	(0.325)	(0.317)		
$h = 1$	-0.067*	-0.189	0.016	0.001	-0.059	-0.176	0.100		0.020	-0.011
	(0.038)	(0.224)			(0.042)	(0.186)	(0.170)			
$h = 2$	-0.106***	-0.133	0.016	0.001						
	(0.030)	(0.142)								
Period: Volatile 2006:3-2011:1										
$h = 0$	-0.067	0.722*	0.044	-0.012	-0.194	0.974**	-2.030**	-0.675	0.126	-0.048
	(0.427)	(0.364)			(0.207)	(0.338)	(0.857)	(1.022)		
$h = 1$	-0.035	0.605**	0.079	0.025	-0.074	0.887***	-0.988*		0.170	0.066
	(0.055)	(0.245)			(0.062)	(0.275)	(0.561)			
$h = 2$	-0.041	0.517***	0.137	0.086						
	(0.063)	(0.123)								

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 6.6. Disagreement Amongst Professional Forecasters – Descriptive Statistics

	PANEL A		PANEL B		PANEL C		PANEL D		PANEL E	PANEL F	
	MEAN	EQ. Mean	MEDIAN	Eq. Med	S.D.	Eq. Var.	Min.	Max.	Correlation	$\sigma_{\pi_{t+h}}$	$\frac{\bar{\sigma}_{t,t+h}}{\sigma_{\pi_{t+h}}}$
Whole Sample Period: 1982:3-2011:1											
$h = 0$	0.836	WF: 1.299	0.680	KW: 3.346	0.480	BF: 2.443	0.278	3.183	-0.172*		0.651
$h = 1$	0.763	P: 0.271	0.653	P: 0.502	0.359	P: 0.046**	0.372	1.982	0.052		0.594
$h = 2$	0.720		0.618		0.330		0.325	1.986	0.208**	1.285	0.560
$h = 3$	0.731		0.664		0.319		0.372	1.898	0.330***		0.569
$h = 4$	0.755		0.671		0.321		0.355	2.034	0.475***		0.588
Greenspan-Bernanke Sample Period: 1987:2-2011:1											
$h = 0$	0.779	WF: 1.640	0.653	KW: 2.858	0.447	BF: 3.820	0.278	3.183	-0.366***		0.598
$h = 1$	0.712	P: 0.165	0.598	P: 0.582	0.324	P: 0.005***	0.372	1.982	-0.215**		0.546
$h = 2$	0.661		0.580		0.269		0.325	1.740	-0.161	1.303	0.507
$h = 3$	0.664		0.588		0.252		0.372	1.610	-0.016		0.510
$h = 4$	0.670		0.591		0.229		0.355	1.349	0.131		0.514
Stable Sample Period: 1990:1 - 2006:2											
$h = 0$	0.648	WF: 1.178	0.581	KW: 3.774	0.276	BF: 2.550	0.278	1.493	0.462***		0.641
$h = 1$	0.603	P: 0.323	0.511	P: 0.437	0.233	P: 0.039**	0.372	1.149	0.072		0.596
$h = 2$	0.568		0.497		0.191		0.325	1.285	0.108	1.011	0.562
$h = 3$	0.573		0.519		0.192		0.372	1.341	0.209		0.567
$h = 4$	0.576		0.533		0.169		0.355	1.206	0.341***		0.570
Volatile Sample Period: 2006:3 - 2011:1											
$h = 0$	1.308	WF: 2.561	1.174	KW: 11.289	0.608	BF: 1.803	0.653	3.183	-0.696***		0.739
$h = 1$	1.089	P: 0.052*	1.018	P: 0.024**	0.373	P: 0.135	0.596	1.982	-0.308		0.616
$h = 2$	0.962		0.924		0.310		0.537	1.740	-0.405**	1.769	0.544
$h = 3$	0.921		0.843		0.274		0.528	1.610	-0.188		0.521
$h = 4$	0.894		0.885		0.213		0.563	1.328	-0.330		0.505

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 6.7. Formation of Discrepancy of Series

Exploiting the availability of quarterly multi-horizon inflation forecasts from the SPF for periods $t + h$ for $h = -1, \dots, 4$, the discrepancy series concerning the difference between the annual inflation forecast and associated quarterly forecasts can be constructed[213]. The discrepancy arising in calendar year s, quarter i is denoted $\delta_{s,Qi}$.

For calendar year s, the discrepancies arising in Q1 and Q2 can simply be calculated as the difference between the annual forecast and the weighted average of quarterly forecasts reported by professionals in the quarter. This is expressed in (0.1) and (0.2) below:

$$\delta_{s,Q1} = E_{s,Q1}[\pi_{s,A}] - \frac{1}{4}\left(E_{s,Q1}[\pi_{s,Q1}] + E_{s,Q1}[\pi_{s,Q2}] + E_{s,Q1}[\pi_{s,Q3}] + E_{s,Q1}[\pi_{s,Q4}]\right) \quad (0.1)$$

$$\delta_{s,Q2} = E_{s,Q2}[\pi_{s,A}] - \frac{1}{4}\left(E_{s,Q2}[\pi_{s,Q1}] + E_{s,Q2}[\pi_{s,Q2}] + E_{s,Q2}[\pi_{s,Q3}] + E_{s,Q2}[\pi_{s,Q4}]\right) \quad (0.2)$$

The forecast of quarter j inflation in a given calendar year s for quarter i in the same calendar year is denoted $E_{s,Qi}[\pi_{s,Qj}]$ is and $E_{s,Qi}[\pi_A]$ is the forecast of annual inflation for the calendar year produced in quarter i.

In the third and fourth quarters of a calendar year professionals provide a single backdated forecast for inflation for the second and third quarters respectively. For earlier quarters in the calendar year however, they are instead required to utilise information concerning the realised value of inflation in order to construct appropriate annual forecasts. The discrepancies between the annual and quarterly forecasts can thus be calculated as:

$$\delta_{s,Q3} = E_{s,Q3}[\pi_A] - \frac{1}{4}\left(\tilde{\pi}_{s,Q1,Q3} + E_{s,Q3}[\pi_{s,Q2}] + E_{s,Q3}[\pi_{s,Q3}] + E_{s,Q3}[\pi_{s,Q4}]\right) \quad (0.3)$$

$$\delta_{s,Q4} = E_{s,Q4}[\pi_A] - \frac{1}{4}\left(\tilde{\pi}_{s,Q1,Q4} + \tilde{\pi}_{s,Q2,Q4} + E_{s,Q4}[\pi_{s,Q4}] + E_{s,Q4}[\pi_{s,Q4}]\right) \quad (0.4)$$

[213] To maintain consistency with the rest of this study, the median annual and quarterly inflation forecasts from the SPF shall be employed in constructing the discrepancy series.

Where s denotes the calendar year $\tilde{\pi}_{s,Qj,Qi}$ is the quarter i estimate of realised inflation in quarter j in calendar year s.

To form the discrepancy series, (0.1) through to (0.4) are estimated for each calendar year s between 1982Q3 and 2011Q1.

Appendix 6.8. Discrepancy Descriptive Statistics

$\delta_{s,Qj}$

	Mean	Median	Std. Dev.	Max.	Min.
WHOLE: 1982:3 2011:1					
$j = 1, \dots, 4$	-0.007	-0.025	0.323	1.155	-1.012
$j = 1$	-0.008	-0.025	0.191	0.537	-0.425
$j = 2$	-0.046	-0.038**	0.253	0.888	-0.775
$j = 3$	-0.019	-0.022	0.340	0.653	-1.012
$j = 4$	0.045	0.132	0.455	1.155	-0.860
Greenspan-Bernanke: 1987:2 – 2011:1					
$j = 1, \dots, 4$	0.014	-0.025	0.307	1.155	-0.860
$j = 1$	-0.020	-0.029*	0.163	0.538	-0.199
$j = 2$	-0.048	-0.038**	0.258	0.888	-0.775
$j = 3$	0.014	0.017	0.305	0.653	-0.615
$j = 4$	0.112	0.142	0.433	1.155	-0.860
Stable: 1990:1 – 2006:2					
$j = 1, \dots, 4$	0.056*	0.000	0.262	0.924	-0.479
$j = 1$	0.009	-0.025	0.180	0.538	-0.163
$j = 2$	-0.006	-0.030*	0.244	0.888	-0.263
$j = 3$	0.113	0.131	0.262	0.653	-0.266
$j = 4$	0.113	0.142	0.338	0.924	-0.479
Volatile: 2006:3 2011:1					
$j = 1, \dots, 4$	-0.069	-0.076	0.400	1.155	-0.860
$j = 1$	-0.127**	-0.153*	0.067	-0.024	-0.199
$j = 2$	-0.019	-0.027	0.055	0.055	-0.076
$j = 3$	-0.194	-0.243	0.362	0.323	-0.615
$j = 4$	0.073	0.014	0.729	1.155	-0.860

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 6.9. Tests of Attentiveness for Third and Fourth Quarter Forecasts

:	c	β	R^2	$\bar{R}^2$
Q3 Forecasts				
Whole 1982:3 – 2011:1	-0.005 (0.061)	0.167* (0.085)	0.124	0.093
Greenspan-Bernanke 1987:2 2011:1	0.013 (0.062)	0.132 (0.106)	0.065	0.024
Stable 1990:1 – 2006:2	0.114 (0.068)	0.011 (0.159)	0.000	-0.071
Volatile 2006:3 2011:1	-0.183 (0.139)	0.250 (0.161)	0.446	0.262
Q4 Forecasts				
Whole 1982:3 – 2011:1	0.074 (0.070)	0.437*** (0.116)	0.344	0.319
Greenspan-Bernanke 1987:2 2011:1	0.100 (0.076)	0.408*** (0.136)	0.290	0.257
Stable 1990:1 – 2006:2	0.126 (0.050)	0.621*** (0.115)	0.675	0.652
Volatile 2006:3 2011:1	0.153 (0.353)	0.481 (0.582)	0.186	-0.086

***,** and * indicate significance at the 1%, 5% and 10% levels.

Appendix 6.10. Coibion and Gorodnichenko (2010) Test of Forecast Revision Process

Testing Equation:

$$\pi_{t+h} - E_t[\pi_{t+h}] = c + \beta(E_t[\pi_{t+h}] - E_{t-1}[\pi_{t+h}]) + \epsilon_t$$

	(1) c	(2) β	(3) R^2	(4) $\bar{R}^2$	(5) $\lambda = \beta/(1+\beta)$
Period: Whole 1982:3 – 2011:1					
$h = 0$	-0.049 (0.128)	-0.560*** (0.050)	0.383	0.378	-1.274***
$h = 1$	-0.026 (0.126)	0.510*** (0.156)	0.055	0.047	0.338***
$h = 2$	-0.069 (0.186)	1.046** (0.411)	0.083	0.075	0.511***
$h = 3$	-0.218 (0.201)	1.005*** (0.312)	0.059	0.051	0.501***
Period: Greenspan-Bernanke 1987:2 – 2011:1					
$h = 0$	0.060 (0.129)	-0.564*** (0.056)	0.384	0.378	-1.295***
$h = 1$	0.087 (0.117)	0.448* (0.243)	0.036	0.025	0.309***
$h = 2$	0.067 (0.115)	0.682 (0.700)	0.024	0.014	0.405
$h = 3$	-0.062 (0.179)	0.045 (0.308)	0.000	-0.011	0.043
Period: Stable 1990:1 – 2006:2					
$h = 0$	0.072 (0.131)	-0.331** (0.153)	0.136	0.123	-0.495
$h = 1$	0.128 (0.327)	0.303 (0.256)	0.017	0.001	0.232
$h = 2$	0.086 (0.381)	0.271 (0.474)	0.004	-0.011	0.213
$h = 3$	-0.046 (0.412)	0.145 (0.523)	0.001	-0.015	0.127
Period: Volatile 2006:3 – 2011:1					
$h = 0$	0.049 (0.304)	-0.664 (0.091)	0.521	0.493	-1.980**
$h = 1$	0.067 (0.374)	0.740*** (0.235)	0.089	0.036	0.425***
$h = 2$	0.089 (0.439)	2.790* (1.529)	0.190	0.143	0.736***
$h = 3$	-0.151 (0.440)	-0.423 (0.245)	0.002	-0.057	-0.997

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 6.11. Coibion and Gorodnichenko (2010) Test of Forecast Revision Process

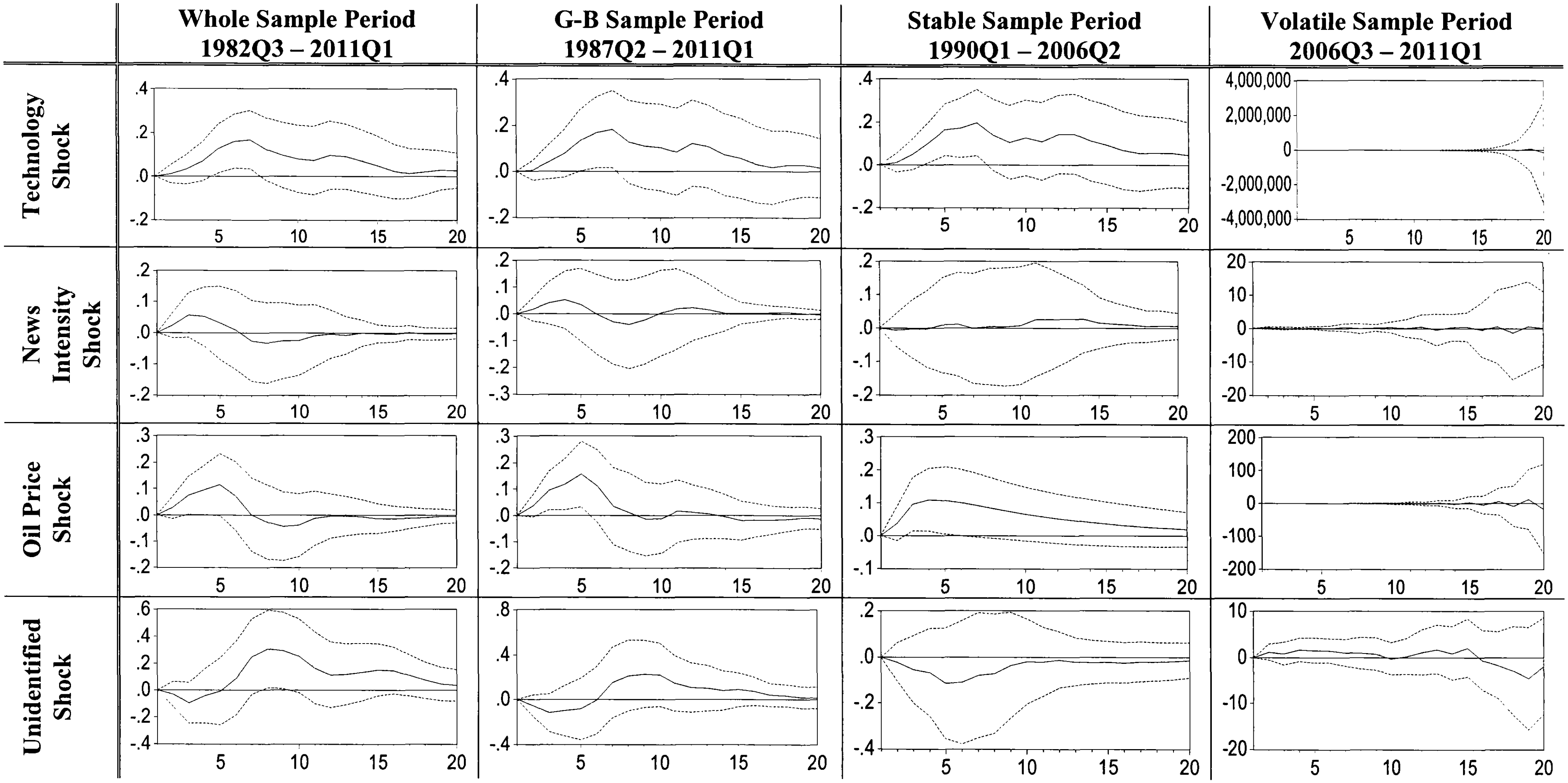
Testing Equation:

$$\pi_{t+h} - E_t[\pi_{t+h}] = c + \beta_1 E_t[\pi_{t+h}] + \beta_2 E_{t-1}[\pi_{t+h}] + \varepsilon_t$$

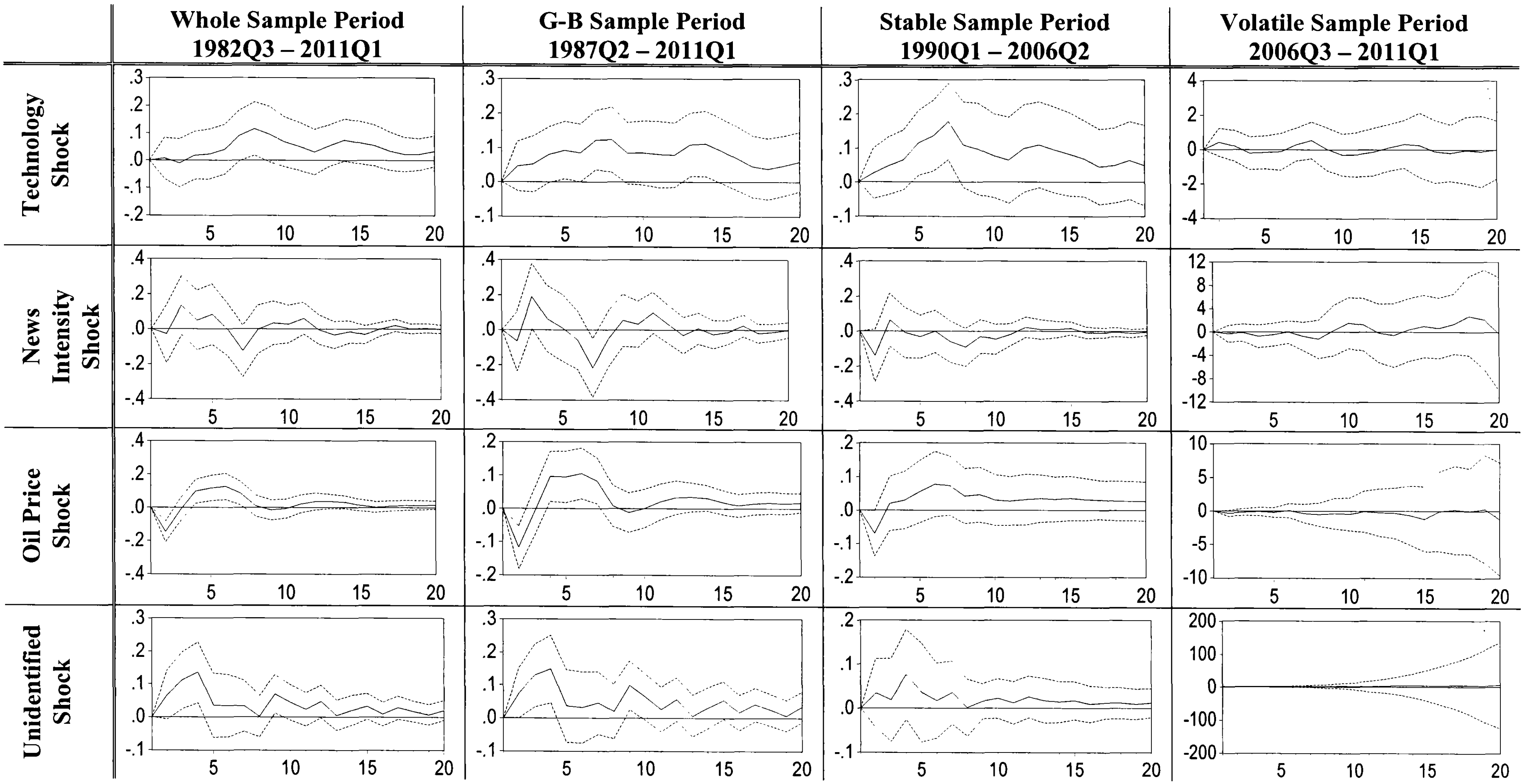
	α_0	β_1	β_2	R^2	$\bar{R}^2$	χ^2: $\beta_1 + \beta_2 = 0$
Period: Whole 1982:3 – 2011:1						
$h = 0$	0.194 (0.352)	-0.569 (0.043)	0.490 (0.125)	0.391	0.380	0.582
$h = 1$	0.433 (0.345)	0.408** (0.204)	-0.555*** (0.167)	0.088	0.071	1.840
$h = 2$	0.734* (0.410)	0.702 (0.470)	-0.957** (0.397)	0.155	0.140	3.796*
$h = 3$	0.934** (0.427)	0.290 (0.340)	-0.649 (0.265)	0.180	0.166	9.224***
Period: Greenspan-Bernanke 1987:2 – 2011:1						
$h = 0$	-0.034 (0.363)	-0.564*** (0.060)	0.596*** (0.159)	0.386	0.372	0.087
$h = 1$	0.242 (0.227)	0.452** (0.227)	-0.505** (0.253)	0.039	0.018	0.170
$h = 2$	0.311 (0.466)	0.677 (0.735)	-0.759 (0.752)	0.030	0.009	0.302
$h = 3$	0.215 (0.717)	0.009 (0.301)	-0.102 (0.356)	0.006	-0.016	0.189
Period: Stable 1990:1 – 2006:2						
$h = 0$	0.031 (0.369)	-0.330*** (0.091)	0.344* (0.190)	0.137	0.109	0.907
$h = 1$	0.423 (1.076)	0.289 (0.214)	-0.392 (0.321)	0.027	-0.004	0.110
$h = 2$	0.480 (0.778)	0.137 (0.397)	-0.275 (0.371)	0.018	-0.013	0.460
$h = 3$	0.630 (1.647)	-0.008 (0.495)	-0.218 (0.588)	0.038	0.007	0.194
Period: Volatile 2006:3 – 2011:1						
$h = 0$	-1.373** (0.491)	-0.673*** (0.089)	1.359*** (0.272)	0.602	0.552	0.002***
$h = 1$	-1.510 (1.567)	0.702** (0.253)	0.030 (0.576)	0.143	0.035	1.107
$h = 2$	2.455 (2.868)	3.150* (1.710)	-4.212 (2.830)	0.221	0.124	0.557
$h = 3$	-1.289 (3.375)	-0.523 (0.368)	1.027 (1.990)	0.005	-0.119	0.089

***,**,* indicate significance at 1, 5 and 10 percent levels.

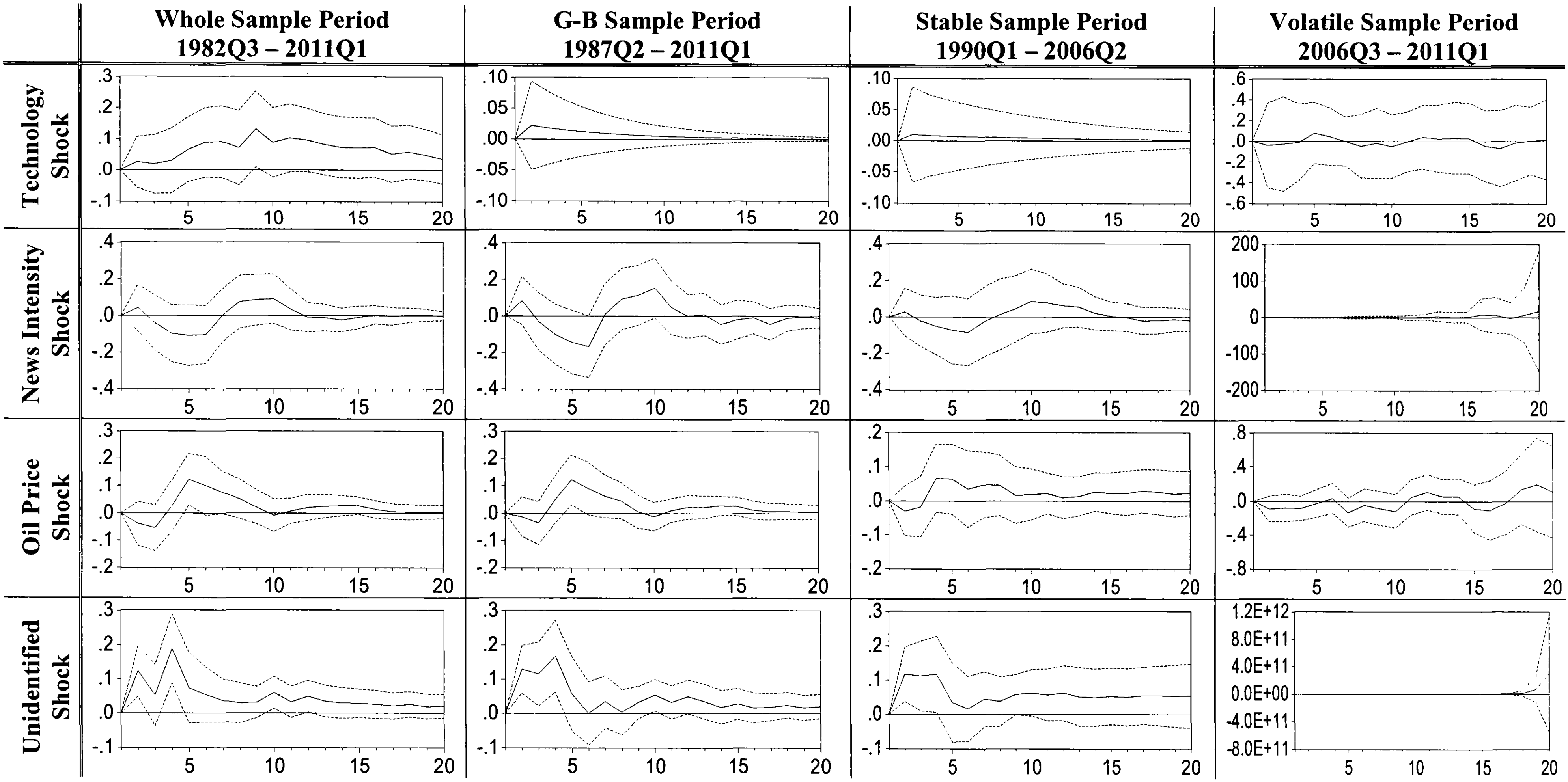
Appendix 6.12. Impulse Response Functions of GDP Deflator to Structural Shocks



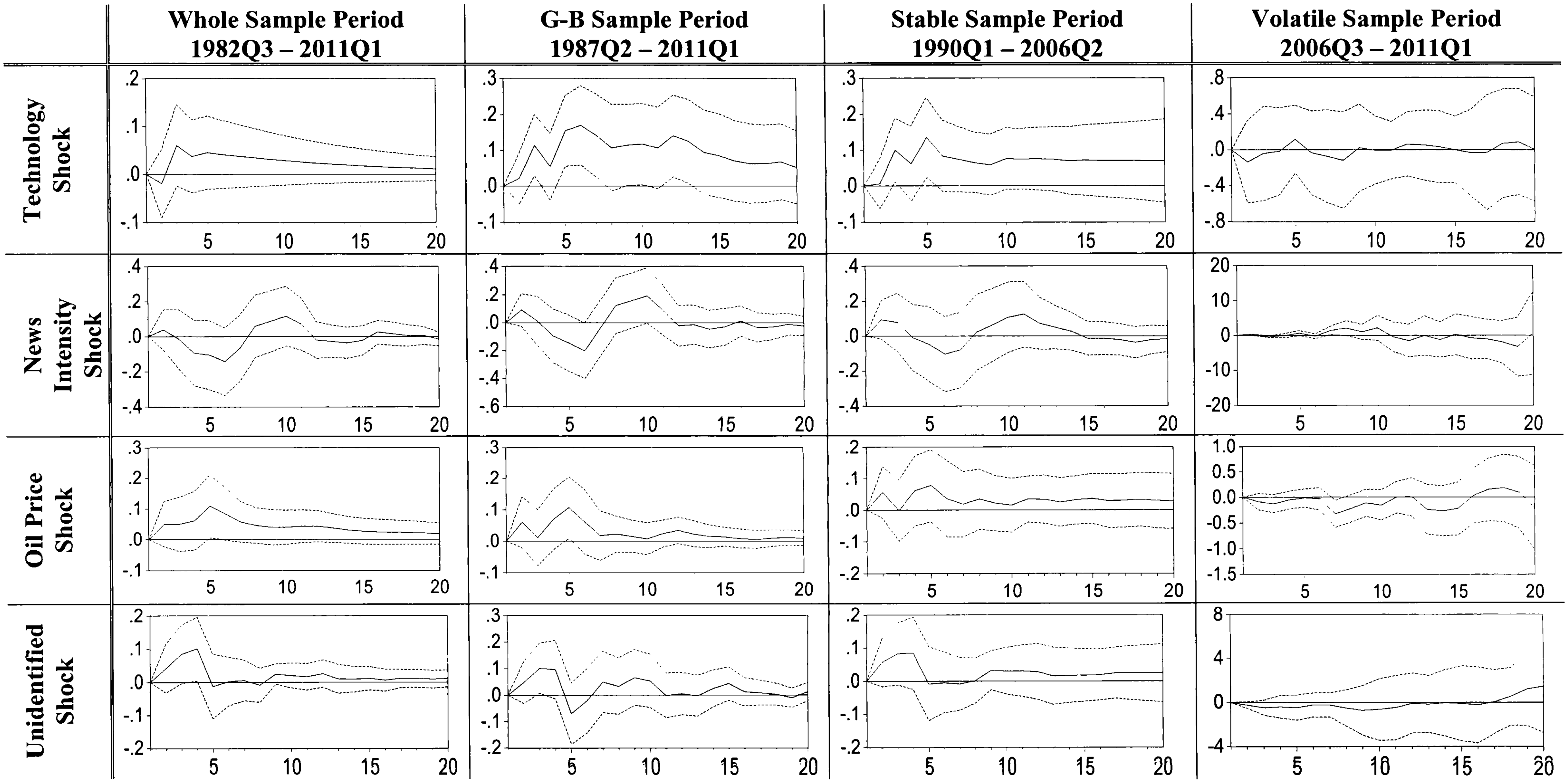
Appendix 6.13. 0-Period Ahead Forecast Error Impulse Response Functions to Structural Shocks



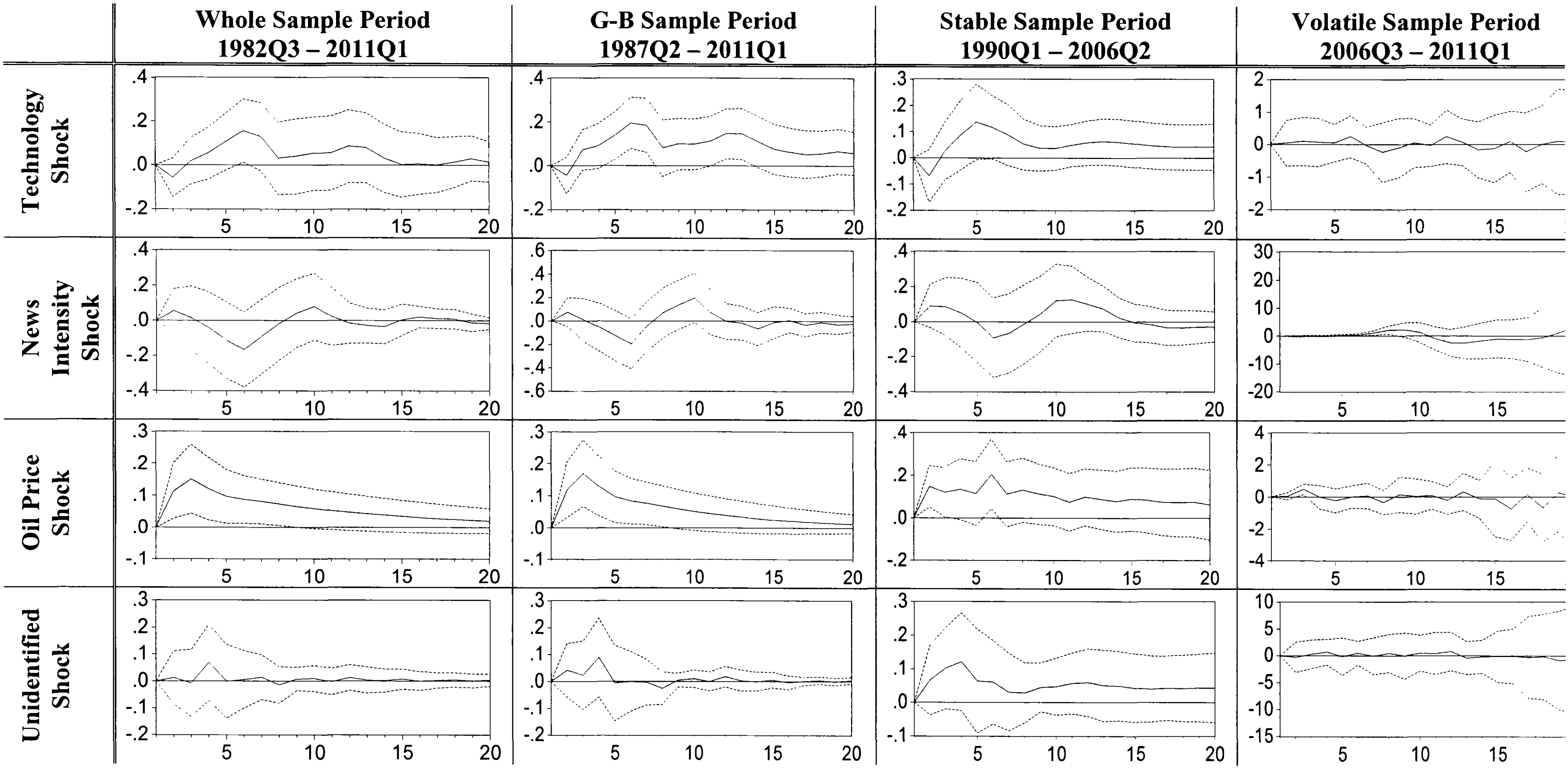
Appendix 6.14. 1-Period Ahead Forecast Error Impulse Response Functions to Structural Shocks



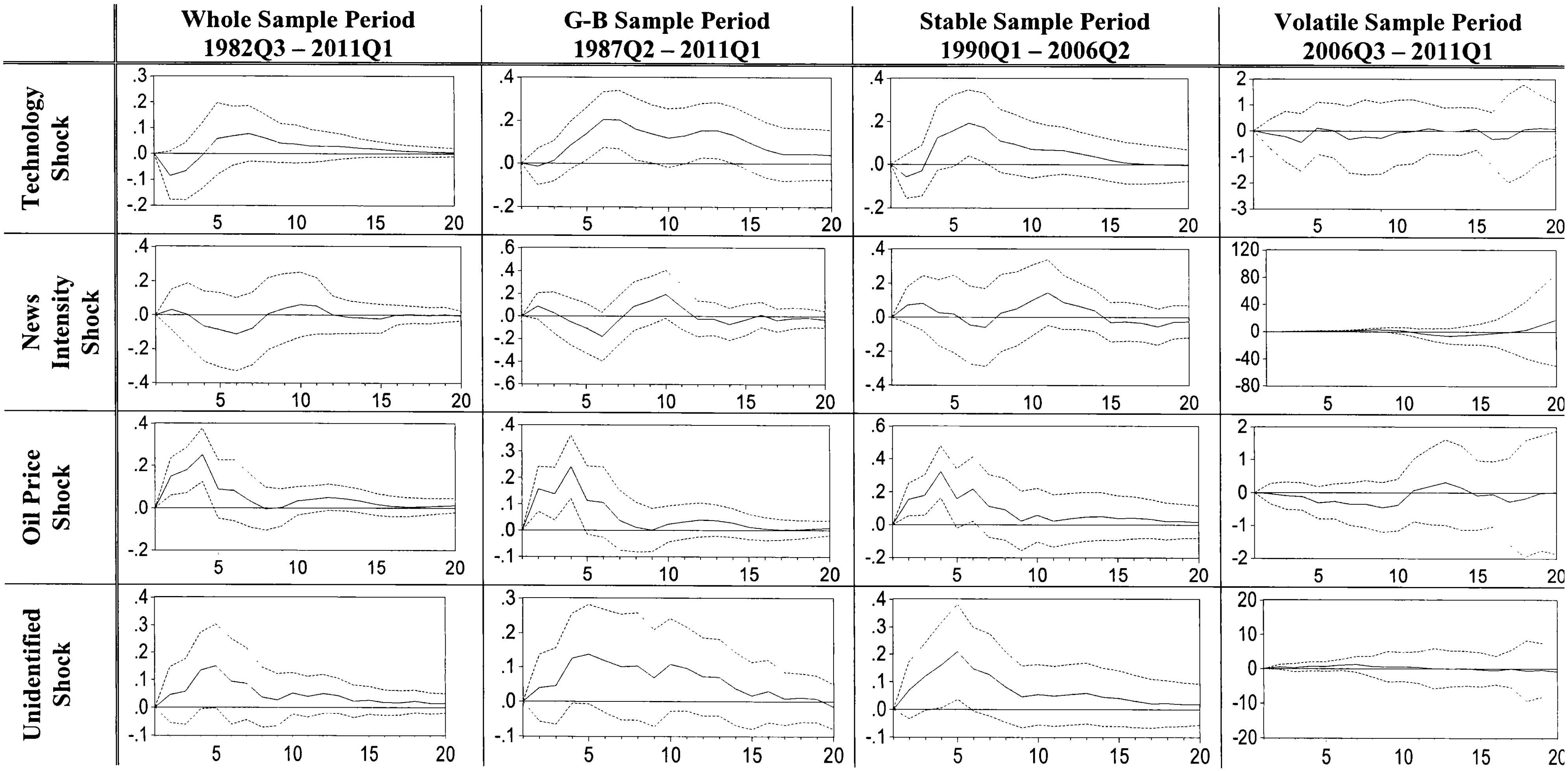
Appendix 6.15. 2-Period Ahead Forecast Error Impulse Response Functions to Structural Shocks



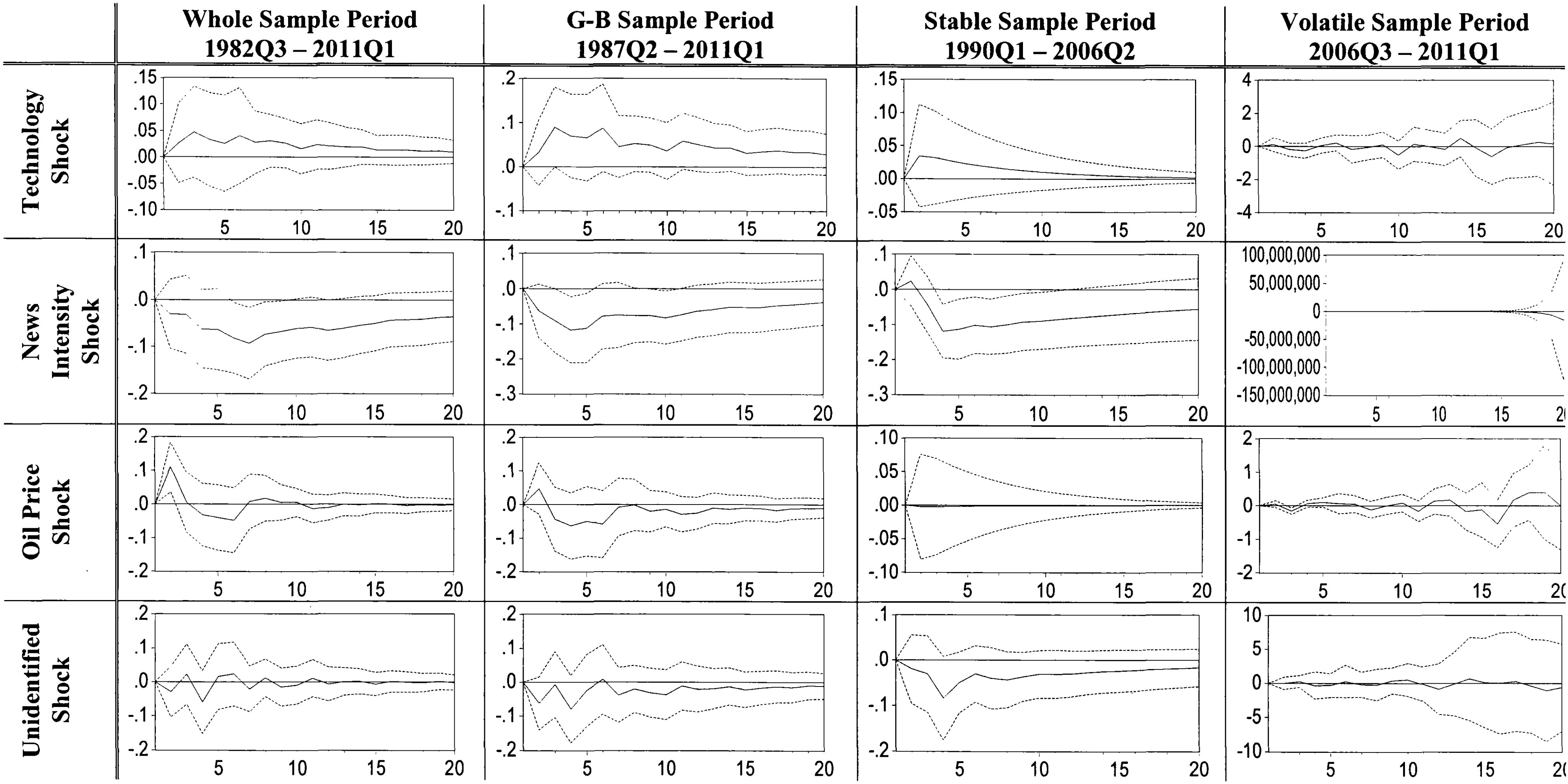
Appendix 6.16. 3-Period Ahead Forecast Error Impulse Response Functions to Structural Shocks



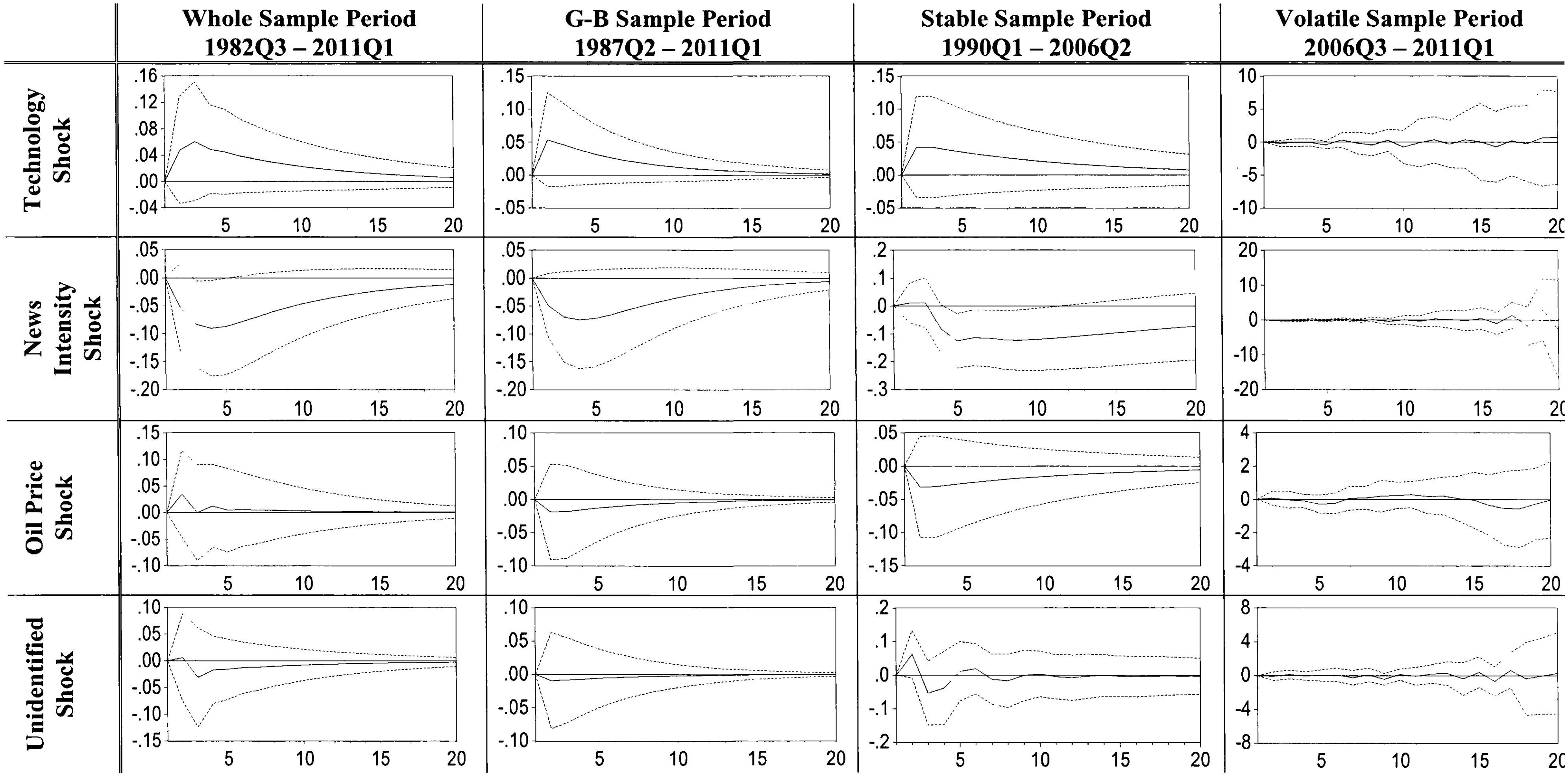
Appendix 6.17. 4-Period Ahead Forecast Error Impulse Response Functions to Structural Shocks



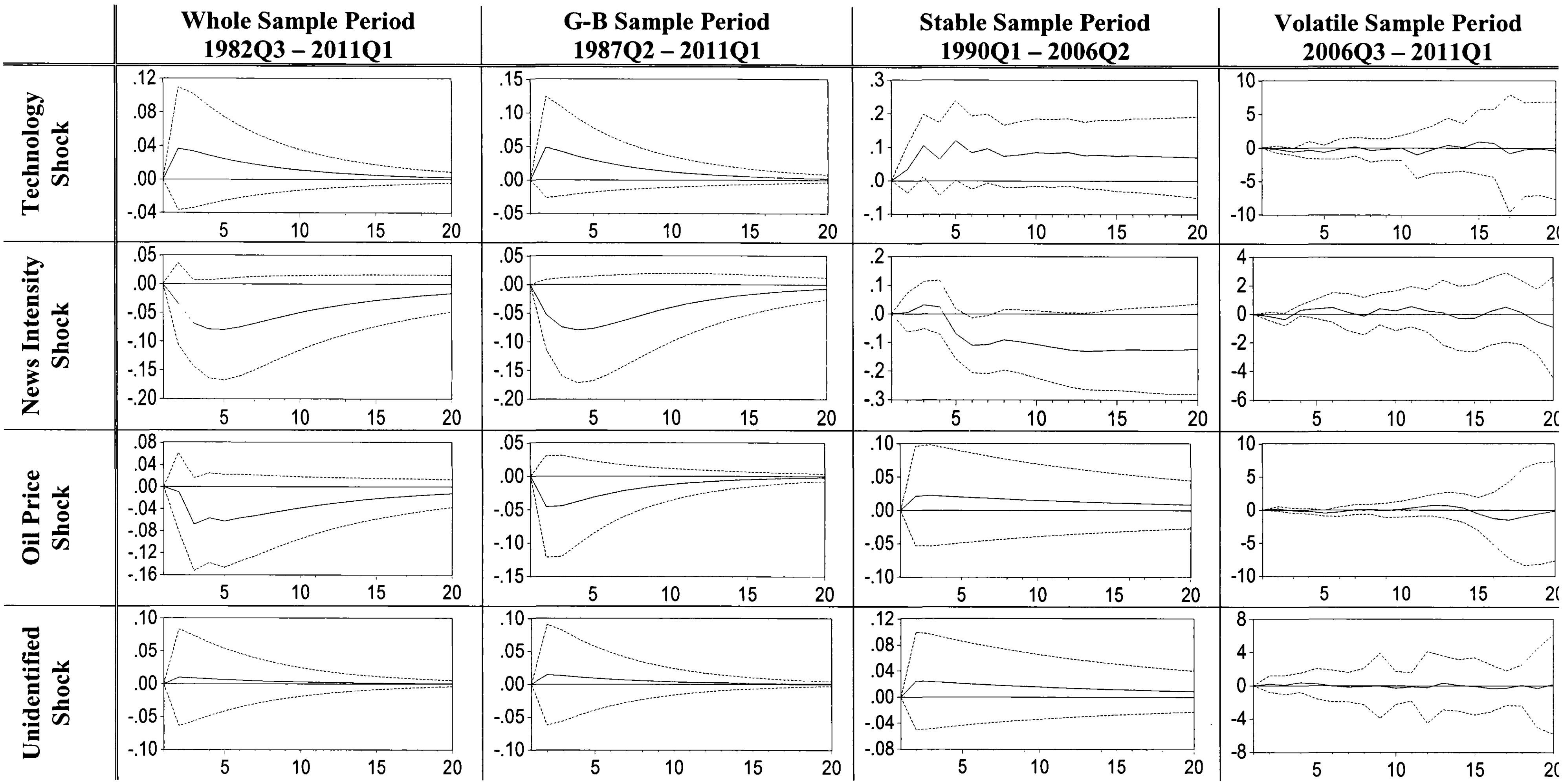
Appendix 6.18. 0-Period Ahead Forecast Error Impulse Response Functions to Absolute Structural Shocks



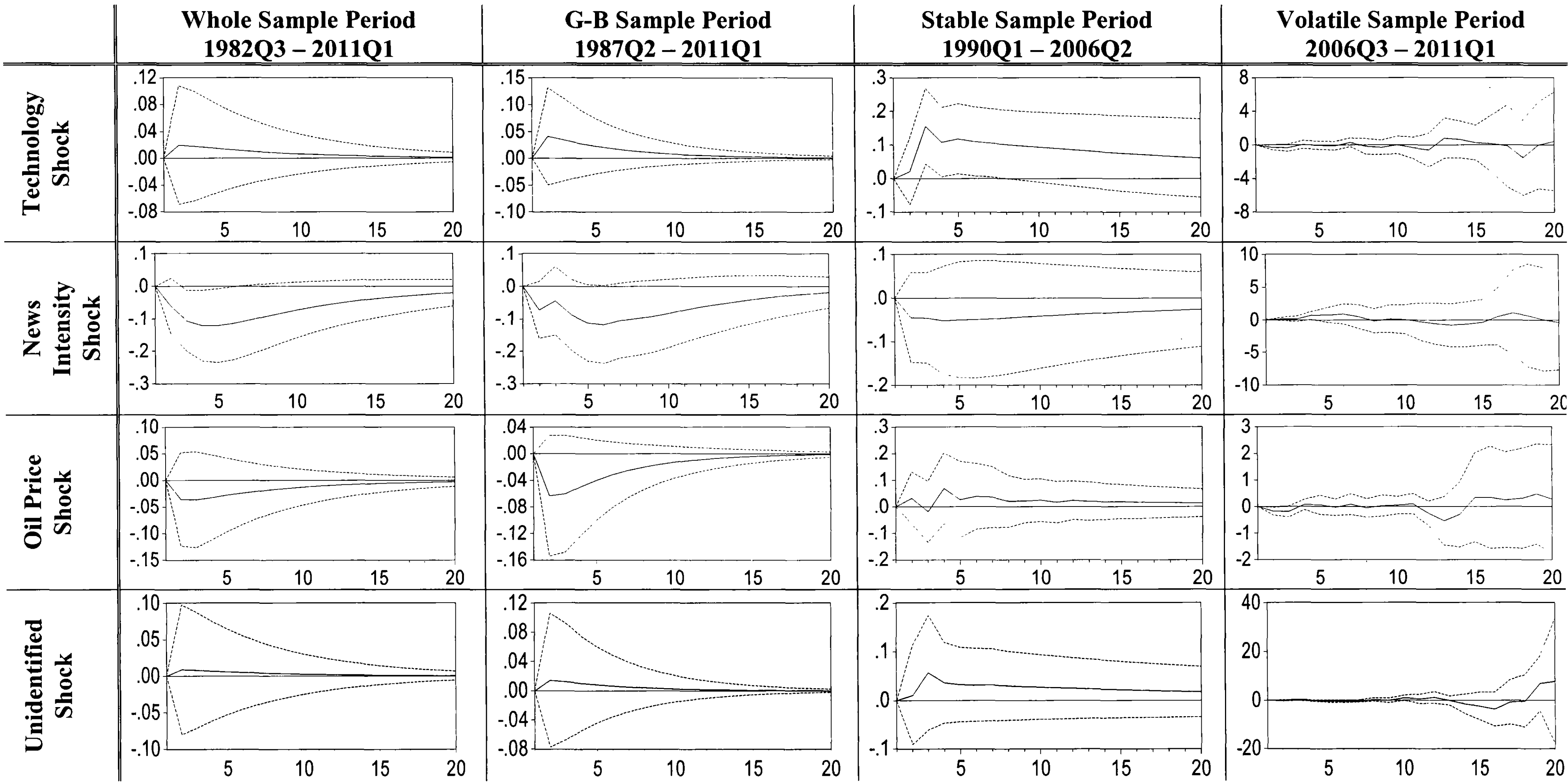
Appendix 6.19. 1-Period Ahead Forecast Error Impulse Response Functions to Absolute Structural Shocks



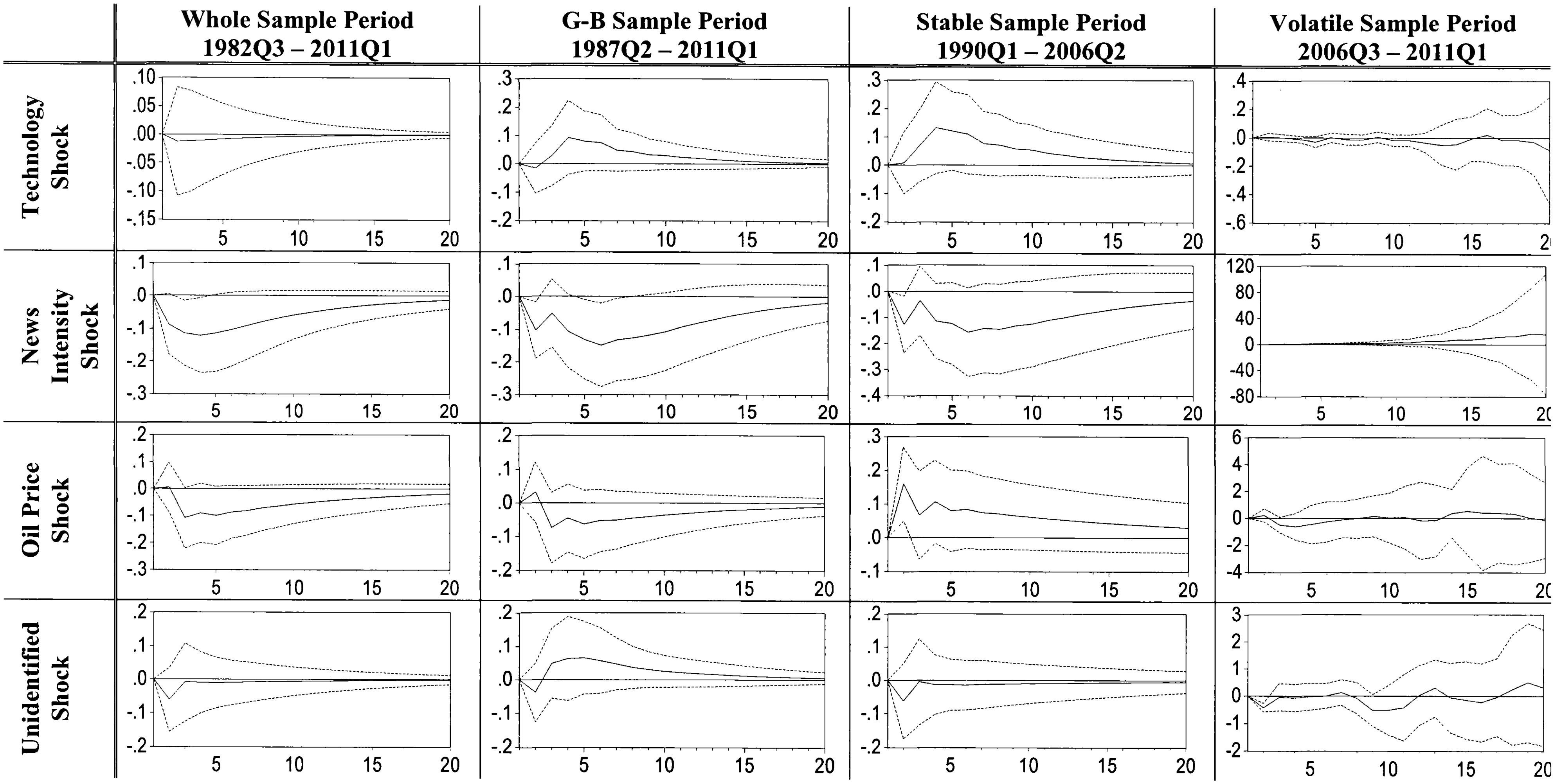
Appendix 6.20. 2-Period Ahead Forecast Error Impulse Response Functions to Absolute Structural Shocks



Appendix 6.21. 3-Period Ahead Forecast Error Impulse Response Functions to Absolute Structural Shocks



Appendix 6.22. 4-Period Ahead Forecast Error Impulse Response Functions to Absolute Structural Shocks



Appendix 6.23. Distinguishing between Information Rigidities – GDP Deflator

Testing Equation:

$$\pi_{t+h} - E_t[\pi_{t+h}] = c + \beta(\pi_{t+h-1} - E_{t-1}[\pi_{t+h-1}]) + \gamma[\pi_{t-1}] + \mu_t$$

	c	β	γ	R^2	$\bar{R}^2$
Period: Whole 1982:3 – 2011:1					
SPF	-0.117	0.646***	0.020	0.454	0.444
$h = 0$	(0.122)	(0.137)	(0.034)		
SPF	-0.054	0.754***	-0.004	0.561	0.553
$h = 1$	(0.100)	(0.099)	(0.029)		
SPF	-0.035	0.854***	-0.009	0.727	0.722
$h = 2$	(0.087)	(0.051)	(0.029)		
SPF	0.045	0.863***	-0.048	0.738	0.734
$h = 3$	(0.137)	(0.051)	(0.053)		
SPF	-0.094	0.844***	0.007	0.737	0.733
$h = 4$	(0.102)	(0.049)	(0.036)		
Period: Greenspan-Bernanke 1987:2 – 2011:1					
SPF	-0.172	0.708***	0.060	0.532	0.522
$h = 0$	(0.137)	(0.124)	(0.059)		
SPF	-0.117	0.811***	0.043	0.691	0.685
$h = 1$	(0.110)	(0.052)	(0.999)		
SPF	-0.146	0.812***	0.045	0.705	0.698
$h = 2$	(0.113)	(0.059)	(0.039)		
SPF	-0.210*	0.776***	0.065	0.661	0.654
$h = 3$	(0.111)	(0.088)	(0.039)		
SPF	-0.356**	0.749***	0.119**	0.680	0.673
$h = 4$	(0.168)	(0.059)	(0.059		
Period: Stable 1990:1 – 2006:2					
SPF	-0.093	0.826***	0.041*	0.689	0.679
$h = 0$	(0.067)	(0.066)	(0.021)		
SPF	-0.102	0.885***	0.050	0.787	0.780
$h = 1$	(0.131)	(0.034)	(0.054)		
SPF	-0.057	0.928***	0.029	0.822	0.816
$h = 2$	(0.136)	(0.049)	(0.055)		
SPF	-0.262*	0.828***	0.104**	0.724	0.715
$h = 3$	(0.133)	(0.065)	(0.046)		
SPF	-0.228	0.814***	0.075	0.695	0.685
$h = 4$	(0.222)	(0.153)	(0.054)		
Period: Volatile 2006:3 – 2011:1					
SPF	-0.853***	0.135	0.427***	0.454	0.386
$h = 0$	(0.203)	(0.107)	(0.118)		
SPF	-0.706**	0.251	0.362**	0.641	0.596
$h = 1$	(0.276)	(0.204)	(0.128)		
SPF	-1.274***	0.079	0.612***	0.798	0.773
$h = 2$	(0.322)	(0.225)	(0.157)		
SPF	-1.291***	0.038	0.646***	0.669	0.627
$h = 3$	(0.421)	(0.200)	(0.178)		
SPF	-2.225***	-0.221	1.024***	0.913	0.902
$h = 4$	(0.336)	(0.151)	(0.148)		

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 6.24. Distinguishing between Information Rigidities – CPI

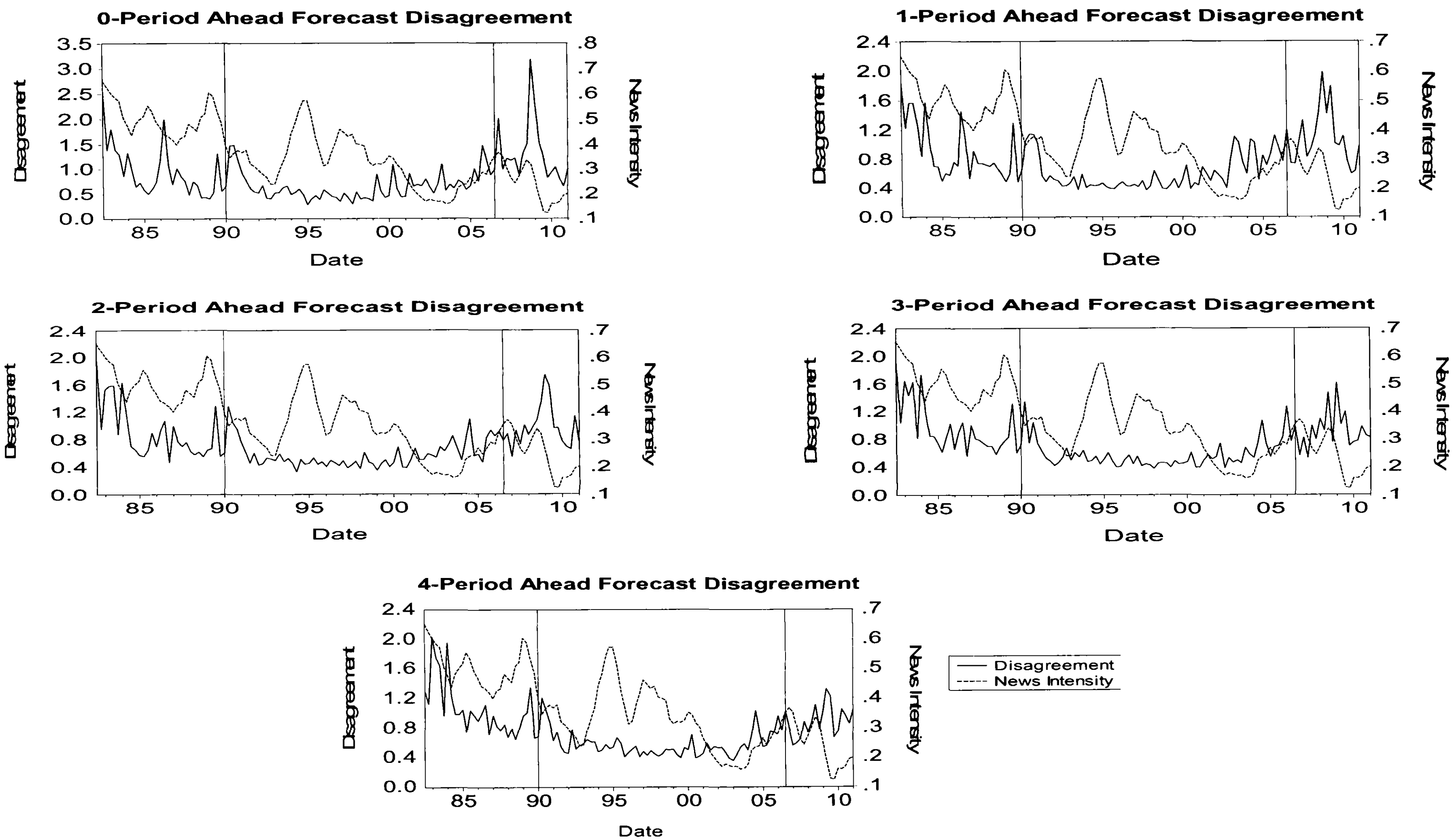
Testing Equation:

$$\pi_{t+h} - E_t[\pi_{t+h}] = c + \beta(\pi_{t+h-1} - E_{t-1}[\pi_{t+h-1}]) + \gamma[\pi_{t-1}] + \mu_t$$

	c	β	γ	R^2	$\bar{R}^2$
Period: Whole 1982:3 – 2011:1					
SPF $h = 0$	-0.780*** (0.184)	0.102 (0.078)	0.254*** (0.071)	0.159	0.144
SPF $h = 1$	0.094 (0.168)	0.631*** (0.082)	-0.041 (0.050)	0.358	0.347
SPF $h = 2$	0.323*** (0.114)	0.830*** (0.044)	-0.115*** (0.038)	0.580	0.572
SPF $h = 3$	0.372*** (0.127)	0.853*** (0.043)	-0.136*** (0.040)	0.614	0.607
SPF $h = 4$†	0.296** (0.142)	0.857*** (0.046)	-0.113*** (0.043)	0.655	0.649
Period: Greenspan-Bernanke 1987:2 – 2011:1					
SPF $h = 0$	-0.816*** (0.211)	0.182** (0.073)	0.295*** (0.090)	0.247	0.231
SPF $h = 1$	-0.071 (0.193)	0.510*** (0.118)	0.038 (0.063)	0.309	0.294
SPF $h = 2$	0.156 (0.185)	0.737*** (0.083)	-0.048 (0.067)	0.487	0.476
SPF $h = 3$	0.068 (0.167)	0.724*** (0.073)	-0.025 (0.051)	0.500	0.490
SPF $h = 4$†	-0.005 (0.197)	0.728*** (0.083)	-0.004 (0.058)	0.538	0.528
Period: Stable 1990:1 – 2006:2					
SPF $h = 0$	-0.641*** (0.174)	0.113 (0.135)	0.235*** (0.061)	0.207	0.182
SPF $h = 1$	-0.021 (0.171)	0.676 (0.124)	0.025 (0.039)	0.462	0.445
SPF $h = 2$	0.151 (0.141)	0.874*** (0.052)	-0.040 (0.038)	0.665	0.654
SPF $h = 3$	0.171 (0.154)	0.881*** (0.048)	-0.053 (0.042)	0.666	0.655
SPF $h = 4$†	0.162 (0.172)	0.905*** (0.078)	-0.050 (0.046)	0.706	0.697
Period: Volatile 2006:3 – 2011:1					
SPF $h = 0$	-1.156*** (0.173)	0.102 (0.170)	0.584*** (0.090)	0.423	0.351
SPF $h = 1$	-0.935 (0.430)	-0.070 (0.228)	0.435** (0.202)	0.265	0.173
SPF $h = 2$	1.117 (1.322)	1.189 (0.728)	-0.544 (0.679)	0.410	0.336
SPF $h = 3$	-0.064 (1.785)	0.643 (0.913)	-0.013 (0.883)	0.416	0.343
SPF $h = 4$†	-2.181 (2.239)	-0.271 (0.953)	0.911 (1.028)	0.458	0.390

***,**,* indicate significance at 1, 5 and 10 percent levels.

Appendix 6.25. News Intensity and Professional Disagreement



Appendix 6.26. Disagreement and News Intensity

Estimating Equation: $\sigma_{t,t+h} = c + \beta_1\sigma_{t-1,t-1+h} + \beta_2\eta_t + \beta_3\pi_t + \beta_4\pi_t^2 + \beta_5(\Delta\pi_t)^2 + u_t$

Standard Errors corrected for heteroskedasticity and autocorrelation using Newey-West procedure with lags determined by Akaike criterion.

Period		c	β_1	β_2	β_3	β_4	β_5	R^2	$\bar{R}^2$
Whole: 1982:3 – 2011:1	$h = 0$	0.304*** (0.071)	0.513*** (0.041)	0.023 (0.211)	-0.033 (0.023)	0.012** (0.005)	0.115*** (0.034)	0.604	0.585
	$h = 1$	0.312*** (0.068)	0.549*** (0.049)	-0.083 (0.166)	-0.034 (0.027)	0.012** (0.005)	0.058*** (0.010)	0.579	0.560
	$h = 2$	0.331*** (0.074)	0.514*** (0.066)	0.095 (0.143)	-0.063*** (0.024)	0.013*** (0.004)	0.044*** (0.008)	0.540	0.519
	$h = 3$	0.451*** (0.131)	0.426*** (0.092)	0.158 (0.222)	-0.121*** (0.035)	0.026*** (0.007)	-0.004 (0.007)	0.425	0.399
	$h = 4$	0.308** (0.140)	0.572*** (0.057)	0.277 (0.247)	-0.086* (0.045)	0.016** (0.006)	-0.003 (0.020)	0.534	0.512
Greenspan-Bernanke: 1987:2 – 2011:1	$h = 0$	0.457*** (0.126)	0.451*** (0.079)	-0.393* (0.213)	-0.034 (0.043)	0.013 (0.009)	0.111*** (0.021)	0.600	0.578
	$h = 1$	0.497*** (0.115)	0.454*** (0.093)	-0.492*** (0.154)	-0.056* (0.033)	0.018*** (0.006)	0.055*** (0.011)	0.584	0.561
	$h = 2$	0.536*** (0.149)	0.395*** (0.149)	-0.309** (0.155)	-0.097*** (0.033)	0.022** (0.007)	0.043*** (0.008)	0.545	0.520
	$h = 3$	0.705*** (0.213)	0.242* (0.133)	-0.372 (0.284)	-0.147*** (0.043)	0.034*** (0.010)	0.001 (0.007)	0.391	0.358
	$h = 4$	0.470*** (0.096)	0.494** (0.206)	-0.120 (0.254)	-0.115** (0.047)	0.024* (0.014)	-0.007 (0.022)	0.538	0.512
Stable 1990:1 – 2006:2	$h = 0$	0.601*** (0.162)	0.244** (0.114)	-0.727*** (0.208)	-0.026 (0.095)	0.020 (0.013)	0.046 (0.139)	0.455	0.410
	$h = 1$	0.375*** (0.124)	0.478*** (0.060)	-0.456*** (0.144)	-0.008 (0.089)	0.008 (0.014)	0.153 (0.106)	0.591	0.557
	$h = 2$	0.403*** (0.058)	0.317*** (0.059)	-0.436** (0.205)	0.016 (0.081)	0.007 (0.011)	0.052* (0.027)	0.456	0.411
	$h = 3$	0.396*** (0.115)	0.262* (0.140)	-0.378** (0.150)	0.027 (0.072)	0.009 (0.009)	-0.056 (0.074)	0.391	0.340
	$h = 4$	0.243*** (0.074)	0.390*** (0.074)	-0.156 (0.122)	0.051 (0.052)	0.002 (0.007)	-0.023 (0.059)	0.453	0.407
Volatile: 2006:3 - 2011:1	$h = 0$	0.115 (0.249)	0.095 (0.096)	4.709*** (0.613)	-0.231*** (0.025)	0.027*** (0.005)	0.102*** (0.017)	0.745	0.647
	$h = 1$	0.618*** (0.183)	0.087 (0.161)	1.500** (0.619)	-0.174** (0.078)	0.037*** (0.011)	0.054*** (0.015)	0.511	0.323
	$h = 2$	0.696 (0.502)	0.131 (0.321)	0.920 (0.786)	-0.170* (0.096)	0.028 (0.023)	0.033*** (0.009)	0.490	0.294
	$h =$ 3†	1.551*** (0.109)	-0.709*** (0.105)	0.307 (0.822)	-0.276*** (0.030)	0.064*** (0.007)	0.030*** (0.008)	0.625	0.481
	$h =$ 4†	1.037*** (0.101)	0.035 (0.154)	-0.304 (0.350)	-0.150*** (0.040)	0.031*** (0.008)	-0.007 (0.009)	0.568	0.402

† denotes HAC Newey-West procedure with fixed lag specification of 2

*,**,*** denote significance at the 10%, 5% and 1% levels respectively

Appendix 6.27. Disagreement and News Intensity ($\beta_1 = 0$)

Estimating Equation: $\sigma_{t,t+h} = c + \beta_1\sigma_{t-1,t-1+h} + \beta_2\eta_t + \beta_3\pi_t + \beta_4\pi_t^2 + \beta_5(\Delta\pi_t)^2 + u_t$

Standard Errors corrected for heteroskedasticity and autocorrelation using Newey-West procedure with lags determined by Akaike criterion.

Period		c	[redacted]	β_2	β_3	β_4	β_5	R^2	$\bar{R}^2$
Whole: 1982:3 – 2011:1	$h = 0$	0.925***		0.233	-0.277***	0.054***	0.159***	0.409	0.388
		(0.118)		(0.366)	(0.050)	(0.012)	(0.037)		
	$h = 1$	0.861***		0.077	-0.226***	0.047***	0.095***	0.356	0.333
		(0.111)		(0.360)	(0.044)	(0.009)	(0.016)		
	$h = 2$	0.785***		0.357	-0.245***	0.048***	0.067***	0.323	0.298
		(0.108)		(0.279)	(0.039)	(0.009)	(0.018)		
	$h = 3$	0.709***		0.468	-0.217***	0.046***	0.027	0.282	0.256
		(0.132)		(0.349)	(0.041)	(0.011)	(0.017)		
	$h = 4$	0.632***		0.859**	-0.212***	0.041***	0.027	0.294	0.269
		(0.230)		(0.348)	(0.043)	(0.012)	(0.024)		
Greenspan-Bernanke: 1987:2 – 2011:1	$h = 0$	1.109***		-0.777***	-0.219***	0.047***	0.144***	0.487	0.464
		(0.085)		(0.294)	(0.052)	(0.010)	(0.022)		
	$h = 1$	1.044***		-0.840***	-0.192***	0.045***	0.083***	0.487	0.465
		(0.103)		(0.276)	(0.052)	(0.009)	(0.009)		
	$h = 2$	0.975***		-0.537***	-0.214***	0.045***	0.058***	0.477	0.454
		(0.076)		(0.161)	(0.035)	(0.006)	(0.009)		
	$h = 3$	0.903***		-0.439	-0.190***	0.044***	0.018	0.363	0.334
		(0.170)		(0.351)	(0.033)	(0.007)	(0.011)		
	$h = 4$	0.856***		-0.143	-0.208***	0.045***	0.018	0.419	0.393
		(0.232)		(0.595)	(0.043)	(0.008)	(0.014)		
Stable 1990:1 – 2006:2	$h = 0$	0.830***		-0.925***	-0.068	0.032***	0.053	0.424	0.386
		(0.122)		(0.285)	(0.103)	(0.012)	(0.148)		
	$h = 1$	0.844***		-0.892***	-0.085	0.028**	0.133	0.457	0.422
		(0.200)		(0.321)	(0.107)	(0.013)	(0.099)		
	$h = 2$	0.669***		-0.631***	-0.031	0.019**	0.049	0.407	0.368
		(0.109)		(0.181)	(0.069)	(0.008)	(0.059)		
	$h = 3$	0.533***		-0.450	0.023	0.013	-0.035	0.349	0.306
		(0.156)		(0.334)	(0.171)	(0.020)	(0.103)		
	$h = 4$	0.453***		-0.198	0.029	0.011	-0.015	0.375	0.334
		(0.073)		(0.186)	(0.070)	(0.009)	(0.054)		
Volatile: 2006:3 - 2011:1	$h = 0$	0.202		5.032***	-0.270***	0.031***	0.104***	0.740	0.666
		(0.162)		(0.920)	(0.030)	(0.008)	(0.020)		
	$h = 1$	0.709***		1.576**	-0.200***	0.041***	0.057***	0.508	0.367
		(0.082)		(0.612)	(0.046)	(0.007)	(0.011)		
	$h = 2$	0.842***		0.955	-0.205***	0.034***	0.035***	0.486	0.339
		(0.128)		(0.748)	(0.014)	(0.008)	(0.005)		
	$h = 3$	0.914		0.282	-0.171***	0.042***	-0.005	0.417	0.251
		(0.127)		(0.904)	(0.018)	(0.004)	(0.004)		
	$h = 4$	1.072***		-0.315	-0.154***	0.032***	-0.006	0.568	0.444
		(0.079)		(0.295)	(0.027)	(0.008)	(0.009)		

† denotes HAC Newey-West procedure with fixed lag specification of 2

*,**,*** denote significance at the 10%, 5% and 1% levels respectively

Appendix 6.28. Disagreement and News Intensity $\beta_4 = 0$

Estimating Equation: $\phi_{t,t+h} = c + \beta_1\phi_{t-1,t-1+h} + \beta_2\eta_t + \beta_3\pi_t + \beta_4\pi_t^2 + \beta_5(\Delta\pi_t)^2 + u_t$

Standard Errors corrected for heteroskedasticity and autocorrelation using Newey-West procedure with lags determined by Akaike criterion.

Period		c	β_1	β_2	β_3	β_4	β_5	R^2	$\bar{R}^2$
Whole: 1982:3 – 2011:1	$h = 0$	0.209***	0.549***	0.006	0.032		0.114**	0.600	0.585
		(0.054)	(0.043)	(0.226)	(0.020)		(0.045)		
	$h = 1$	0.210***	0.599***	-0.100	0.032***		0.056***	0.572	0.556
		(0.056)	(0.056)	(0.133)	(0.012)		(0.013)		
	$h = 2$	0.221***	0.574***	0.062	0.011		0.042***	0.530	0.513
		(0.064)	(0.060)	(0.125)	(0.019)		(0.012)		
	$h = 3$	0.264*	0.531***	0.076	0.016		-0.009	0.381	0.359
		(0.156)	(0.072)	(0.219)	(0.028)		(0.019)		
	$h = 4$	0.193	0.637***	0.208	0.001		-0.004	0.516	0.499
		(0.135)	(0.085)	(0.259)	(0.031)		(0.027)		
Greenspan-Bernanke: 1987:2 – 2011:1	$h = 0$	0.323***	0.509***	-0.344	0.039***		0.108***	0.594	0.576
		(0.091)	(0.065)	(0.211)	(0.012)		(0.019)		
	$h = 1$	0.286***	0.578***	-0.397**	0.041***		0.049***	0.566	0.547
		(0.084)	(0.095)	(0.154)	(0.015)		(0.010)		
	$h = 2$	0.263***	0.585***	-0.201	0.019		0.037***	0.514	0.492
		(0.062)	(0.113)	(0.145)	(0.019)		(0.009)		
	$h = 3$	0.350**	0.522***	-0.297	0.025		-0.016	0.276	0.244
		(0.134)	(0.144)	(0.188)	(0.035)		(0.016)		
	$h = 4$	0.210***	0.722***	-0.111	0.008		-0.017	0.473	0.450
		(0.068)	(0.157)	(0.168)	(0.029)		(0.019)		
Stable 1990:1 – 2006:2	$h = 0$	0.372***	0.295***	-0.685***	0.101***		0.066	0.444	0.407
		(0.088)	(0.097)	(0.204)	(0.033)		(0.128)		
	$h = 1$	0.275***	0.502***	-0.435***	0.047***		0.163**	0.588	0.561
		(0.073)	(0.039)	(0.047)	(0.163)		(0.068)		
	$h = 2$	0.312***	0.348***	-0.417**	0.063**		0.061	0.453	0.418
		(0.067)	(0.092)	(0.125)	(0.025)		(0.050)		
	$h = 3$	0.301***	0.277**	-0.374**	0.083***		-0.046	0.386	0.345
		(0.066)	(0.136)	(0.148)	(0.030)		(0.075)		
	$h = 4$	0.223***	0.396***	-0.155	0.062***		-0.021	0.452	0.416
		(0.067)	(0.088)	(0.127)	(0.019)		(0.060)		
Volatile: 2006:3 2011:1	$h = 0$†	0.043	0.180	4.438***	-0.116**		0.093*	0.719	0.639
		(0.328)	(0.115)	(1.465)	(0.048)		(0.044)		
	$h = 1$†	0.312*	0.386***	1.260*	-0.009		0.037***	0.419	0.254
		(0.174)	(0.111)	(0.600)	(0.031)		(0.008)		
	$h = 2$	0.321	0.471*	0.841	-0.034		0.025***	0.433	0.270
		(0.338)	(0.246)	(1.014)	(0.046)		(0.007)		
	$h = 3$	0.960***	-0.037	0.323	-0.028		-0.015	0.057	-0.212
		(0.081)	(0.038)	(0.934)	(0.025)		(0.009)		
	$h = 4$	0.684***	0.391***	-0.175	-0.023		-0.023***	0.306	0.107
		(0.098)	(0.087)	(0.478)	(0.027)		(0.007)		

† denotes HAC Newey-West procedure with fixed lag specification of 2

*,**,*** denote significance at the 10%, 5% and 1% levels respectively

Appendix 6.29. Disagreement and News Intensity $\beta_3 = 0$

Estimating Equation: $\phi_{t,t+h} = c + \beta_1\phi_{t-1,t-1+h} + \beta_2\eta_t + \beta_3\pi_t + \beta_4\pi_t^2 + \beta_5(\Delta\pi_t)^2 + u_t$

Standard Errors corrected for heteroskedasticity and autocorrelation using Newey-West procedure with lags determined by Akaike criterion.

Period		c	β_1	β_2	β_3	β_4	β_5	R^2	$\bar{R}^2$
Whole: 1982:3 – 2011:1	$h = 0$	0.257***	0.529***	-0.006		0.007*	0.115***	0.603	0.588
		(0.082)	(0.046)	(0.221)		(0.004)	(0.044)		
	$h = 1$	0.261***	0.571***	-0.113		0.007***	0.058***	0.577	0.562
		(0.062)	(0.052)	(0.135)		(0.002)	(0.013)		
	$h = 2$	0.283***	0.557***	0.031		0.004	0.043***	0.534	0.517
		(0.054)	(0.067)	(0.105)		(0.002)	(0.010)		
	$h = 3$	0.290**	0.494***	0.014		0.007***	-0.006	0.396	0.375
		(0.124)	(0.070)	(0.288)		(0.002)	(0.016)		
	$h = 4$	0.196**	0.622***	0.160		0.003	-0.003	0.520	0.502
		(0.093)	(0.082)	(0.275)		(0.003)	(0.025)		
Greenspan-Bernanke: 1987:2 – 2011:1	$h = 0$	0.397***	0.475***	-0.399*		0.008***	0.110***	0.599	0.581
		(0.106)	(0.067)	(0.218)		(0.003)	(0.021)		
	$h = 1$	0.383***	0.514***	-0.486**		0.009***	0.053***	0.579	0.560
		(0.104)	(0.094)	(0.159)		(0.002)	(0.012)		
	$h = 2$	0.323***	0.533***	-0.290*		0.006	0.040***	0.526	0.505
		(0.120)	(0.166)	(0.166)		(0.004)	(0.011)		
	$h = 3$	0.440***	0.413**	-0.450		0.010***	-0.008	0.321	0.291
		(0.144)	(0.159)	(0.339)		(0.003)	(0.017)		
	$h = 4$	0.253***	0.656***	-0.203		0.005	-0.012	0.490	0.467
		(0.062)	(0.242)	(0.252)		(0.004)	(0.026)		
Stable 1990:1 – 2006:2	$h = 0$	0.556***	0.249**	-0.726***		0.016***	0.048	0.454	0.419
		(0.098)	(0.103)	(0.209)		(0.005)	(0.144)		
	$h = 1$	0.362***	0.480***	-0.456***		0.007***	0.153**	0.591	0.564
		(0.057)	(0.043)	(0.126)		(0.002)	(0.073)		
	$h = 2$	0.431***	0.310***	-0.438***		0.010***	0.051	0.456	0.421
		(0.074)	(0.104)	(0.124)		(0.003)	(0.047)		
	$h = 3$	0.438***	0.261*	-0.374**		0.012***	-0.058	0.390	0.350
		(0.084)	(0.138)	(0.144)		(0.003)	(0.076)		
	$h = 4$	0.326***	0.380***	-0.150		0.009***	-0.028	0.448	0.412
		(0.066)	(0.092)	(0.127)		(0.003)	(0.057)		
Volatile: 2006:3 2011:1	$h = 0$	-0.044	0.322**	3.320***		-0.008	0.092*	0.677	0.584
		(0.311)	(0.134)	(1.073)		(0.006)	(0.044)		
	$h = 1$	0.306*	0.412***	0.868*		0.007	0.040***	0.432	0.270
		(0.160)	(0.096)	(0.434)		(0.007)	(0.012)		
	$h = 2$	0.231	0.566**	0.569		-0.001	0.026**	0.416	0.249
		(0.368)	(0.255)	(1.019)		(0.008)	(0.009)		
	$h = 3$	1.009***	-0.034	-0.504		0.011	-0.008	0.107	-0.149
		(0.127)	(0.069)	(0.948)		(0.007)	(0.011)		
	$h = 4$	0.608***	0.494***	-0.599		0.005	-0.022*	0.312	0.116
		(0.081)	(0.064)	(0.420)		(0.004)	(0.012)		

† denotes HAC Newey-West procedure with fixed lag specification of 2

*,**,*** denote significance at the 10%, 5% and 1% levels respectively

Appendix 6.30. Anxiety and News Intensity

Estimating Equation: $\phi_{t,t+h} = c + \beta_1\phi_{t-1,t-1+h} + \beta_2\eta_t + \beta_3\pi_t + \beta_4\pi_t^2 + \beta_5(\Delta\pi_t)^2 + u_t$

Standard Errors corrected for heteroskedasticity and autocorrelation using Newey-West procedure with lags determined by Akaike criterion.

Period		c	β_1	β_2	β_3	β_4	β_5	R^2	$\bar{R}^2$
Whole: 1982:3 – 2011:1	$h = 0$	0.067 (0.104)	0.582*** (0.127)	-0.140 (0.145)	-0.014 (0.049)	0.007 (0.010)	0.034*** (0.005)	0.592	0.573
	$h = 1$	0.057 (0.090)	0.593*** (0.149)	-0.071 (0.068)	-0.019 (0.048)	0.008 (0.008)	0.022*** (0.003)	0.675	0.660
	$h = 2$	0.061 (0.062)	0.521*** (0.180)	-0.002 (0.039)	-0.014 (0.029)	0.005 (0.005)	0.013*** (0.002)	0.615	0.597
	$h = 3$	0.038 (0.024)	0.553*** (0.110)	0.067** (0.031)	-0.001 (0.010)	0.001 (0.002)	0.007*** (0.002)	0.600	0.582
	$h = 4$	0.012 (0.010)	0.704*** (0.066)	0.072** (0.030)	0.008** (0.004)	-0.001* (0.001)	0.004*** (0.001)	0.685	0.670
Greenspan-Bernanke: 1987:2 – 2011:1	$h = 0$	0.022 (0.120)	0.631*** (0.145)	-0.053 (0.174)	-0.011 (0.061)	0.007 (0.013)	0.035*** (0.005)	0.624	0.603
	$h = 1$	0.029 (0.099)	0.627*** (0.183)	-0.032 (0.093)	-0.013 (0.051)	0.007 (0.010)	0.023*** (0.004)	0.699	0.683
	$h = 2$	0.045 (0.062)	0.541*** (0.196)	0.023 (0.049)	-0.011 (0.028)	0.005 (0.005)	0.013*** (0.002)	0.659	0.641
	$h = 3$	0.031 (0.026)	0.536*** (0.133)	0.106** (0.049)	-0.003 (0.012)	0.002 (0.002)	0.008*** (0.002)	0.651	0.631
	$h = 4$	0.010 (0.011)	0.675*** (0.080)	0.107*** (0.033)	0.005 (0.004)	-0.001 (0.001)	0.004*** (0.001)	0.727	0.712
Stable 1990:1 – 2006:2	$h = 0$	0.236*** (0.049)	0.506*** (0.085)	-0.086 (0.119)	-0.140*** (0.044)	0.027*** (0.007)	0.086 (0.082)	0.593	0.559
	$h = 1$	0.245*** (0.053)	0.466*** (0.074)	-0.055 (0.088)	-0.135*** (0.033)	0.025*** (0.005)	0.054 (0.037)	0.710	0.686
	$h = 2$	0.206* (0.114)	0.340 (0.223)	0.014 (0.060)	-0.098* (0.057)	0.018* (0.010)	0.012 (0.016)	0.640	0.610
	$h = 3$	0.087** (0.041)	0.470*** (0.100)	0.092** (0.039)	-0.031 (0.021)	0.006* (0.003)	0.006 (0.006)	0.529	0.490
	$h = 4$	0.023 (0.029)	0.680*** (0.084)	0.089*** (0.025)	0.000 (0.016)	0.000 (0.002)	0.001 (0.009)	0.650	0.621
Volatile: 2006:3 2011:1	$h = 0$†	-0.391** (0.131)	1.233*** (0.075)	0.708 (0.501)	0.164*** (0.013)	-0.032*** (0.004)	0.021*** (0.006)	0.834	0.770
	$h = 1$†	-0.169*** (0.047)	0.861*** (0.096)	0.477 (0.338)	0.030 (0.018)	-0.001 (0.003)	0.017*** (0.005)	0.822	0.754
	$h = 2$	-0.073* (0.037)	0.839*** (0.040)	0.226 (0.175)	0.021*** (0.005)	-0.001** (0.000)	0.009** (0.004)	0.854	0.797
	$h = 3$	0.004 (0.009)	0.604*** (0.061)	0.186* (0.088)	0.004 (0.005)	0.000 (0.001)	0.006*** (0.001)	0.746	0.648
	$h = 4$	0.039*** (0.008)	0.509*** (0.092)	0.116** (0.051)	0.005 (0.004)	0.000 (0.001)	0.003 (0.001)	0.651	0.517

† denotes HAC Newey-West procedure with fixed lag specification of 2

*,**,*** denote significance at the 10%, 5% and 1% levels respectively

Appendix 6.31. Disagreement and Anxiety

Estimating Equation: $\sigma_{t,t+h} = c + \beta_1\sigma_{t-1,t-1+h} + \beta_2\phi_{t,t+h} + \beta_3\pi_t + \beta_4\pi_t^2 + \beta_5(\Delta\pi_t)^2 + u_t$

Standard Errors corrected for heteroskedasticity and autocorrelation using Newey-West procedure with lags determined by Akaike criterion.
† denotes Newey-West procedure with 2 lags (fixed)

Period		c	β_1	β_2	β_3	β_4	β_5	R^2	$\bar{R}^2$
Whole: 1982:3 – 2011:1	$h = 0$	0.310*** (0.114)	0.514*** (0.032)	-0.006 (0.294)	-0.032 (0.048)	0.012 (0.008)	0.115*** (0.030)	0.604	0.585
	$h = 1$	0.322*** (0.088)	0.548*** (0.054)	-0.108 (0.271)	-0.051 (0.032)	0.015** (0.006)	0.062*** (0.018)	0.579	0.560
	$h = 2$	0.302*** (0.115)	0.524*** (0.006)	0.207 (0.480)	-0.043 (0.031)	0.010 (0.009)	0.039* (0.020)	0.541	0.520
	$h = 3$	0.337*** (0.080)	0.458*** (0.090)	0.778 (0.552)	-0.092** (0.036)	0.019** (0.007)	-0.014 (0.016)	0.433	0.407
	$h = 4$	0.279*** (0.104)	0.602*** (0.043)	0.438 (0.407)	-0.068 (0.042)	0.014** (0.007)	-0.007 (0.016)	0.530	0.508
Greenspan-Bernanke: 1987:2 – 2011:1	$h = 0$	0.314*** (0.105)	0.457*** (0.057)	0.178 (0.314)	-0.018 (0.064)	0.007 (0.011)	0.105*** (0.028)	0.597	0.574
	$h = 1$	0.299*** (0.106)	0.515*** (0.085)	0.132 (0.226)	-0.041 (0.044)	0.011 (0.008)	0.049*** (0.016)	0.565	0.540
	$h = 2$	0.319* (0.171)	0.444*** (0.134)	0.574 (0.474)	-0.060 (0.044)	0.011 (0.010)	0.031* (0.016)	0.550	0.525
	$h = 3$	0.463*** (0.096)	0.305** (0.153)	0.755 (0.743)	-0.135*** (0.027)	0.026*** (0.006)	-0.009 (0.009)	0.387	0.352
	$h = 4$	0.392*** (0.094)	0.493* (0.271)	0.380 (0.483)	-0.121*** (0.044)	0.023* (0.012)	-0.008 (0.020)	0.542	0.516
Stable 1990:1 – 2006:2	$h = 0$	0.395* (0.234)	0.362** (0.161)	-0.172 (0.255)	-0.064 (0.110)	0.022 (0.013)	0.124 (0.128)	0.406	0.356
	$h = 1$	0.354*** (0.095)	0.565*** (0.073)	-0.404*** (0.133)	-0.094* (0.053)	0.021** (0.010)	0.230** (0.108)	0.583	0.548
	$h = 2$	0.233*** (0.085)	0.432*** (0.095)	-0.070 (0.340)	0.013 (0.048)	0.005 (0.007)	0.086** (0.040)	0.415	0.367
	$h = 3$	0.313 (0.196)	0.296** (0.140)	-0.131 (0.411)	0.008 (0.186)	0.010 (0.022)	-0.028 (0.094)	0.355	0.302
	$h = 4$	0.244*** (0.075)	0.394*** (0.071)	-0.236 (0.258)	0.042 (0.046)	0.003 (0.007)	-0.016 (0.056)	0.448	0.402
Volatile: 2006:3 2011:1	$h = 0$†	0.753*** (0.172)	0.035 (0.122)	1.230*** (0.399)	0.058 (0.035)	-0.011 (0.012)	0.058 (0.035)	0.644	0.507
	$h = 1$†	0.919*** (0.280)	-0.118 (0.268)	1.062*** (0.285)	-0.088 (0.065)	0.020 (0.012)	0.028*** (0.009)	0.586	0.426
	$h = 2$†	0.715 (0.569)	-0.018 (0.468)	1.930*** (0.377)	-0.109 (0.153)	0.010 (0.030)	0.000 (0.020)	0.701	0.586
	$h = 3$†	1.197*** (0.161)	-0.613 (0.358)	2.101*** (0.425)	-0.231 (0.172)	0.050 (0.036)	0.007 (0.051)	0.734	0.631
	$h = 4$	0.992** (0.335)	0.044 (0.301)	-0.144 (0.432)	-0.156*** (0.022)	0.031*** (0.007)	-0.007 (0.009)	0.559	0.390

† denotes HAC Newey-West procedure with fixed lag specification of 2

*,**,*** denote significance at the 10%, 5% and 1% levels respectively

Appendix 6.32. Disagreement and Oil Price Shocks

Estimating Equation: $\sigma_{t,t+h} = c + \alpha|\Delta\pi_{t-1}| + \beta e_{t-1}^2 + \gamma|E_{t+h}[\pi_t] - E_{t+h-1}[\pi_{t-1}]| + \lambda|\theta_t - \theta_{t-1}|$

Standard Errors corrected for heteroskedasticity and autocorrelation using Newey-West procedure with lags determined by Akaike criterion.

Period		c	α	β	γ	λ	R^2	$\bar{R}^2$
Whole: 1982:3 – 2011:1	$h = 0$	0.543*** (0.052)	0.006 (0.030)	0.036*** (0.009)	0.198*** (0.035)	0.023*** (0.003)	0.618	0.604
	$h = 1$	0.566*** (0.067)	-0.031 (0.032)	0.071** (0.028)	0.326*** (0.089)	0.011*** (0.004)	0.336	0.312
	$h = 2$	0.566** (0.072)	-0.060 (0.048)	0.057** (0.024)	0.265*** (0.086)	0.008*** (0.003)	0.265	0.239
	$h = 3$	0.550*** (0.073)	-0.007 (0.013)	0.035** (0.013)	0.607*** (0.129)	0.002 (0.002)	0.205	0.176
	$h = 4$†	0.611*** (0.111)	0.000 (0.048)	0.050* (0.026)	0.293*** (0.078)	0.000 (0.002)	0.287	0.261
Greenspan-Bernanke: 1987:2 – 2011:1	$h = 0$	0.503*** (0.059)	0.033 (0.032)	0.041*** (0.009)	0.176*** (0.044)	0.026*** (0.004)	0.693	0.679
	$h = 1$	0.544*** (0.078)	0.021 (0.061)	0.056*** (0.017)	0.141* (0.071)	0.021*** (0.003)	0.467	0.444
	$h = 2$	0.549*** (0.071)	-0.036 (0.054)	0.028*** (0.008)	0.088 (0.106)	0.017*** (0.003)	0.358	0.220
	$h = 3$	0.560*** (0.091)	-0.004 (0.056)	0.019*** (0.005)	0.325*** (0.120)	0.007* (0.004)	0.125	0.086
	$h = 4$	0.638*** (0.140)	-0.001 (0.048)	0.015 (0.009)	-0.091 (0.195)	0.007 (0.005)	0.097	0.058
Stable 1990:1 – 2006:2	$h = 0$	0.467*** (0.077)	0.092* (0.054)	-0.003 (0.012)	0.223*** (0.063)	0.023 (0.021)	0.438	0.402
	$h = 1$	0.419*** (0.036)	0.060** (0.029)	0.136** (0.057)	0.142 (0.121)	0.034*** (0.011)	0.438	0.401
	$h = 2$	0.469*** (0.055)	0.104** (0.049)	0.005 (0.030)	0.113 (0.188)	0.031** (0.013)	0.271	0.223
	$h = 3$	0.493*** (0.043)	0.098 (0.065)	0.015 (0.049)	0.078 (0.178)	0.023*** (0.009)	0.169	0.115
	$h = 4$	0.525*** (0.037)	0.053 (0.045)	-0.012 (0.027)	-0.019 (0.157)	0.025*** (0.007)	0.147	0.091
Volatile: 2006:3 - 2011:1	$h = 0$	0.808*** (0.067)	-0.062 (0.059)	0.012 (0.013)	0.128** (0.049)	0.023*** (0.005)	0.774	0.710
	$h = 1$	0.845*** (0.033)	-0.026 (0.037)	0.018 (0.014)	0.232 (0.162)	0.010* (0.004)	0.455	0.299
	$h = 2$	0.780*** (0.081)	-0.114*** (0.031)	0.010 (0.010)	0.149* (0.084)	0.010*** (0.002)	0.549	0.420
	$h = 3$	0.739*** (0.104)	-0.044 (0.038)	0.006 (0.012)	1.267** (0.454)	-0.002 (0.003)	0.475	0.325
	$h = 4$	1.037*** (0.080)	-0.043 (0.027)	0.005 (0.009)	-0.972*** (0.248)	-0.003 (0.001)	0.284	0.079

† Sample period adjusted to 1982Q4 – 2011Q1

*,**,*** denote significance at the 10%, 5% and 1% levels respectively

Appendix 6.33. Disagreement and Baseline Shocks

Estimating Equation: $\sigma_{t,t+h} = c + \alpha|\Delta\pi_{t-1}| + \beta e_{t-1}^2 + \gamma|E_{t+h}[\pi_t] - E_{t-1}[\pi_{t+h-1}]|$

Standard Errors corrected for heteroskedasticity and autocorrelation using Newey-West procedure with lags determined by Akaike criterion.

Period		c	α	β	γ	R^2	$\bar{R}^2$
Whole: 1982:3 – 2011:1	$h = 0$	0.556*** (0.046)	0.032 (0.028)	0.046*** (0.013)	0.282*** (0.019)	0.547	0.535
	$h = 1$	0.561*** (0.067)	-0.032 (0.033)	0.086*** (0.026)	0.450*** (0.088)	0.308	0.289
	$h = 2$	0.575*** (0.067)	-0.055 (0.047)	0.069*** (0.017)	0.310*** (0.066)	0.245	0.224
	$h = 3$	0.557*** (0.069)	-0.006 (0.043)	0.037*** (0.012)	0.598*** (0.119)	0.203	0.181
	$h = 4$†	0.611*** (0.105)	0.000 (0.049)	0.050* (0.025)	0.293*** (0.085)	0.287	0.268
Greenspan-Bernanke: 1987:2 – 2011:1	$h = 0$	0.510*** (0.054)	0.044 (0.032)	0.052*** (0.011)	0.297*** (0.020)	0.614	0.601
	$h = 1$	0.535*** (0.080)	0.002 (0.050)	0.087*** (0.022)	0.409*** (0.097)	0.359	0.338
	$h = 2$	0.558*** (0.078)	-0.038 (0.047)	0.059*** (0.014)	0.248** (0.110)	0.230	0.205
	$h = 3$	0.576*** (0.089)	-0.003 (0.043)	0.030*** (0.009)	0.338*** (0.124)	0.094	0.064
	$h = 4$	0.660*** (0.134)	-0.001 (0.042)	0.024** (0.012)	-0.128 (0.226)	0.063	0.032
Stable 1990:1 – 2006:2	$h = 0$	0.498*** (0.047)	0.103** (0.051)	-0.010 (0.013)	0.275*** (0.044)	0.415	0.387
	$h = 1$	0.463*** (0.062)	0.083*** (0.029)	0.160* (0.091)	0.279** (0.114)	0.356	0.325
	$h = 2$	0.510*** (0.164)	0.124 (0.089)	0.035 (0.032)	0.245 (0.154)	0.159	0.118
	$h = 3$	0.529*** (0.045)	0.121 (0.074)	0.027 (0.051)	0.171 (0.169)	0.098	0.054
	$h = 4$	0.578*** (0.052)	0.074 (0.057)	-0.001 (0.051)	-0.001 (0.187)	0.038	-0.008
Volatile: 2006:3 2011:1	$h = 0$	0.877*** (0.102)	-0.043 (0.058)	0.020 (0.030)	0.246*** (0.039)	0.648	0.577
	$h = 1$	0.849*** (0.092)	-0.046 (0.075)	0.024 (0.024)	0.475*** (0.118)	0.429	0.315
	$h = 2$	0.797*** (0.107)	-0.122* (0.067)	0.019 (0.025)	0.470** (0.186)	0.443	0.331
	$h = 3$	0.722*** (0.039)	-0.045 (0.036)	0.003 (0.008)	1.247** (0.459)	0.462	0.355
	$h = 4$	0.996*** (0.076)	-0.044 (0.029)	0.003 (0.006)	-0.866** (0.366)	0.252	0.103

† Sample period adjusted to 1982Q4 – 2011Q1

*,**,*** denote significance at the 10%, 5% and 1% levels respectively

Appendix 6.34. Disagreement and News Shocks

Estimating Equation: $\sigma_{t,t+h} = c + \alpha|\Delta\pi_{t-1}| + \beta e_{t-1}^2 + \gamma|E_{t+h}[\pi_t] - E_{t+h-1}[\pi_{t-1}]| + \phi|\eta_t - \eta_{t-1}|$

Standard Errors corrected for heteroskedasticity and autocorrelation using Newey-West procedure with lags determined by Akaike criterion.

Period		c	α	β	γ	ϕ	R^2	$\bar{R}^2$
Whole: 1982:3 – 2011:1	$h = 0$	0.532*** (0.039)	0.037 (0.030)	0.049*** (0.009)	0.288*** (0.018)	0.664 (0.948)	0.597	0.582
	$h = 1$	0.483*** (0.048)	-0.021 (0.031)	0.088*** (0.021)	0.456*** (0.083)	2.629* (1.571)	0.337	0.313
	$h = 2$	0.474*** (0.052)	-0.039 (0.042)	0.073*** (0.018)	0.304*** (0.064)	3.469*** (1.258)	0.303	0.278
	$h = 3$	0.475*** (0.068)	0.006 (0.038)	0.039*** (0.013)	0.559*** (0.117)	3.095** (1.288)	0.253	0.226
	$h = 4$†	0.582*** (0.130)	0.004 (0.044)	0.051* (0.026)	0.271*** (0.103)	1.150 (1.517)	0.292	0.266
Greenspan-Bernanke: 1987:2 – 2011:1	$h = 0$	0.507*** (0.038)	0.044 (0.034)	0.052 (0.011)	0.297*** (0.018)	0.105 (1.321)	0.614	0.597
	$h = 1$	0.506*** (0.063)	0.006 (0.046)	0.088*** (0.020)	0.410*** (0.098)	1.046 (2.249)	0.364	0.336
	$h = 2$	0.518*** (0.057)	-0.032 (0.043)	0.060*** (0.010)	0.244*** (0.092)	1.479 (1.555)	0.244	0.211
	$h = 3$	0.533*** (0.091)	0.002 (0.038)	0.030*** (0.009)	0.306** (0.128)	1.726 (1.709)	0.115	0.076
	$h = 4$	0.608*** (0.107)	0.007 (0.036)	0.024** (0.009)	-0.160 (0.222)	2.044 (1.667)	0.099	0.060
Stable 1990:1 – 2006:2	$h = 0$	0.514*** (0.046)	0.104** (0.048)	-0.008 (0.014)	0.272*** (0.042)	-0.556 (0.652)	0.417	0.379
	$h = 1$	0.517*** (0.057)	0.084*** (0.023)	0.158* (0.093)	0.269*** (0.071)	-1.934*** (0.644)	0.388	0.348
	$h = 2$	0.536*** (0.166)	0.127*** (0.045)	0.029 (0.140)	0.253 (0.578)	-0.903 (3.845)	0.169	0.114
	$h = 3$	0.525*** (0.051)	0.121 (0.074)	0.028 (0.046)	0.167 (0.161)	0.166 (1.039)	0.098	0.039
	$h = 4$	0.564*** (0.058)	0.074 (0.058)	0.001 (0.046)	-0.004 (0.190)	0.466 (0.890)	0.042	-0.021
Volatile: 2006:3 2011:1	$h = 0$	0.767*** (0.092)	-0.027 (0.049)	0.018 (0.016)	0.244*** (0.026)	4.109** (1.843)	0.664	0.567
	$h = 1$	0.496*** (0.072)	0.010 (0.028)	0.037** (0.013)	0.481*** (0.081)	11.361*** (1.770)	0.745	0.672
	$h = 2$	0.592*** (0.066)	-0.089*** (0.021)	0.013 (0.009)	0.524*** (0.125)	7.279*** (0.630)	0.633	0.528
	$h = 3$	0.606*** (0.089)	-0.026 (0.025)	0.002 (0.006)	1.160** (0.474)	4.657** (1.698)	0.562	0.437
	$h = 4$	0.920*** (0.050)	-0.028** (0.011)	0.002 (0.008)	-0.951*** (0.265)	3.168 (1.971)	0.329	0.137

† Sample period adjusted to 1982Q4 – 2011Q1

*,**,*** denote significance at the 10%, 5% and 1% levels respectively