Economic policy uncertainty spillovers in Europe before and after the Eurozone crisis

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Abstract

This paper focuses on economic policy uncertainty spillovers across Europe, before and after the outburst of the Eurozone crisis, using data for 7 Eurozone countries for the period 2003-2019. At first, we analyse the spillovers of uncertainty in Europe via the estimation of the Diebold-Yilmaz spillover index. The results indicate that uncertainty connectedness was 50.5% before the crisis, while it dropped to 30.6% afterwards indicating a sharp drop in uncertainty spillovers across the seven Eurozone countries. We also find that the importance of domestic causes in national uncertainty has increased during the crisis at the expense of imported factors. Dynamic net spillovers reveal that core Eurozone countries are uncertainty exporters before the crisis, while periphery countries transmit uncertainty to other countries during the crisis. An examination of the country which suffered the most during the crisis, using impulse response analysis, reveals that the Greek macroeconomic indicators (stock market, GDP, unemployment, and the ESI) were affected more by domestic, rather than European uncertainty. The highest responses are indicated during the crisis. Overall, there is positive interdependence between Greek and European uncertainty, which diminishes during the crisis.

JEL classification: C32, D80, E20, E66, F42, G18

Keywords: economic policy uncertainty, rolling impulse responses, uncertainty spillovers, spillover index, Greek economy.

"Entrenched uncertainty is a global problem"

September 2019, Financial Times

1. Introduction

Following the recent financial crisis of 2008-2009 and the subsequent Eurozone crisis, uncertainty at the macroeconomic and policy level seems to be on the rise at a global scale. Since the creation of the Economic Policy Uncertainty (hereafter EPU) index by Baker, Bloom and Davis (hereafter BBD, 2016), research on uncertainty has flourished. The Eurozone, from the end of 2008, when the first bailout programme was offered as help to Latvia until August 2018, when Greece's third and last bailout programme ended, is a good example of heightened uncertainty. Due to the strong economic, financial, and trade links among the Eurozone countries, it is anticipated that uncertainty episodes in one country may be easily transmitted to other member states.

The global financial crisis, followed by the Eurozone crisis with high rates of unemployment, high debt levels, and a struggling employment has heightened uncertainty, as expressed through the media for several years. This increasing uncertainty for the future of each country's economy, the effects of the subsequent economic policies and the regulations applied by governments, some of which were part of memorandum programmes for some European countries, is depicted in the European EPU index. The literature has shown that EPU is negatively correlated with the business cycle and has caused significant negative effects on macroeconomic variables such as GDP, employment, investment, etc. (BBD, 2016; Stockhammar and Österholm, 2016; Kaya, et al., 2018). Uncertainty has also affected the stock market, as investors in the financial markets closely observe GDP, investment, and other macro variables, that might be negatively impacted by a shock on uncertainty. Combining all this information, EPU could intensify the negative consequences of the crisis further.

So far, the biggest part of the literature on uncertainty focuses on the negative effects of an uncertainty shock. However, another important aspect is to examine the spillovers of such a shock to other economies, as the national economy might also be affected by uncertainty shocks in other countries. Despite the recent appearance of the

EPU concept in the literature, empirical work on EPU has fast attracted the interest of researchers. However, to date, there has been a small number of papers dealing with uncertainty shock spillovers with the majority focusing on the transmission of US uncertainty shocks (Colombo, 2013; Armelius et al., 2017; Caggiano et al., 2020). Another part of the literature investigates the effects of US or European uncertainty shocks on the economies of other countries outside US and Europe (IMF, 2013). Klossner and Sekkel (2014) and Balli et al., (2017) examine the EPU cross-country spillovers in developed countries. The last paper also investigates the determinants of these spillovers and finds that trade links and common language are transmission-enhancing factors.

This paper contributes to the literature on policy uncertainty by highlighting an issue which had until recently been largely neglected by the current literature. We concentrate more on the issue of uncertainty spillovers at a Eurozone level, rather than focusing on the effects of uncertainty on the domestic economy. We attempt to contribute to the related literature in two ways: First, we examine the dynamic behaviour of the EPU connectedness and the dynamic net volatility spillovers of uncertainty for seven Eurozone countries in the period that includes the recent Eurozone crisis. Our second aim is to investigate whether it is domestic or European uncertainty shocks that affect Greek macroeconomic variables the most, with an emphasis on the dynamic evolution of these effects before and after the crisis.

We address the first issue by examining EPU transmissions in a Vector Autoregressive (VAR) context, using the Diebold-Yilmaz (2009, 2012) spillover index. Monthly data from March 2003 until June 2019 for seven Eurozone countries are used. Our findings indicate that there is considerable transmission of uncertainty, which however falls significantly after the beginning of the crisis, as the spillover index drops from around 50% to almost 30%. At the same time, the relative importance of domestic uncertainty in all countries increased during the crisis. Findings also show that Greece, Ireland, and Spain are mainly uncertainty importers, whereas the large countries, France and Germany, are mainly uncertainty exporters. The dynamic net spillovers imply that before the crisis the core Eurozone countries (e.g., France and Germany) mainly exported uncertainty shocks, while during the crisis it was mostly the periphery countries (e.g. Greece and Ireland) that transmitted EPU shocks to the rest of the Eurozone.

In quest of the answer to the second question of this research, which is more specific for the Greek economy, we proceed with an impulse response analysis. The analysis is possible following the development of the recently-created EPU index for Greece by Fountas et al. (2018). To examine the effects of policy uncertainty shocks, both domestic and European, on Greek economic variables, we use the Greek and the European EPU indices, and the Greek variables of GDP, unemployment, stock market index and Economic Sentiment Index (hereafter ESI), for the period 1998Q2-2019Q1. Comparing the responses of the Greek economic variables to domestic and European uncertainty shocks, we conclude that the above variables respond to domestic uncertainty shocks for a longer period, compared to European EPU shocks. The results also indicate positive interdependence between domestic and European uncertainty, which however weakens during the crisis, a result in line with our first results concerning the findings of uncertainty spillovers across Europe. Given the considerable instability observed during this period, arising from a volatile economic and political environment, we establish the sensitivity of our results using a rolling impulse response function approach. This dynamic analysis results in similar conclusions to the ones obtained under the traditional full sample approach. An important result is that the largest responses to uncertainty shocks are detected in late 2008/early 2009. For this estimation period, we find that the responses to uncertainty shocks last long, and actually, they gradually keep increasing to reach the highest response 10 quarters after the initial EPU shock.

The rest of the paper is outlined as follows. Section 2 contains a review of the literature on the effects of EPU on macroeconomic variables across various countries and the literature on uncertainty spillovers using the Diebold-Yilmaz spillover index. Section 3 presents the methodology and the empirical analysis on the uncertainty spillovers across Europe. Section 4 presents the effects of domestic and European policy uncertainty on Greek macroeconomic variables and some robustness analysis using rolling impulse response functions. Finally, section 5 concludes the paper.

2. Literature Review

Recently, applied macroeconomists have attempted to find an appropriate measure that quantifies the multi-dimensional concept of uncertainty. Moore (2017) refers to different categories of uncertainty measurement, the newspaper-based, the finance-based and the forecaster disagreement measures. The Volatility Index (VIX) is a financial market volatility indicator that is commonly used as an uncertainty measure and is calculated by the implied volatilities on the S&P 500. However, by the nature of its construction, this measurement is not strongly connected to economic activity, as it is mostly related to investors' risk-aversion (Bekaert et al., 2013). Uncertainty proxies that are closely related to economic activity are those of dispersion between forecasters for economic variables (forecaster disagreement measures). In this case, the drawback is that these measures may not indicate uncertainty, but may capture disagreement instead (Moore, 2017). Jurado et al. (2015) proposes a measure of macroeconomic uncertainty that is based on the unpredictable component of a broad set of macroeconomic variables. The conditional variance of a series in a Generalised Autoregressive Conditional Heteroskedasticity (GARCH) model is also considered to be a measure of uncertainty about specific macroeconomic variables, such as output growth or inflation (Grier and Perry, 1998; Bredin and Fountas, 2005; Bredin and Fountas, 2009; Hamilton, 2010; Bredin et al., 2011).

The EPU index suggested by BBD (2016) deviates from the previous measures of uncertainty in applied macroeconomics, as it focuses on the uncertainty triggered by economic policy-making. It is a newspaper-based indicator that captures both short- and long-run uncertainty about who will apply the economic policy, what regulations will be applied by policy makers, how effective these regulations will be, and what the consequences of the economic policy will be. BBD have developed EPU series for several major industrial countries, including the US, the UK, France, Germany, Japan, etc. Finally, other researchers, following BBD's approach, created the series for other countries, like Ireland (Zalla, 2017), Chile (Cerda et al., 2018), Greece (Fountas et al., 2018) etc. To the present, the index has been created for more than 25 countries and the number continuously rises. BBD also proceeded with some tests for the credibility and validity of the EPU index. The support of the credibility of the index is remarkable. Much research has been conducted, giving important results on the events that are depicted on an EPU graph, the causal effects between the EPU and macroeconomic or financial variables, and the importance of uncertainty during economic crises.

According to several studies, a large and steep increase in uncertainty has been observed in every country during or after economic crises (BBD, 2016; Cerda et al., 2018). Previous research for other countries indicates that uncertainty shocks negatively affect domestic output, employment, and other macroeconomic variables.

More specifically, BBD (2016) use US macro-level data and, following the application of several VAR models and the examination of the impulse responses of macroeconomic variables, they conclude that policy uncertainty shocks are associated with declines in output, investment, and employment. They also perform the same analysis for a panel of 12 different countries and find similar results. Using firm-level data, they find that when uncertainty increases investment falls and stock market price fluctuations increase. Some papers look at the effects of US uncertainty on European uncertainty. Stockhammar and Österholm (2016) and Armelius et al. (2017) find evidence that US uncertainty shocks affect negatively Swedish GDP growth. Colombo (2013) examines the transmission of US uncertainty shocks to Europe, identifying a high impact on European GDP.

Cerda et al. (2018) run five different VAR models on quarterly data for the economy of Chile and conclude that positive uncertainty innovations lead to deterioration of GDP, investment as well as consumption. For the case of South Korea (Cheng, 2017) there is evidence of negative effects of uncertainty on the domestic economy, however the important finding is that foreign uncertainty has a greater impact on Korean economy than domestic uncertainty. Zalla (2017) investigates the implications of EPU shocks for the Irish economy and shows evidence of negative effects on industrial production and the stock market. Arbatli et al. (2017) and Sahinoz and Cosar (2018) estimate impulse response functions for Japan and Turkey, respectively, and obtain similar results with other countries.

The large literature outlined above focuses on the effects of policy uncertainty on the domestic economy. More recently, some papers examine the transmission of uncertainty shocks to some domestic sectors (e.g., housing) or across a spectrum of domestic uncertainty categories using the Diebold-Yilmaz spillover index. Antonakakis et al. (2016) and Thiem (2018) look at US uncertainty effects on the domestic economy. Antonakakis et al. (2016) test for the existence of spillovers among the EPU, the stock and the housing market in the US. They find evidence for time-varying spillovers which seem to be increasing significantly after the global crisis of 2008. Thiem (2018) examines the connectedness among 6 different EPU index categories (monetary, fiscal, healthcare, national security, regulatory and trade policy uncertainty) for the US and finds evidence for high spillovers.

Several studies concentrate on cross-country uncertainty spillovers. Uncertainty may spillover across national borders via various transmission mechanisms. These include trade links, financial links, trade and fiscal imbalances, a common language, and a common border. However, a distinct EPU spillover channel (where a domestic EPU spike creates uncertainty abroad) has also been identified, even in the presence of a separate trade channel (Caggiano et al., 2020). Balli et al. (2017) estimate cross-country uncertainty spillovers and find out that the main channels through which uncertainty is transmitted from one country to the other are trade and the common language. They also find that the less balanced countries are in financial, fiscal, and trading terms, the higher the possibilities of EPU transmissions. Liow et al. (2018) analyse the EPU spillovers among 7 countries (USA, UK, Canada, Germany, France, China, and Japan) and estimate the respective spillover index to be almost equal to 50%. Klossner and Sekkel (2014) also analyse the EPU spillovers among six developed countries and find that they account for a large share of the dynamics of policy uncertainty with this share rising during the recent financial crisis. Caggiano et al. (2020) examine EPU spillovers between the US, Canada, and the UK. They find that US uncertainty spills over to the EPU index in Canada and affects unemployment negatively, thus pointing to an EPU spillover channel. This channel of uncertainty transmission is separate to a possible trade channel. However, trade is not the only channel through which economic policy uncertainty is transmitted abroad, as the paper finds evidence of US uncertainty transmission to the UK, without the UK traditionally having close trading relations with the other side of the Atlantic. Finally, Śmiech et al. (2020) add more to the literature, by investigating the connectedness among three types of uncertainty (consumer, industrial and financial) across countries. A major finding is that uncertainty transmissions are usually higher among geographically close (which have higher trade and financial links) countries and Southern European countries are net volatility transmitters during the debt crisis. Moreover, they find that the strength of connection across the EU countries weakens in the post-Eurozone crisis period.

3. Uncertainty spillovers in Europe

3.1 Model and Data

The empirical analysis, as already explained, is divided into two parts. In the first part we estimate the uncertainty spillovers among seven European countries and compare these spillovers in the pre- and post-crisis periods. We consider the beginning of the crisis to be January 2010. We also examine how the dynamic net spillovers of each country evolve through time during the crisis. To do so, we apply a VAR analysis and estimate the Diebold-Yilmaz spillover index (2009, 2012).

Research on spillovers across different countries or different variables within a country is an important part of the empirical economics literature. Diebold and Yilmaz (2009) developed a measure that captures such spillovers, and later, in 2012 expanded their research to further enhance its power. They develop the spillover index using a variance decomposition from a VAR model. This spillover index is actually a measure of connectedness among variables in a multivariate framework; the higher its value is, the more intense the connectedness is. Diebold and Yilmaz (2012) indicated some drawbacks of their initially proposed index (2009). The first one was that the index was dependent on the variables' ordering, as it was based on a Cholesky decomposition of the VAR model. The second limitation was the estimation of an index for the total connectedness, which however was not capturing the direction of the spillover. To overcome these problems, they based the estimation of the spillover index on a generalised VAR framework, to make the index independent of the ordering of the variables. Additionally, they also introduced the directional spillover index.

To derive the index, at first a covariance stationary 7-variable VAR(p) is applied:

$$\boldsymbol{y}_t = \sum_{i=1}^{p} \Phi_i \boldsymbol{y}_{t-i} + \boldsymbol{\varepsilon}_i \ , \tag{1}$$

where $\varepsilon \sim (0, \Sigma)$ is a vector of *iid* disturbances and *y* is the vector of the EPU indices of the seven Eurozone countries that will be examined (France, Germany, Greece, Ireland, Italy, Spain, and the Netherlands). The respective moving average (MA) representation is:

$$\boldsymbol{y}_t = \sum_{i=1}^{\infty} \boldsymbol{A}_i \boldsymbol{\varepsilon}_i \ , \tag{2}$$

where $\boldsymbol{A_i}$ is a *nxn* coefficient matrix and $\boldsymbol{A}_i = \Phi_1 \boldsymbol{A}_{i-1} + \cdots + \Phi_p \boldsymbol{A}_{i-p}$, $\mathbf{A_0}$ is a *nxn* identity matrix, and $\boldsymbol{A_i}=0$ for $i<0$.

To estimate the variance decompositions, we apply the generalised VAR framework proposed by Koop, Pesaran, Potter and Shin (hereafter KPPS framework) (Koop et al., 1996; Pesaran and Shin, 1998). This framework allows for the shocks to be correlated, but appropriately, using the historically observed distribution of the errors, the result becomes invariant to the ordering. The use of the generalised instead of the orthogonalised shocks means that the row sum of the elements of the variance decomposition is not restricted to be one. Thus, the row sum of the spillover indices will also be different from unity.

Based on the KPPS framework, the z-step-ahead forecast error variance decompositions are estimated:

$$\varphi_{ij}^{g}(Z) = \frac{\sigma_{jj}^{-1} \sum_{t=0}^{Z-1} (e'_{i} A_{z} \Sigma e_{j})^{2}}{\sum_{t=0}^{Z-1} (e'_{i} A_{z} \Sigma A'_{z} e_{j})}, \quad (3)$$

where Σ is the error variance-covariance matrix, σ_{jj} is the standard deviation for the error term for the j^{th} equation, and e_i is the selection vector, where the i^{th} element is one and the others 0.

In order to get the spillover index, the variance decomposition is normalised by the row sum.

$$\tilde{\varphi}_{ij}^{g}(Z) = \frac{\varphi_{ij}^{g}(Z)}{\sum_{j=1}^{N} \varphi_{ij}^{g}(Z)}. \quad (4)$$

The total spillover index captures the contribution of volatility shocks across all the countries to the total forecast error variance:

$$S^{g}(Z) = \frac{\sum_{i,j=1, i\neq j}^{N} \tilde{\varphi}_{ij}^{g}(Z)}{\sum_{i,j=1}^{N} \tilde{\varphi}_{ij}^{g}(Z)} x100 = \frac{\sum_{i,j=1, i\neq j}^{N} \tilde{\varphi}_{ij}^{g}(Z)}{N} x100. \quad (5)$$

The directional spillover index measures the spillovers received by country i from all the other countries j:

$$S_{i\bullet}^{g}(Z) = \frac{\sum_{j=1, i\neq j}^{N} \tilde{\varphi}_{ij}^{g}(Z)}{\sum_{i,j=1}^{N} \tilde{\varphi}_{ij}^{g}(Z)} x100 = \frac{\sum_{j=1, i\neq j}^{N} \tilde{\varphi}_{ij}^{g}(Z)}{N} x100. \quad (6)$$

and respectively, the directional spillover transmitted from country i to all other countries j:

$$S_{\bullet i}^{g}(Z) = \frac{\sum_{j=1, i\neq j}^{N} \tilde{\varphi}_{ji}^{g}(Z)}{\sum_{i,j=1}^{N} \tilde{\varphi}_{ji}^{g}(Z)} x100 = \frac{\sum_{j=1, i\neq j}^{N} \tilde{\varphi}_{ji}^{g}(Z)}{N} x100. \quad (7)$$

Finally, the net volatility spillover index is:

$$S_{i}^{g}(Z) = S_{\bullet i}^{g}(Z) - S_{i\bullet}^{g}(Z). \quad (8)$$

In order to treat the spillover index as time-varying, Diebold and Yilmaz (2012) use a rolling window methodology to estimate the aforementioned indices.

The data for the EPU index of the seven Eurozone countries in our VAR are retrieved from the policyuncertainty.com database. Figure 1 plots the monthly EPU index for these countries for the period 2003M03 – 2019M06. The starting year of the analysis is dictated by data limitations for the Netherlands where EPU data is not available prior to this year. Figure 1 indicates an increase in the mean and the volatility of the policy uncertainty index since the beginning of the global financial crisis.

Insert Figure 1: EPU indices for the seven Eurozone countries

We apply the model for two different periods to estimate the total and directional spillovers: the first begins in January 2003, which is dictated by the availability of EPU data for all the countries in our sample examine, and ends in December 2009, before the beginning of the Eurozone crisis. The second period, dubbed "post-crisis" period, runs from January 2010 to June 2019. The VMA representation through a generalised framework is used, as proposed by Diebold and Yilmaz (2012, 2014). In this way, the analysis is independent of the ordering of the variables. We also estimated the dynamic total connectedness index and the net spillovers of each country to examine the evolution through time. We set the forecast horizon for the variance decomposition equal to 10 months and the rolling window for the estimation of the spillovers equal to 24 months.

3.2 Results

The results for the spillover index for the above seven Eurozone countries are summarised in Table 1. Each country-column is divided into two sub-columns, the first is for the period January 2003 to December 2009 (pre-crisis period) and the second for the period January 2010 to June 2019 (crisis period). The meaning of the off-diagonal entries (directional spillovers) in this table is as follows: the ij^{th} entry $(i \neq j)$ measures the estimated contribution to the forecast error variance of policy uncertainty of country i due to innovations in policy uncertainty to country j. The values in the rows report the fraction of the forecast error variance the headline country imports from each of the other countries. For example, 16.1% of the forecast error variance of France is imported from Germany (pre-crisis period). The figures in the columns report the fraction of the forecast error variance the headline country exports to each of the other countries. For example, France exports 13.6% of its forecast error variance to Germany. Summing across the rows, we can calculate the fraction of the forecast error variance that is imported from the other countries in total (this is shown in the last column in the table titled "contribution from others"). This fraction is calculated using equation (6). Summing across the columns, we can calculate the fraction of the forecast error variance that is exported to the other countries in total (this is shown in the row in the table titled "contribution to others"). The row titled "net contribution" measures the difference between uncertainty exports and imports. The diagonal elements in Table 1 measure the own contribution, i.e., the fraction of forecast error variance due to domestic uncertainty shocks. The values in the bottom right corner (50.5% and 30.6% for the pre-crisis and crisis periods, respectively) measure the total connectedness or total spillover index calculated by equation (5). It reflects the average of the non-diagonal entries (below or above the diagonal) in Table 1and it is a measure of the sum of all bilateral uncertainty spillovers in the Eurozone-7. The last row in Table 1 reports the total contribution to the forecast error variance, which includes the contribution to others, plus the own contribution.

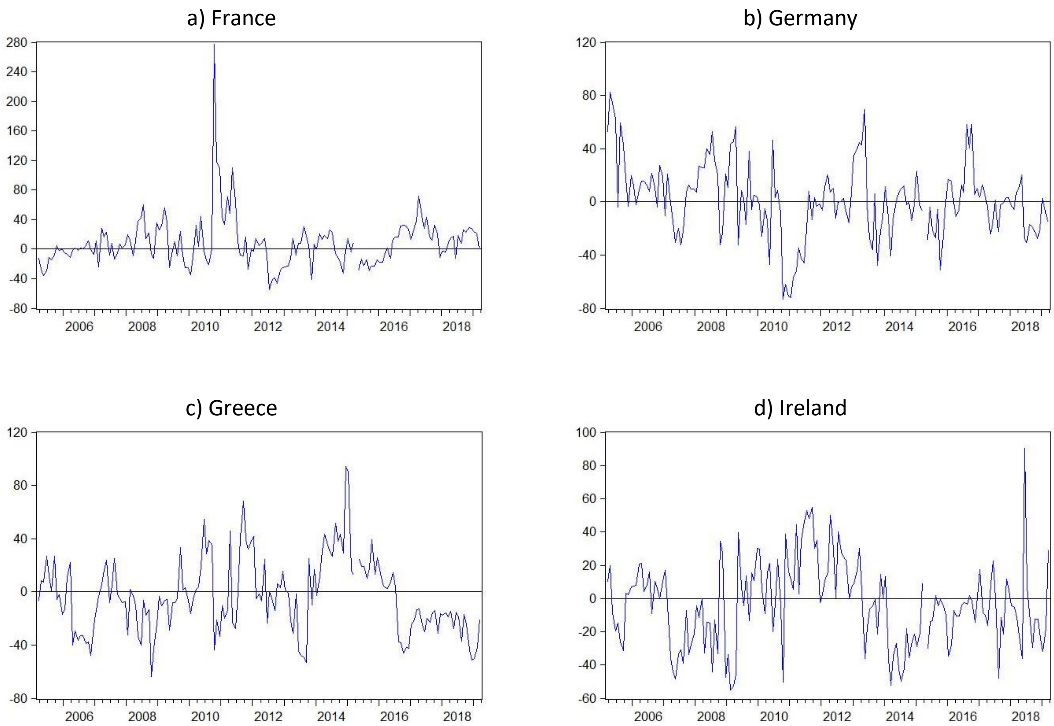
Insert Table 1: Generalised conditional spillovers

The estimates reported in Table 1 lead to the following conclusions. First, the total spillover of uncertainty among the Eurozone countries fell from 50.50% in the pre-crisis period to 30.60%, following the onset of the crisis. The first number implies that a little over one-half of the total variance of the forecast errors for the seven Eurozone countries is explained by the cross-country spillovers of uncertainty shocks. This significant drop in the total uncertainty spillover index is reflected in the fact that the importance of domestic sources of uncertainty (as opposed to uncertainty imports) increased during the crisis period. This is shown by the diagonal elements in the table which increased for all countries from the pre-crisis to the crisis period. In other words, it is clear that, following the outburst of the crisis in the Eurozone, each country has been more "closed" and not affected as much by foreign factors; rather uncertainty is mostly affected by domestic events and shocks.

Second, this increase in the contribution of own uncertainty innovations is more obvious in countries that experienced a more severe debt crisis and, in some cases, followed an economic adjustment programme. For example, the contribution of own innovations increased in Greece from 56.9% to 73.1%, in Ireland from 52.4% to 89.4%, in Italy from 47.5% to 62.5% and in Spain from 37.6% to 66.4%. Third, core countries of the Eurozone were significant exporters of uncertainty in the pre-crisis periods, notably, France, Germany and the Netherlands with contributions of uncertainty to others equal to 68.6%, 72.4% and 69.4%, respectively. Fourth, some countries (e.g., France, Germany, and the Netherlands) even though they were net exporters of uncertainty before the crisis, following the start of the crisis, they became less so, or in some cases became net importers (Germany). On the other hand, some countries were importers of uncertainty during both periods (Greece, Ireland, Spain) or switched from importer to exporter (Italy).

Insert Figure 2: Total connectedness index

Figure 3: Dynamic net volatility spillovers for 7 Eurozone countries



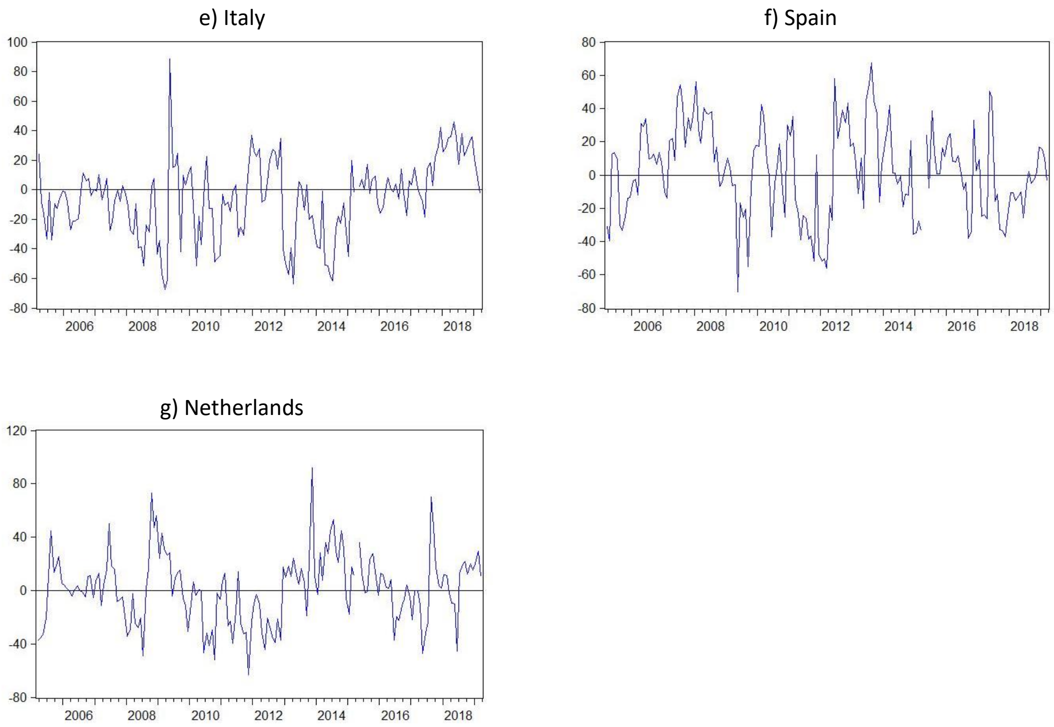


Figure 2 plots the time-varying total uncertainty spillover index. As shown in this figure, the uncertainty connectedness index was quite volatile during the study period, as it rose during the crisis (2008-2014), fell afterwards, increased again at the end of 2016, the year of the Brexit referendum, and fell once more after 2018.

Insert Figure 3: Dynamic net volatility spillovers for 7 Eurozone countries

To have a clearer picture of the uncertainty transmissions among the Eurozone countries and how they have evolved over time, apart from the total connectedness, we examine the dynamic net spillovers of EPU for the seven countries, presented in Figure 3. Figure 3 plots the net volatility spillovers of EPU transmitted from each country to the rest of the countries under examination, as estimated by equation 8.

We observe that countries like Germany and the Netherlands, which had been mainly “exporting” uncertainty in the pre-crisis period, during the crisis have longer periods of negative net spillovers (2009-2012). France, despite the high positive net spillovers in 2010-2011, in the following years it also presents long periods of negative net spillovers, meaning that after 2012 France is a receiver of EPU volatility spillovers from other countries. The high peak in October 2010 for France can be explained by the long-lasting and intense strikes the country was going under, due to the new pension reforms the government was trying to implement.

On the other hand, periphery countries, like Greece and Ireland, which were mainly importing uncertainty shocks before the onset of the crisis, show longer periods of positive net spillovers to the other countries during the crisis. Specifically, Ireland had high EPU volatility transmission to the rest of the countries during 2008-2013 period, which in part coincides with the participation in the bailout programmes. When the bailout programme of Ireland ended in December 2013, we observe that the country goes back to its pre-crisis situation, mainly receiving spillovers from other countries. In the same vein, Greece entered the bailout programmes in May 2010. Until then, the net spillovers were negative for long periods, however after the May 2010 there is high EPU volatility spillover from Greece to other countries, and especially during late 2011 until 2016, with the exception of the first half of 2013, there is a prolonged period of positive and high net spillover for the country. It was the period of high political uncertainty with 4 governmental elections (two rounds in 2012 and two rounds in 2015), the introduction of capital controls and a referendum in 2015.

3.3 Robustness Tests

For the validation of the previous results, we run some robustness tests. At first, we use different samples, according to the different point in time when the crisis began or ended for different countries. More specifically, we chose the break date and the end of the sample according to the start and the end dates of the bailout program in 3 countries (Greece, Ireland, and Latvia). Moreover, we change the forecast horizon used in the variance decomposition to 12 and 24 months as well as the rolling window to 12 months. We also repeated the estimations by excluding one country at a time. The results from the robustness tests corroborate the conclusion that during the crisis the importance of domestic uncertainty is in all countries higher than in the pre-crisis period. Additionally, the percentage of total uncertainty spillover among the countries in the robustness tests, in both periods under examination, remains qualitatively and quantitatively similar to the initial analysis.

Finally, as part of the robustness testing procedure, we added 3 more European countries, which are not members of the Eurozone, i.e., Russia, Sweden, and the UK.

Table 2 provides all the estimated spillover indices (total, directional, net). We can see that the total connectedness falls from 52% before the crisis to 38.7%, a result in line with the analysis of the 7 Eurozone countries. Also, regarding the diagonal elements, apart from France, Germany and Russia, in all other cases they imply an increase of the importance of domestic uncertainty after the beginning of the crisis.

Insert Table 2 Generalised conditional spillovers – robustness

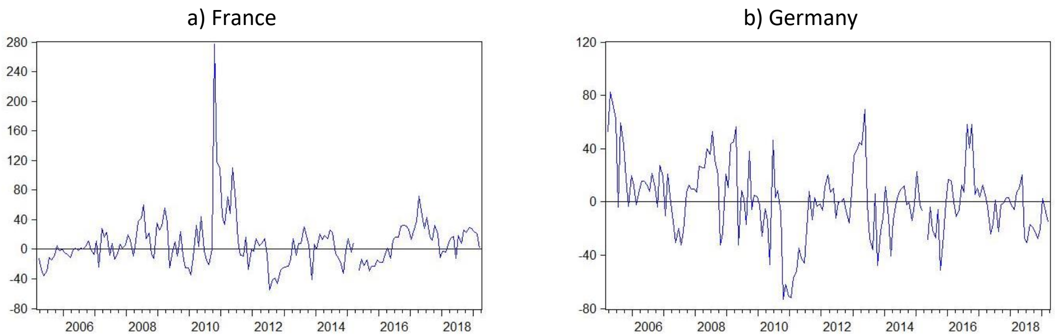
4. Uncertainty and the Greek economy

4.1 Data and Methods

Given the increasing uncertainty surrounding the Greek economy following the economic crisis, we attempt to measure the effects of uncertainty on key Greek macroeconomic variables. In a recent paper, Fountas et al. (2018) presented the construction of the Greek EPU index from January 1998 to January 2018. They also related the movements of the index with important economic, social, and political events, both domestic and international. As they observe, the Greek EPU index peaks at the months when these major events took place. Important domestic events, economic and political ones, also triggered policy uncertainty increases in Greece.

Insert Figure 4: The Greek and European Economic Policy Uncertainty indices

Figure 3: Dynamic net volatility spillovers for 7 Eurozone countries



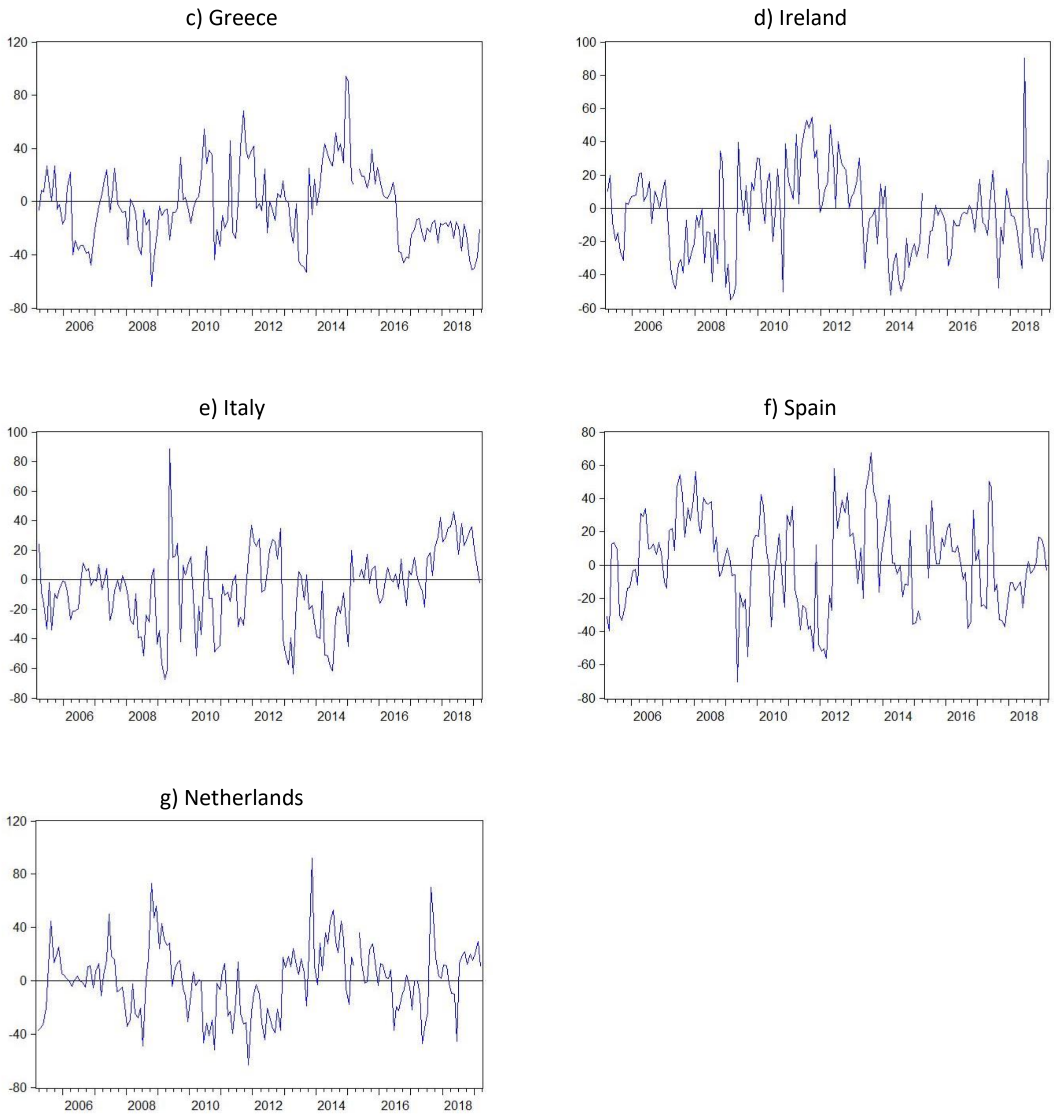


Figure 4 illustrates the Greek and European EPU indices in monthly frequency for the period January 1998 to June 2019. A first look at the graph might not give us the picture of increased uncertainty during the crisis, both for the case of Europe and especially for Greece, as there were months with high uncertainty even before the beginning of the crisis. However, simple descriptive statistics help us establish the deterioration in terms of uncertainty, as the mean value as well as the standard deviation (volatility) increase significantly after 2010, both for Greece and Europe in general[1]. More specifically, the mean of the Greek uncertainty index increased by 50% and the mean of the European EPU index almost doubled. As shown in Figure 4, until the

[1] For the Greek EPU the mean value increased from 100 to 146 and the standard deviation from 42 to 53. For the European EPU the mean value increased from 105 to 200 and the standard deviation from 32 to 46.

beginning of the crisis, Greek and European uncertainty move very closely to each other, even though Greek uncertainty seems to be more volatile. After the onset of the crisis the picture changes a bit and the two EPU indices seem to follow different paths. This observation comes to add to the results of the spillover index that the uncertainty spillovers in the Eurozone fall after the beginning of the crisis. We observe periods of high uncertainty in Europe like in 2010 and 2016, when the Greek EPU is not as high as it would have been expected regarding the European turmoil in those years. In addition, in 2015, a year full of important events for the Greek economy that triggered a rise in domestic uncertainty, the European uncertainty index does not reach high levels. Thus, to account for the likely importance of EU membership in shaping the effects of uncertainty on the Greek economy, we examine the effects of shocks on both the Greek and the European EPU indices[2] on Greek macroeconomic variables. We also wish to examine if these effects differ before and after the beginning of the crisis. In this respect, we first analyse the effects for the full sample, and then, as a robustness test, we employ a rolling impulse response function analysis.

To measure the impact of uncertainty on the Greek economy, we follow the previous literature and estimate VAR models and the impulse responses of Greek macroeconomic variables to uncertainty shocks. The VAR in standard form is given by the following equation:

$$\boldsymbol{y}_t = \boldsymbol{A}_0 + \boldsymbol{A}_1 \boldsymbol{y}_{t-1} + \cdots + \boldsymbol{A}_p \boldsymbol{y}_{t-p} + \boldsymbol{\beta} \quad \boldsymbol{t} + \boldsymbol{e}_t \,, \qquad (9)$$

where $\boldsymbol{y}_t$ is a *nx1* vector of the six endogenous variables, Greek EPU index, European EPU index, Greek real GDP, Greek Economic Sentiment Indicator (ESI), unemployment and stock market index, $A_i\boldsymbol{s}$ are *nxn* coefficient matrices, $\boldsymbol{e}_t$ is a *nx1* vector of error terms, *p* is the lag length and *t* is a linear time trend. We choose real GDP as an important proxy for real economic activity, a similar choice with Armelius et al. (2017) and Cheng (2017). The unemployment rate is a crucial variable to consider given the high value observed during the peak of the crisis reaching the extraordinary level of 28%. In the literature some studies use the employment variable, but the unemployment variable has also been used (Caggiano et al., 2020). The stock market index is included as a proxy for conditions in the financial markets (see also, BBD,

[2] BBD (2016) constructed a European EPU index, as a mean of the EPU indices of France, Germany, Italy, Spain, and the UK.

2016; Zalla, 2017). The European EPU is included due to Greece's Eurozone membership and the anticipated transmission of uncertainty among countries sharing a common currency. Other studies use a foreign EPU index that relates to an important trading partner or a large country. For example, Caggiano et al. (2020) use the US EPU when the domestic country is Canada, and Cheng (2017) also uses the US EPU in a VAR for the South Korean economy. Finally, the ESI is a composite index that captures the sentiment of various sectors of the supply-side of the economy (industrial, services) and consumers and is expected to be influenced by uncertainty.

To investigate the effects of uncertainty on macroeconomic variables, we calculate Generalised Impulse Response Functions (hereafter GIRFs). We choose GIRFs instead of simple IRFs because, as shown by Pesaran and Shin (1998), GIRFs are constructed using an orthogonal set of innovations that does not depend on the ordering of the variables that are included in the VAR model. We estimate a VAR model on quarterly data for the full period 1998Q2-2019Q1. The sample period is dictated by the available data for the Greek harmonised unemployment. The variables Greek real GDP (millions of chained 2010 Euros) and Greek (harmonised) unemployment are seasonally adjusted, and the stock price index is the FTSE-ATHEX-Large-Cap. The EPU indices were retrieved from the policyuncertainty.com (the official site of the EPU index), the ESI from the European Commission, real GDP from FRED, harmonised unemployment from OECD, and finally the stock market index from investing.com. All variables are in log levels. As it is customary in the literature, we run a VAR in levels, and not in first differences, following previous similar research (Colombo, 2013; BBD, 2016) in order not to lose important long-run information of the variables (Sims et al., 1990). Furthermore, due to the shortness of our sample, we do not consider the possibility of cointegration.

4.2 Results and discussion

The starting point of our empirical analysis is a VAR model for the full sample (1998Q2-2019Q1). Based on the LR test, six lags were chosen; this lag length is sufficient to ensure serially uncorrelated errors. The generalised impulse responses for up to ten quarters for the full sample are depicted in Figure 5. The graphs on the left column portray the responses of the variables to Greek uncertainty shocks and the graphs on the right column show the corresponding responses to European EPU innovations. The median response is reported, as well as 67% confidence interval bands based on asymptotic standard errors. We find that stock prices respond negatively to shocks on the Greek as well as the European EPU index, with the highest response in 2^{nd} and 3^{rd} quarter after the shock, and later the response gradually falls. The impulse responses of unemployment to Greek uncertainty shocks are statistically significant almost through the 10 quarters and the responses to European uncertainty are statistically significant, except for the 3rd and 4th quarter after the shock. They are positive and increasing until 8 quarters after the shock, and then start falling. Real GDP responds negatively to both shocks and its response to Greek uncertainty shocks is a bit higher and longer in duration than to European uncertainty shocks. Finally, ESI responds negatively to both Greek and European uncertainty shocks and the response lasts for about 6 quarters, while the response to Greek EPU is a bit larger than the response to European EPU innovations.

In general, these results highlight the importance of uncertainty originating in both Greece and core European countries in shaping movements in Greek macroeconomic variables. The signs of the responses are as anticipated in all cases. In other words, in response to positive uncertainty shocks, the stock index, real GDP and the ESI fall, and unemployment rises. Another interesting result concerns the interdependence between European and Greek uncertainty. As anticipated, we observe that the response of the Greek EPU to a shock on the European EPU index is positive and qualitatively similar with the response of the European EPU to shocks on the Greek EPU. Quantitatively though, it seems that the effect of European uncertainty on Greek uncertainty is larger for the full sample.

To test the robustness of the results, we additionally run the full sample GIRFs replacing the European uncertainty index with the global EPU index[3]. The results are again similar to the initial model of our analysis, thus reenforcing the robustness of the initial model. The only exception is the duration of the response of Global EPU to Greek EPU shocks, which is smaller compared to the European response to Greek uncertainty shocks. This divergence makes sense, as the European countries and their uncertainty are expected to be affected more from Greek uncertainty shocks, compared to the rest of the countries of the world.

[3] The global EPU index is constructed by BBD (2016) as a GDP-weighted average of the uncertainty indices of 21 countries (see policyuncertainty.com).

Insert Figure 5: Generalised Impulse Responses for the full sample

As mentioned previously, a rolling VAR model estimation has been applied as a next step. In other words, rolling impulse responses are estimated to capture the dynamic evolution of the responses and thus examine how changes evolve before, during, and after the Greek debt crisis. The sample extends from the first quarter of 2004 until the first quarter of 2019, and we use a window of 24 quarters[4], that is 6 years. The size of the window has been selected based on the sample size. However, robustness tests have been conducted for window sizes of 22 quarters and 28 quarters. The general pattern of the rolling GIRFs in these cases is similar to the 24-quarter window estimations presented in this paper, apart from some minor differences in non-statistically significant estimations. The smoothness of the estimations also changes, but this is expected as the larger the size of the window in a rolling estimation, the smoother the estimations are (Zivot and Wang, 2006). The GIRFs have been estimated for up to ten quarters after the shock. Figures 6a-6e portray the responses of the variables to Greek uncertainty shocks, while figures 7a-7e portray the responses of the variables to European uncertainty shocks, so that we can make a comparison between the responses to domestic and European EPU shocks. The median responses are reported in the graphs, and the 67% confidence interval bands are estimated, but not depicted for reasons of simplicity and clarity of the 3D figures.

Insert Figure 6: Rolling Generalised Impulse Responses to Greek EPU shocks

A comparison of figures 6a-6e with those on the left column of figure 5 indicates that the pattern of the responses to Greek EPU shocks changes over time for all examined variables. In particular, the responses diverge especially in late 2008-early 2009 from the rest of the examined period. The responses also become smoother during the most recent years, when the crisis period is excluded from the sample of the window.

[4] A rolling estimation for a window size less than 21 quarters does not run, due to a lack of degrees of freedom.

Figure 6a shows that the responses of European uncertainty to Greek uncertainty were higher in the first years of the sample and were getting smoother towards the most recent years. Until the beginning of the Greek debt crisis there were high responses in the first quarter after the shock, which would diminish after some quarters, while in last quarter of 2008 and first of 2009 we identify the highest response, and also a very sharp fall 8-10 quarters after the shock, which however are not statistically significant. The responses are statistically significant only for 2-4 quarters after the shock until 2016 and later the statistically significant duration of the responses in longer, lasts even 8-9 quarters, though lower in value.

Figure 7: Rolling Generalised Impulse Responses to European EPU shocks

Comparing the above response to its reverse, meaning the response of the Greek EPU impulse responses to a European uncertainty shock shown on figure 7a, we detect higher values throughout the whole examined period. Responses are higher and statistically significant in the first two quarters after the European EPU shock, and fall afterwards. However, the values of the responses are much higher, reach almost 0.7, while the reverse responses reached only 0.3. But in this case the responses are statistically significant only for 2-3 quarters after the shock throughout the whole period, thus the duration of the shock is not higher during the recent years. We also observe that in last quarter of 2008 and first of 2009 there is a sharp increase of the response after 6 quarters from the shock, instead of a sharp fall, however again it is not statistically significant, as in the reverse response. This comparison is in line with the results of the full sample estimation, corroborating the finding that Greek EPU responses to European EPU shocks are higher than the reverse responses, and does not fall even in recent years.

The stock index impulse responses shown in figure 6b are negative. The highest responses are detected around 2 to 3 quarters after the shock, with the exception of late 2008 and early 2009, when the response is low the first quarter after the shock but increases and reaches its highest value in absolute terms 10 quarters after the shock. Interestingly, in the first quarter of 2009 the responses are statistically significant even 9 quarters after the initial shock. This might be a sign of how much the Greek stock market was negatively affected by the collapse of the Lehman Brothers in October 2008 and the onset of the global financial crisis. In general, the responses of the stock market index to domestic uncertainty shocks were lower before the crisis, while there are high responses in absolute value during the crisis and, in particular, in 2012 to 2014, but this period the duration of the statistically significant response is much shorter (only 3 quarters). The values of the rolling responses of the Greek stock market index to European uncertainty shocks, depicted in figure 7b, are very similar to the responses to domestic uncertainty shocks, however the duration is shorter.

Responses of unemployment to Greek uncertainty shocks are depicted in figure 6c. They are very smooth before the crisis but in late 2008 and early 2009 there is again a sharp increase. During the years of the crisis, until 2017, there are relatively high responses which grow higher some quarters after the shock, while in the last 2 years the responses of unemployment are smoother. The interesting finding which again corroborates the results of the full sample GIRFs is that the responses of unemployment start smoother and gradually increase and they reach high values about 8 quarters after the uncertainty shock. It is also noteworthy that the statistically significant responses last very long during most part of the examined period, as also found in the full-sample analysis. The responses of unemployment to European uncertainty shocks are very similar, as portrayed in figure 7c, however shorter in duration than the responses to Greek EPU shocks.

GDP responses (Figure 6d) follow a pattern very similar to the stock market index. We observe negative responses to domestic uncertainty shocks across all rolling IRFs. It is important to note that an uncertainty shock in the first quarter of 2009 leads to a sharp increase in absolute value in the response after 10 periods, and then comes back to the normal pattern. In the recent post-2016 period, the responses are milder, probably due to excluding the values of the crisis from the sample. Most of the time responses are statistically significant for about 3 quarters after the shock, but after 2015 the duration of the response is much longer, about 8 quarters. The responses of GDP to European uncertainty innovations shown in Figure 7d are very similar throughout the years, with the exception of duration, as they are statistically significant for fewer quarters after the shock, a finding again in line with the full sample estimation.

Finally, Figures 6e and 7e show the rolling impulse responses of Greek ESI to domestic and European uncertainty shocks, respectively. The two figures show a very similar pattern. The responses are very smooth and negative throughout the whole examined period, apart from late 2008 and early 2009, when again there is a sharp increase in absolute value. The highest response is around 2 to 3 quarters after the shock and then it smoothens gradually. The responses are statistically significant for almost up to 5 quarters after the shock, which is in line with the full sample findings. In summary, the reported results indicate that the adverse effects of uncertainty shocks on economic variables have the expected sign and are largest in absolute magnitude when shocks occur in late 2008/early 2009, a time associated with the recent financial crisis.

5. Conclusions

The main subject of this study is the examination of uncertainty spillovers in Europe during the period 2003-2019. We estimate the Diebold-Yilmaz spillover indices (total, directional and net) for several European countries in order to measure total uncertainty spillovers as well as spillovers between country pairs. We obtain the following results. First, there is evidence of considerable transmission of EPU among Eurozone countries. Second, comparing the value of the total spillover index before the crisis and since the start of the crisis, we conclude that the transmission of uncertainty between countries fell following the start of the recent crisis. The finding that own uncertainty contribution increases in all economies after 2010 means that the crisis led to countries becoming more "closed" and mostly affected by domestic events and turbulence. Third, the directional spillover indices reveal that the countries with larger and stronger economies are mainly uncertainty exporters, while those with weaker economies tend to be uncertainty importers. To examine the evolution of these spillovers over time, we estimated the dynamic net volatility spillovers for each country. The findings indicate that before the onset of the crisis, the core countries of the Eurozone, like France and Germany, were the ones transmitting uncertainty shocks to the other Eurozone countries. However, the crisis changed this norm, making periphery countries, like Ireland and Greece, EPU shock exporters during the years of the crisis.

In order to further investigate the magnitude of uncertainty spillovers and the time variation of these spillovers before and during the recent crisis, we examine the case of Greece, the country that suffered the most severe crisis. We compare the impulse responses of Greek macroeconomic variables to both domestic and European EPU shocks using data for the full sample as well as rolling estimations. The results indicate the negative reaction of GDP, stock market index, and the ESI and the positive reaction of unemployment to uncertainty shocks. It is also obvious that the highest responses are detected in the beginning of the crisis.

The value of the responses to domestic and European uncertainty shocks is very similar, however the duration of the response of the economic variables to Greek EPU shocks is longer than the response to European EPU shocks, indicating that the Greek economic variables are affected for a longer term by domestic uncertainty rather than foreign. This result is perhaps anticipated as the Greek EPU index is, especially during the crisis, affected mostly by domestic political and economic events. There is also positive interdependence between Greek and European policy uncertainty, but the results indicate that Greek EPU responses to European EPU shocks are higher than the reverse responses. This finding is in line with the evidence from the spillover analysis, that Greece is mainly importing uncertainty from the Eurozone countries, rather than exporting.

Compliance with Ethical Standards:

Conflict of Interest: Stilianos Fountas declares that he has no conflict of interest. Paraskevi Tzika declares that she has no conflict of interest.

Ethical approval: This article does not contain any studies with animals performed by any of the authors.

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

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Table 1: Generalised conditional spillovers

	France		Germany		Greece		Ireland		Italy		Spain		Netherlands		Contribution from others	
France	50.2	58.1	16.1	18.6	6.1	9.6	2.3	0.8	7.7	8	10.3	3.4	7.3	1.5	49.8	41.9
Germany	13.6	16.7	52.3	62	5.4	7	2.6	0.8	0.5	8.2	15.3	3.5	10.2	1.9	47.7	38
Greece	10.9	16.4	8.2	2.4	56.9	73.1	2.5	0.2	6.8	1.9	2.2	5.4	12.5	0.6	43.1	26.9
Ireland	6.7	5.5	10.2	1.7	3.5	0.4	52.4	89.4	5.9	0.2	12.7	1.7	8.6	1.1	47.6	10.6
Italy	11.7	4.4	2.0	6	11.4	1	5.8	0.3	47.5	62.5	2.5	6.8	19.2	19	52.5	37.5
Spain	15.1	4	22.7	1.1	6.8	3.7	4.3	0.9	1.9	9.8	37.6	66.4	11.6	14.1	62.4	33.6
Netherlands	10.6	1.8	13.3	2.1	8.7	0.7	6.8	1.1	5.9	15.2	5.5	4.5	49.4	74.7	50.6	25.3
Contribution to others	68.6	48.8	72.4	31.9	41.9	22.3	24.4	4	28.7	43.2	48.3	25.2	69.4	38.3	353.8	213.9
Contribution from others	49.8	41.9	47.7	38	43.1	26.9	47.6	10.6	52.5	37.5	62.4	33.6	50.6	25.3	353.8	213.9
Net contribution	18.8	6.9	24.7	-6.1	-1.2	-4.6	-23.2	-6.6	-23.8	5.7	-14.1	-8.4	18.8	13		
Contribution including own	118.7	106.9	124.7	93.9	98.7	95.4	76.9	93.4	76.2	105.8	85.9	91.6	118.8	113	50.5%	30.60%

Notes: For each country, the first column shows the estimate for the period January 2003-December 2009 and the second column includes the estimates for the period January 2010-June 2019. The spillover indices refer to the EPU index of 7 Eurozone countries. A VAR(1) was selected based on the AIC criterion. The variance decomposition to extract the spillover indices was estimated for 10 forecast horizons and a 24-month rolling window. The ij^{th} entry measures the estimated contribution to the forecast error variance of policy uncertainty of country i due to innovations in policy uncertainty to country j. The figures in the rows report the fraction of the forecast error variance the headline country imports from each of the other countries. The figures in the columns report the fraction of the forecast error variance the headline country exports to each of the other countries.

Table 2 Generalised conditional spillovers – robustness

	France		Germany		Greece		Ireland		Italy		Spain		Netherlands		Russia		Sweden		UK		Contribution from others	
France	43.2	42.7	13.4	13.7	4.6	8.4	1.8	0.5	7	6.5	9.3	3.8	5.3	2.8	0.4	0.9	1.3	5	13.7	15.9	56.8	57.3
Germany	11.9	11.7	44.4	43.1	4	5.4	2.6	0.3	0.8	6.3	13.9	3.9	6.1	2.1	0.8	0.3	5	9.2	10.5	17.6	55.6	56.9
Greece	9.5	14.6	7.1	2.5	52.6	63.4	2.2	0.2	6.7	1.5	2.2	4.6	11.2	0.5	2.3	2.2	0.5	6.9	5.8	3.7	47.4	36.6
Ireland	5.5	4.1	7.1	0.9	2.3	0.1	46.1	76	5.6	0.6	10.6	1.2	5.3	1.5	0.7	4	3.6	1.3	13.1	10.4	53.9	24
Italy	10.2	4.7	1.4	6.1	9.6	0.9	5.2	0.3	43.2	58.8	2.3	7	18.3	16.4	2.4	0.3	1.2	3.1	6.1	2.4	56.8	41.2
Spain	12.7	5.2	17.5	1.5	5	3.2	3.9	0.7	2	9.8	32.9	59.4	7.6	12.4	0.4	2.3	4	2.8	13.9	2.5	67.1	40.6
Netherlands	8.2	2.5	7.2	3.4	5.4	0.5	6.5	1.4	6.6	14.2	4.6	3.4	36	67.4	3.7	1.3	8.4	1.1	13.4	4.9	64	
Russia	0.7	0.7	2.3	2	2.9	3.3	2	0.6	2	1.2	0.2	4.2	3.9	1.7	82.2	76.3	2.2	9.3	1.6	0.7	17.8	23.7
Sweden	4.3	4.9	3.3	9.4	0.9	6.7	5.7	0.8	1.7	1.4	4	4.7	5.1	0.4	1.5	0.7	64.6	69.6	8.9	1.4	35.4	23.7
UK	15.1	12.6	11.1	15.3	3.3	3.6	7.2	2.6	4.4	1.4	11.2	0.9	6.9	3.4	0.4	0.6	5.8	3.2	34.6	56.3	65.4	30.4
Contribution to	78.1	61.1	70.4	54.8	38	32.1	37.1	7.4	36.9	43.1	58.5	33.5	69.8	41.2	12.5	12.5	32.1	41.9	87	59.6	520.3	387.2
Contribution	56.8	57.3	55.6	56.9	47.4	36.6	53.9	24	56.8	41.2	67.1	40.6	64		17.8	23.7	35.4	23.7	65.4	30.4	520.3	387.2
Net contribu	21.3	3.8	14.8	-2.1	-9.4	-4.5	-16.8	-16.6	-19.9	1.9	-8.6	-7.1	5.8	8.6	-5.3	-11.2	-3.3	11.5	21.6	15.9		
Contribution	121.3	103.8	114.7	97.9	90.6	95.5	83.2	83.3	80.1	101.8	91.4	92.9	105.8	108.6	94.7	88.7	96.7	111.5	121.5	115.9	52%	38.7%

Notes: For each country, the first column shows the estimate for the period January 2003-December 2009 and the second column includes the estimates for the period January 2010-June 2019. The spillover indices refer to the EPU index of 7 Eurozone countries plus Russia, Sweden and the UK. A VAR(1) was selected based on the AIC criterion. The variance decomposition to extract the spillover indices was estimated for 10 forecast horizons and a 24-month rolling window. The ijth entry measures the estimated contribution to the forecast error variance of policy uncertainty of country i due to innovations in policy uncertainty to country j. The figures in the rows report the fraction of the forecast error variance the headline country imports from each of the other countries. The figures in the columns report the fraction of the forecast error variance the headline country exports to each of the other countries.

Figure 1: EPU indices for the seven Eurozone countries

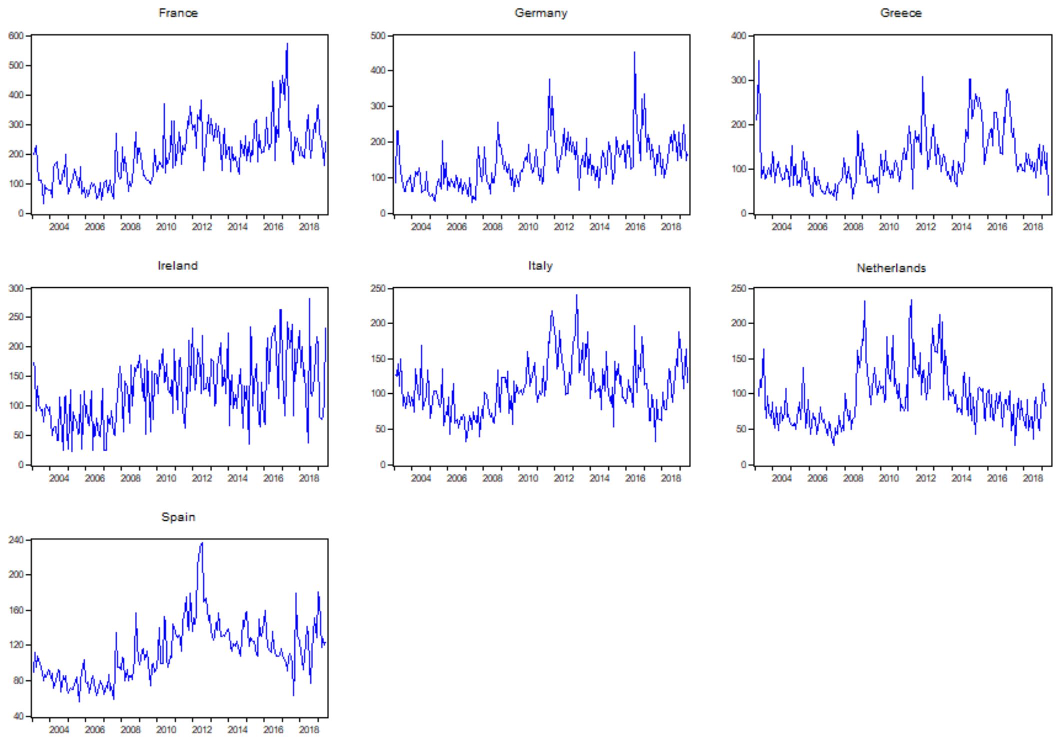
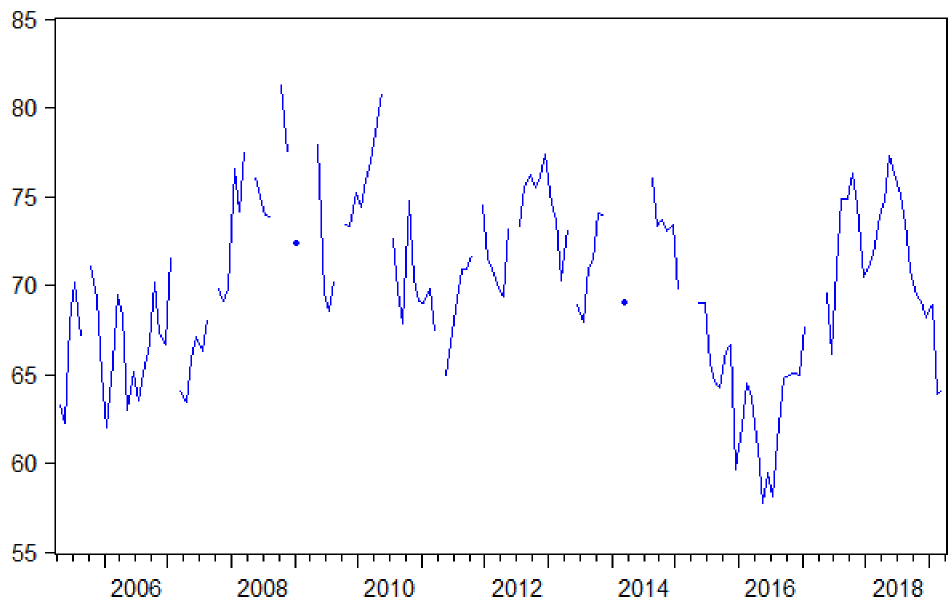


Figure 2: Total connectedness index



Notes: The total spillover plot is derived by the sum of all "contributions to others" from Table 1, estimated using 24-months rolling windows estimation.

Figure 3: Dynamic net volatility spillovers for 7 Eurozone countries

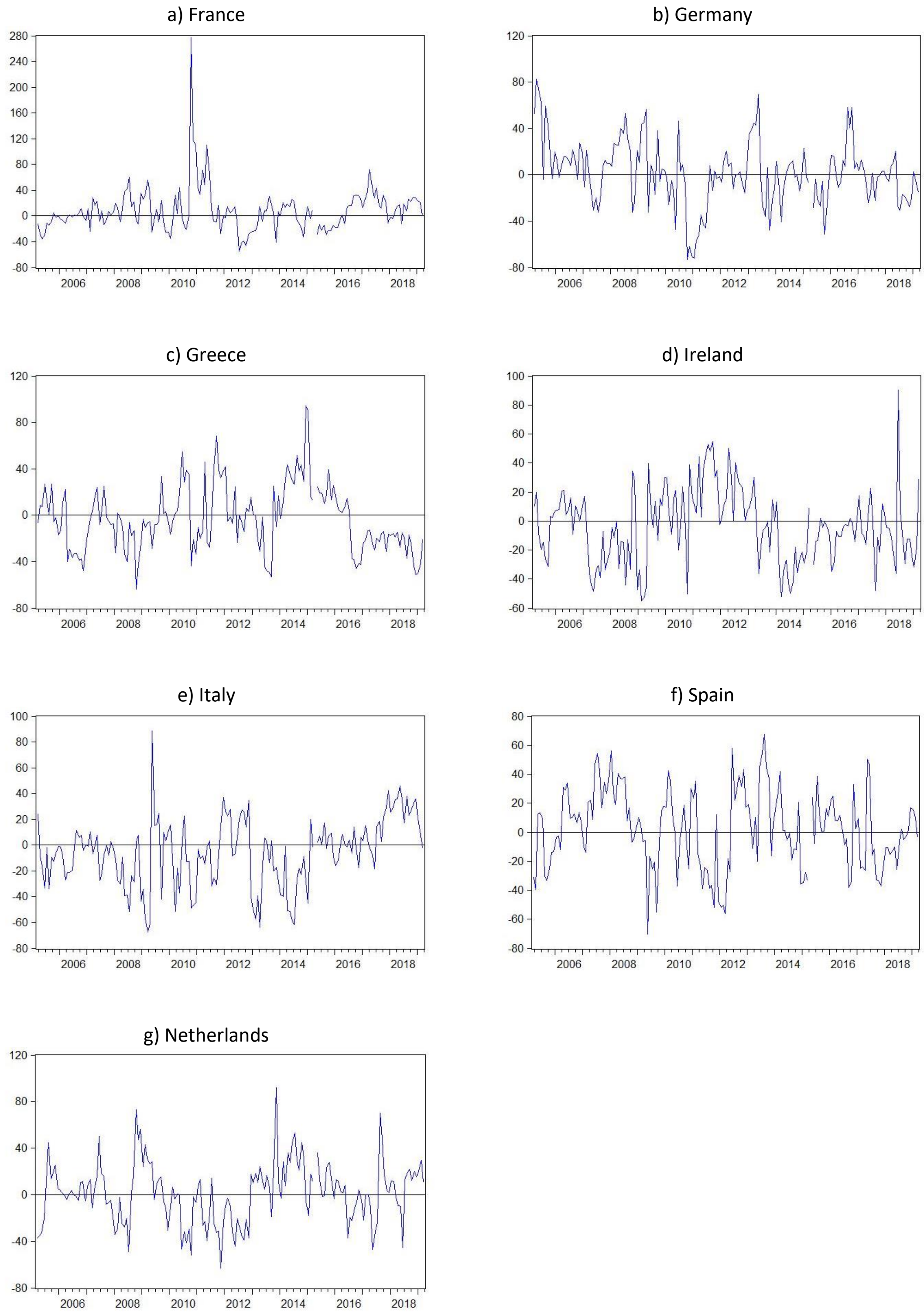
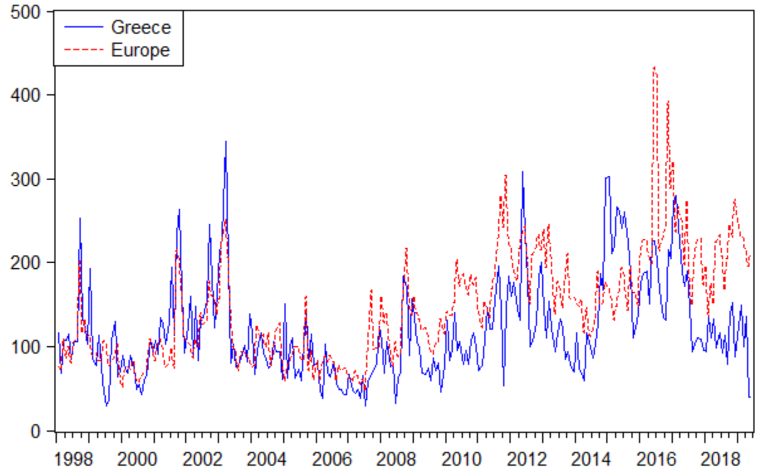
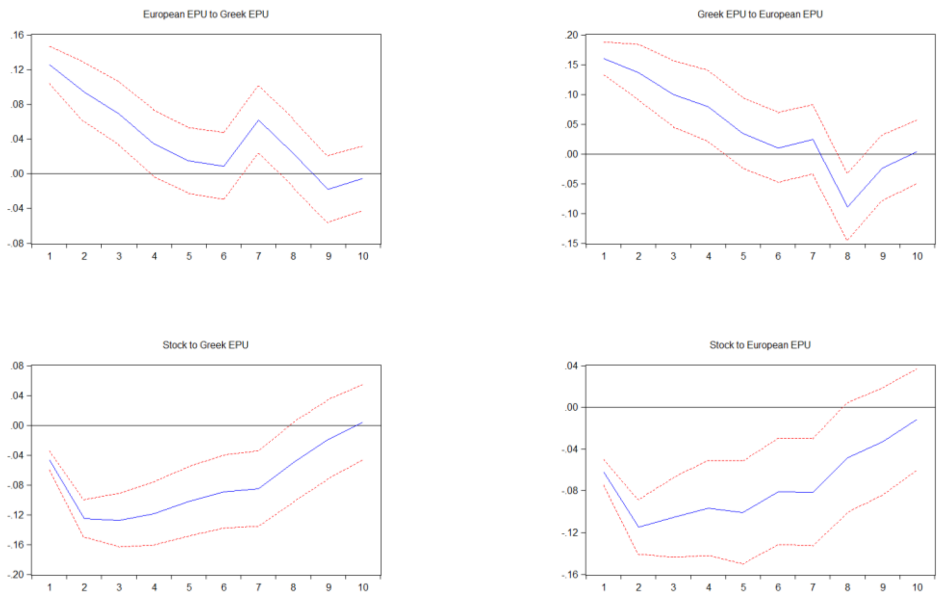


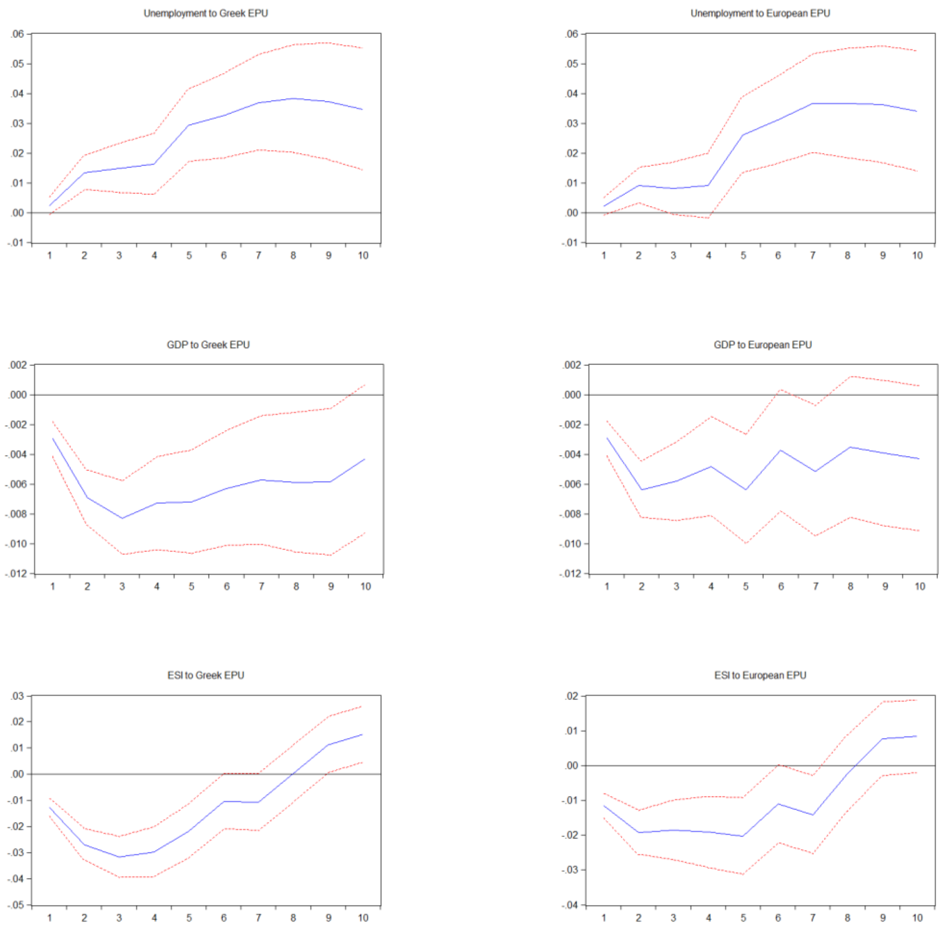
Figure 4: The Greek and European Economic Policy Uncertainty indices



Notes: Monthly data for the two EPU indices, for the period January 1998-June 2019

Figure 5: Generalised Impulse Responses for the full sample

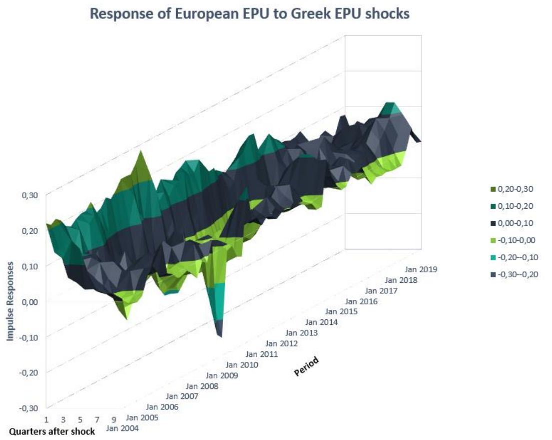




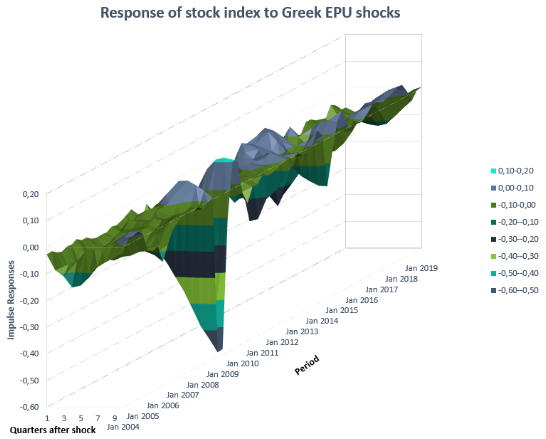
Notes: Generalised Impulse Responses to One S.D. Innovations (± 1 S.E.) in the Greek and European EPU indices. Sample: 1998Q2-2019Q1.

Figure 6: Rolling Generalised Impulse Responses to Greek EPU shocks

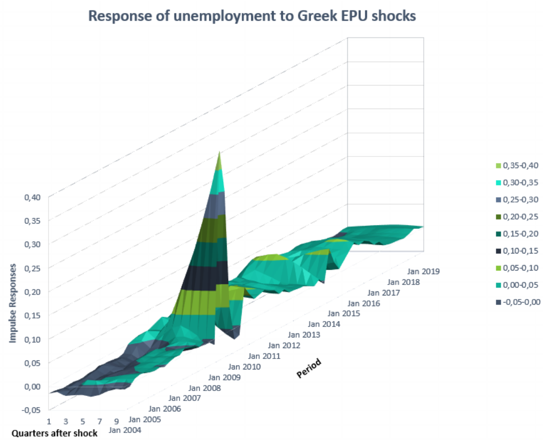
a)



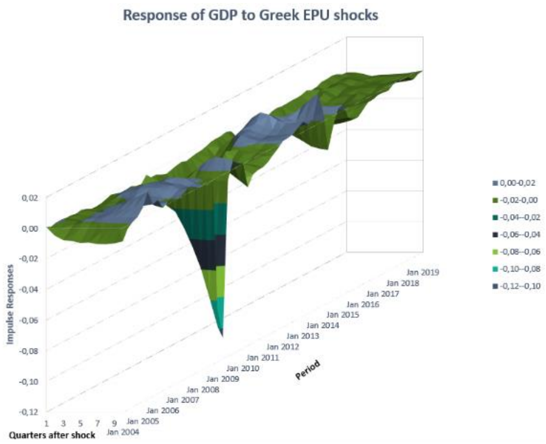
b)



c)



d)



e)

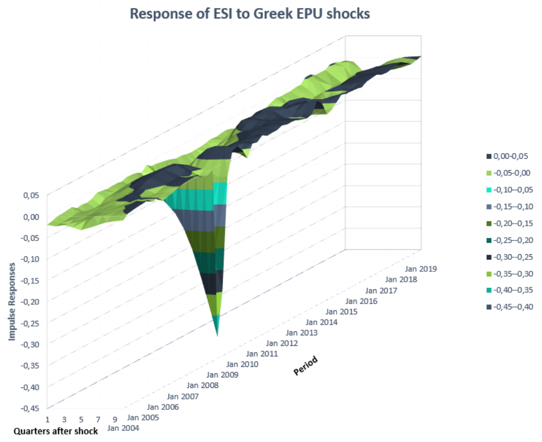
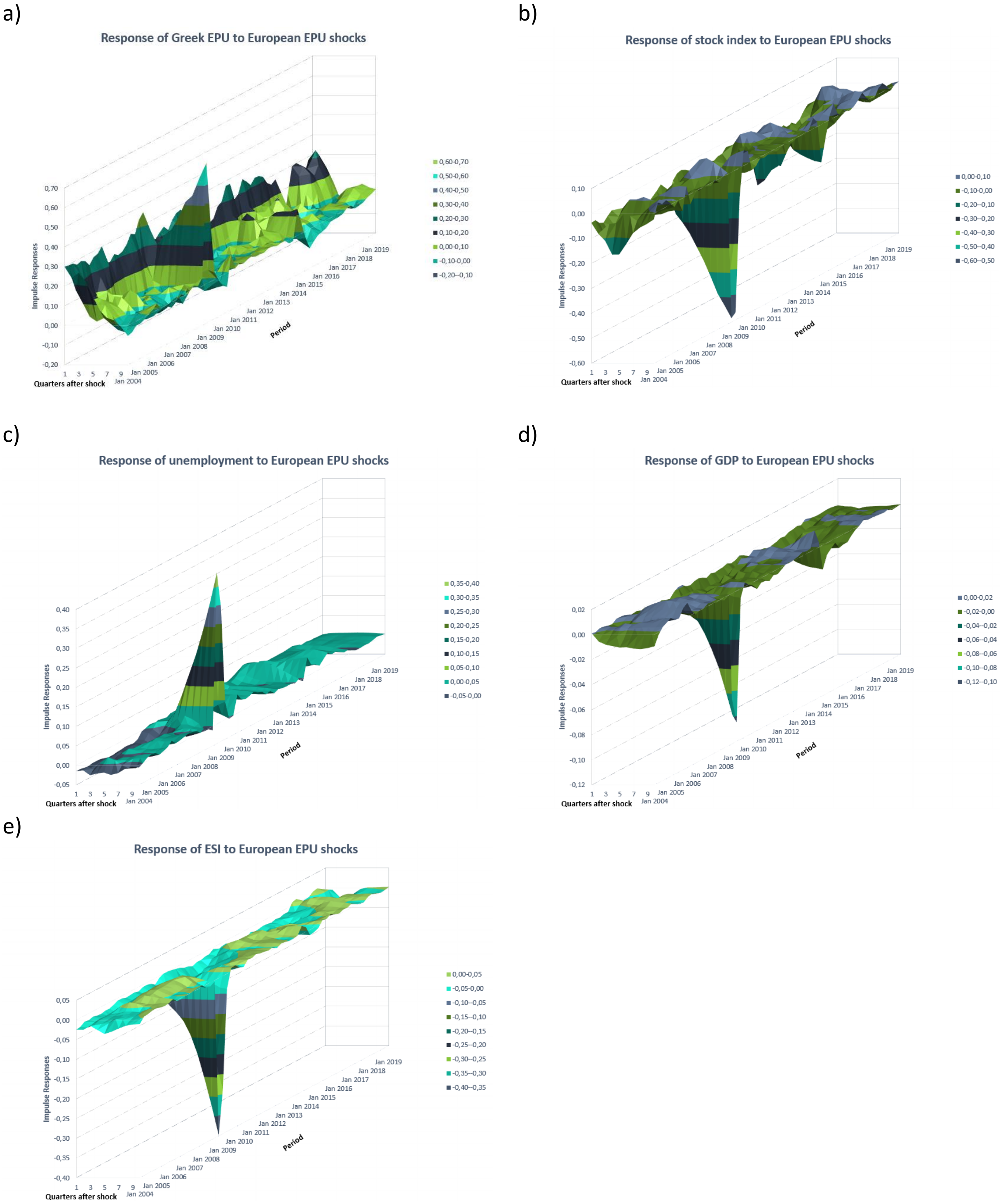


Figure 7: Rolling Generalised Impulse Responses to European EPU shocks



Appendix

Table 3 Descriptive statistics of the EPU indices of 7 Eurozone countries

	FRANCE	GERMANY	GREECE	IRELAND	ITALY	SPAIN	NETHERLANDS
Mean	196.23	139.66	119.78	126.58	109.11	113.07	94.148
Maximum	574.63	454.00	344.23	282.12	241.01	236.58	233.73
Minimum	30.62	28.43	28.63	22.96	31.701	56.27	27.21
Std. Dev.	97.27	66.21	60.28	56.79	38.076	33.05	40.03

table 4 Descriptive statistics of the Greek economic variables

	Greek EPU	European EPU	GDP	stock market index	unemployment	ESI index
Mean	119,96	145,68	51832,83	11253,71	734511,90	98,72
Maximum	51,73	60,55	6080,22	8389,27	325676,70	10,95
Minimum	44,47	60,33	44207,00	1517,48	378000,00	77,97
Std. Dev.	265,75	307,63	63346,00	28831,10	1343000,00	119,97