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Does CDS trading affect risk-taking incentives in managerial compensation?

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ABSTRACT

We find that managers receive more risk-taking incentives in their compensation packages once their firms are referenced by credit default swap (CDS) trading, particularly when institutional ownership is high and when firms are in financial distress. These findings provide suggestive evidence that boards offer pay packages that encourage greater risk taking to take advantage of the reduced creditor monitoring after CDS introduction. Further, we show that the onset of CDS trading attenuates the effect of vega on leverage, consistent with the threat of exacting creditors restraining managerial risk appetite.

JEL classification: G32; G34

Keywords: Credit default swaps; Executive compensation; Risk taking; Leverage

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1. Introduction

Credit default swaps (CDSs) have been credited as one of the most influential and controversial innovations in global financial markets in recent decades.² The presence of CDS facilitates risk sharing and alleviates credit supply frictions (Saretto and Tookes, 2013). However, it also separates creditors' control rights from cash flow rights, giving rise to potential moral hazard problems (Bolton and Oehmke, 2011). The literature has mostly focused on how CDSs affect the creditor–debtor relation and thereby impact corporate financial decisions. Little attention has been devoted to the role of managerial incentives in a firm's transition associated with the onset of CDS trading. This scarcity may seem surprising given that corporate decisions are made by managers who often have their own interests. Our paper helps shed light on this issue.

Managers with undiversified human capital are typically risk-averse (Jensen and Meckling, 1976; Holmström, 1999). Given that CDS trading is associated with tougher renegotiations and a higher probability of bankruptcy (Bolton and Oehmke, 2011; Subrahmanyam et al., 2014), it remains unclear why, after CDS trade initiation, reference firms' managers choose more aggressive financial policies to further increase firm risk, such as the higher leverage documented by Saretto and Tookes (2013). One possible explanation is that these managers are incentivized to increase risk taking through more convex compensation schemes. The convexity here refers to the sensitivity of CEO wealth to stock return volatility, or vega. A higher vega makes risk more valuable to managers, encouraging riskier firm policies (Coles et al., 2006; Chava and Purnanandam, 2010; Gormley et al., 2013). We investigate this possibility.

² A CDS contract is between a protection buyer and a protection seller. The protection buyer pays a premium (commonly referred to as the CDS premium) to the protection seller. In exchange, the protection buyer receives a payment from the protection seller if a credit event (e.g., a credit rating downgrade, restructuring, or bankruptcy) occurs on a reference credit instrument within a predetermined time period. However, while a traditional insurance contract typically offers coverage only for damages incurred by the protection buyer, a CDS contract can be “naked” meaning it provides payment in case of a credit event, even if the protection buyer has no underlying credit exposure (Bolton and Oehmke, 2013).

More precisely, this paper asks whether managers receive more risk-taking incentives in their compensation packages, as measured by vega, once their firms are referenced by CDS trading. Moreover, note that risk-taking behavior is also determined by managerial risk appetite, that is, managers' willingness to take risk with a given level of risk-taking incentives, which could vary as a function of the firm's decision environment. For instance, it could be the case that managers become more reluctant to pursue risky strategies following the onset of CDS trading, despite an increase in incentive provision. To gain a better understanding of the CDS effect on risk-taking behavior, we also investigate whether CDS trading influences managerial risk appetite for a given level of vega.

Considering the existing evidence of more aggressive financial policies in the post-CDS period, we posit that CDS trading is positively related to CEO vega. Our theoretical underpinning is based on the literature examining the effect of CDS on creditors' incentives to engage in costly monitoring. Shareholders have an incentive to expropriate debtholder wealth by shifting to riskier investments, a phenomenon commonly referred to as risk shifting (Fama and Miller, 1972; Jensen and Meckling, 1976). In the context of the traditional creditor–debtor relation, lending institutions, especially banks, continuously monitor borrowers to alleviate moral hazard (Fama, 1985; Diamond, 1991; Rajan, 1992). In particular, lenders scrutinize their borrowers' managerial compensation packages to deter potential risk-shifting behavior, and impose stringent financial covenants and terms to constrain borrowers' compensation policies.³

³ For example, Daniel et al. (2004) show that higher levels of CEO vega are associated with higher bond credit spreads, suggesting that the bond markets understand and account for the effect of incentives on risk taking. Billett et al. (2010) find that bondholders experience negative abnormal returns when firms announce new CEO option grants. Further, Brockman et al. (2010) document a positive relation between CEO vega and short-term debt, implying that creditors adjust debt maturity to restrain managerial risk seeking in response to an increase in CEO vega. In a similar vein, Castro et al. (2016) find that an increase in CEO vega leads to a greater concentration of the firm's debt structure. More concentrated debt structures facilitate creditor monitoring by mitigating free-rider and coordination problems (Diamond, 1991; Sufi, 2007).

CDS availability significantly alters the creditor–debtor relation. Protection from a CDS contract limits the downside exposure of creditors, providing them with greater bargaining power in renegotiation (Bolton and Oehmke, 2011). Accordingly, CDS-protected creditors may find it more efficient to rely on pre-specified credit events to trigger renegotiation or default payment and shift away from costly monitoring (Morrison, 2005; Parlour and Winton, 2013). The reduced creditor monitoring may provide borrowing firms with more opportunities to increase risk-taking incentives in compensation to better align managerial incentives with shareholder interests. In sum, we expect that boards offer pay packages that encourage greater risk taking in response to the post-CDS decline in creditor monitoring intensity.⁴

To test this hypothesis, we exploit variation in the timing of CDS trade initiation and examine whether CEO vega changes around the event. The main finding from this analysis is that the inception of CDS trading on a firm is associated with an increase in the vega of the firm’s CEO, after controlling for standard determinants of managerial incentive compensation. In particular, our baseline regressions include firm and CEO–firm fixed effects to absorb any time-invariant unobserved characteristics at the firm or CEO–firm levels that could affect compensation policies. The positive effect of CDS introduction on vega is also economically significant. For example, in a specification with CEO–firm fixed effects, we find that vega increases by 29.1% following the onset of CDS trading. This finding is not driven by unobserved CEO traits or endogenous CEO–firm matching. Moreover, an

⁴ We acknowledge another possible explanation for why CEO vega would increase after CDS introduction based on managerial risk aversion. CDS-protected creditors can be tougher during debt renegotiation, making borrowers more vulnerable to bankruptcy. Anticipating tougher renegotiation, and taking into account significant personal costs of corporate bankruptcy (Eckbo et al., 2016), CEOs make more conservative operating and investing decisions to avoid defaults and covenant violations once their firms are referenced by CDS trading. For example, CEOs might be more reluctant to invest in risky projects even when those projects have positive net present values. To prevent excessive CEO conservatism at the expense of value maximization, boards may provide additional risk-taking incentives following CDS introduction to offset the potential increase in managerial risk aversion. However, we do not focus on this risk aversion explanation for two reasons. First, risk aversion is largely unobserved, which limits our ability to test this explanation explicitly. Second, this explanation is hard to reconcile with the findings of our split sample analysis based on institutional ownership, although we are careful to recognize that our analysis does not allow us to rule out this alternative explanation.

examination of the timing of the CDS effect suggests that the reference firm adjusts the risk-taking incentives embedded in managerial compensation only *after* the initiation of CDS trading. Thus, the data reveals no contemporaneous or reverse patterns.

A potential concern with the interpretation of our baseline results is that CDS availability is likely to be endogenous. Unobservable factors correlated with both managerial compensation and the selection of firms for CDS trading could bias the results. Alternatively, CDS trading may be initiated when market participants anticipate greater risk taking by managers with convex incentive schemes. We conduct two tests to address these concerns. First, we employ a matching approach and examine the changes in CEO vega from the year before to the years after CDS introduction relative to the changes in a matched sample of non-CDS firms. We find a substantial increase in the vega of reference firms' CEOs near CDS introduction, compared with matched non-CDS firms.

Second, we adopt the instrumental variable (IV) approach and two-stage least squares (2SLS) regression analysis. We use three instrumental variables, initially proposed by Saretto and Tookes (2013) and Subrahmanyam et al. (2014), as a source of exogenous variation in the likelihood of CDS trading: i) the foreign exchange hedging positions of lenders and bond underwriters, ii) the Tier 1 capital ratios of lenders and bond underwriters, and iii) Trade Reporting and Compliance Engine (TRACE) coverage. On the one hand, these instruments are economically sound because they are associated with the overall hedging interest of lenders or credit suppliers. Consistent with this view, we find that they are significant determinants of CDS trading. On the other hand, it also appears that they are uncorrelated with borrowers' managerial compensation policies, except through their impact on CDS market activities. Overall, the results confirm that introducing CDS trading on a firm has a positive effect on the vega of the firm's CEO.

We next explore the heterogeneity in the effect of CDS trade initiation on CEO vega. If the vega effect is associated with creditor monitoring, then the increase in vega following CDS introduction should be more prominent when shareholders have stronger motives to take advantage of the reduced creditor monitoring and to offer pay packages that encourage greater risk taking. We identify two settings where firms' incentives to exploit the opportunity created by the post-CDS decline in creditor scrutiny are likely to be strong. First, prior literature suggests that institutional investors have the ability and incentives to influence CEO compensation decisions (Gillan and Starks, 2000; Hartzell and Starks, 2003; Almazan et al., 2005). Thus, the boards of firms with larger institutional holdings are more likely to act in the interests of shareholders and design managerial compensation packages accordingly. Second, financially distressed firms may have greater risk-shifting incentives, which could manifest in increased convexity in CEO compensation (Eisdorfer, 2008). Consistent with the creditor monitoring view, our results show that the increase in vega is concentrated among borrowers that are financially distressed and those with larger institutional holdings.

Finally, to investigate whether CDS trading has any impact on managerial risk appetite, we examine the effect of CDS introduction on the relation between leverage and vega.⁵ CDS-protected creditors are likely to be more intransigent in renegotiation, triggering bankruptcy that can impose significant personal costs on managers (Bolton and Oehmke, 2011; Subrahmanyam et al., 2014). If, for a given level of risk-taking incentives, managers tend to avoid renegotiation with exacting creditors by making more conservative financial decisions after CDS introduction than before, then we would expect CDSs to reduce the sensitivity of leverage to vega. The results are mainly twofold. First, consistent with prior studies (Coles et al., 2006; Chava and Purnanandam, 2010; Gormley et al., 2013), we generally find that a

⁵ We are particularly interested in firms' capital structures because both vega and CDS trading have been documented to impact leverage (see, e.g., Coles et al., 2006; Saretto and Tookes, 2013; Li and Tang, 2016); in contrast, the predictions on the relation between CDS introduction and corporate investment decisions, and between CDS and firm risk are ambiguous.

higher CEO vega is associated with higher leverage. Second, we show that CDS introduction attenuates the positive relation between vega and leverage, suggesting that CDSs pose a potential threat to managers and thereby restrain their risk taking. Taken together, these findings appear to suggest that, when making leverage decisions, risk-averse managers balance the exacting creditor threat and convex incentive schemes. Their motives to avoid renegotiation with exacting creditors partially offset the increased risk-taking incentives embedded in compensation packages, resulting in a reduced sensitivity of leverage to vega following the onset of CDS trading.

The primary contribution of our study is in providing evidence that CDS trade initiation on a firm's debt influences the firm's managerial compensation policies because it alters contractual parties' payoffs and incentives. In particular, we find that managers receive more risk-taking incentives in their compensation contracts once their firms are referenced by CDS trading. This finding adds to the strand of compensation literature that investigates the design or determination of managerial incentive contracts (Low, 2009; Hayes et al., 2012; Cohen et al., 2013; Gormley et al., 2013).

Our study also helps illuminate how managers balance the increased risk-taking incentives arising from the decreased creditor monitoring and their reduced risk appetite due to the exacting creditor threat when making leverage decisions. The results suggest that, although the initiation of CDS trading on a firm leads to an increase in the vega of the firm's CEO, it also lowers the sensitivity of leverage to vega.

The remainder of the paper is organized as follows. Section 2 describes our sample, model specification, and summary statistics. Section 3 presents our main empirical results regarding the effect of CDS on CEO vega. Section 4 examines the impact of CDS on the relation between vega and firm leverage. Section 5 discusses alternative explanations of the results. Section 6 concludes the paper.

2. Data and empirical specification

2.1. Data

We are interested in the impact of CDS trading on the CEO's incentive contracts. Our starting point to construct the sample is the universe of nonfinancial firms over the period 2002–2014 in the ExecuComp database that provides CEO compensation information.⁶ Year 2002 is the first year that CDS quote data is available from Bloomberg. 2014 is the last year for which we have information on CEO vega. We then expand this information to include CDS quote data from Bloomberg, also used by Saretto and Tookes (2013) and Das et al. (2014). As noted by Saretto and Tookes, Bloomberg quote data captures firms with substantial CDS trading activities and allow for the sufficiently broad dissemination of contractual information to develop an impact. Given the over-the-counter nature of CDS contracts, we use the first CDS trading date in our sample as the CDS introduction date and explore changes in CEO vega following CDS trade initiation.

Moreover, we obtain firm-level financial data from Compustat, stock price information from CRSP, corporate governance variables from RiskMetrics, bank debt information from Capital IQ, and institutional investor ownership data from the Thomson Reuters Form 13F database. All accounting variables are winsorized at the first and 99th percentiles to mitigate the potential impact of outliers. Observations with missing values for the variables employed in the regressions are excluded. The final sample includes firms in the intersection of these databases, consisting of 9,176 firm–year observations for 1,387 unique firms. During the sample period, we identify 132 firms that have CDS trading initiated on their debt and 961 firm-years in which CDS contracts are trading.

⁶ Our main dependent variable, CEO vega, is obtained from Coles et al. (2006), who construct the variable using the ExecuComp data. The data is available at <http://sites.temple.edu/lnaveen/data/>.

2.2. Baseline empirical specification

We use panel regressions to examine the effect of CDS trading. The fully specified baseline empirical model is the following:

$$\ln(1 + Vega)_{i,t} = \alpha + \beta \cdot CDS\ trading_{i,t-1} + \gamma \cdot Control_{i,t-1} + D_i + Industry \cdot year + \varepsilon_{i,t} \quad (1)$$

The dependent variable is the sensitivity of CEO wealth to stock return volatility, or *Vega*, a common measure of managerial risk-taking incentives. Specifically, it is defined as the change in the value of the CEO's wealth due to a 0.01 increase in the annualized standard deviation of the firm's stock return (Coles et al., 2006).

Another plausible measure of risk-taking incentives is CEO option grants, computed as the natural logarithm of one plus option compensation. However, options have ambiguous implications for risk. On the one hand, options increase in value with firm risk. Their convex payoff structure creates an incentive to take risk because managers share in the gains but not all of the losses. On the other hand, options increase the sensitivity of a risk-averse CEO's wealth to the underlying stock price, weakening the CEO's risk-taking incentives (Carpenter, 2000; Ross, 2004). In addition, option compensation increases wealth, which may alter risk tolerance. Together, the overall net effect of option compensation on risk taking is not clear a priori and depends upon the level of CEO wealth, the degree of diversification in a CEO's personal portfolio, and the risk-aversion parameter, among others (Guay, 1999).

By contrast, the effect of vega on risk taking is theoretically unambiguous because vega is a measure of convexity. Increases in vega should increase the convexity of the CEO's wealth-performance relation, leading to more risk taking. Empirically, Coles et al. (2006), Chava and Purnanandam (2010), Armstrong and Vashishtha (2012), and Hayes et al. (2012) all examine the association between vega and risk taking, and find a positive relation.

The focus of this paper is on the convexity of a CEO's personal portfolio and its unambiguous effect on risk taking around CDS introduction, which is different from the theoretically ambiguous net effect of option compensation. Therefore, our main measure of risk-taking incentives is vega. We also use CEO option compensation as an alternative measure. Our finding of the post-CDS increase in risk-taking incentives is robust to this alternative measure, consistent with options being an important source of pay-risk sensitivity.

Following Saretto and Tookes (2013) and Subrahmanyam et al. (2014), our main variable of interest *CDS trading* is an indicator variable that equals one for a CDS firm after the inception of the firm's CDS trading and zero prior to it. This variable allows us to exploit the variation in the timing of CDS introduction to estimate the impact of the availability of CDS contracts on CEO vega.

Control stands for a set of determinants of the CEO's incentive contracts and potential confounders, following the previous literature on the design of CEO incentive compensation (Coles et al., 2006; Low, 2009; Hayes et al., 2012; Custódio et al., 2013; Bakke et al., 2016). First, we control for firm characteristics, including firm size, measured as the natural logarithm of sales ($\ln(\text{Sales})$); profitability, measured as both the return on assets (*ROA*) and stock returns (*Stock return*); growth opportunities, measured as Tobin's q (*Tobin's q*); and firm risk, measured as stock return volatility (*Volatility*); bank-loan dependency, measured as the bank debt indicator (*Bank debt*); and firm financial distress risk, measured as both *Z-score* and *KZ index*. In particular, *Z-score* is constructed based on the Z-score model of Altman (1968), and *KZ index* is an index following the work of Kaplan and Zingales (1997).

Moreover, the CEO characteristics that we control for include age (*Age*), tenure (*Tenure*), an indicator of whether the CEO is female (*Female CEO*), and the level and structure of compensation packages ($\ln(\text{Total pay})$, *Equity mix*, and $\ln(1 + \text{Delta})$). Finally, to account for the potential impact of corporate governance on the design of managerial

compensation, we include the fraction of independent directors on boards (*Board independence*), the fraction of shares owned by institutional investors (*Institutional ownership*), and the entrenchment index (*E Index*) compiled by Bebchuk et al. (2009). Throughout the empirical analysis, the explanatory variables are lagged by one period relative to the dependent variable to alleviate potential endogeneity problems. Appendix A provides detailed variable definitions.

To further mitigate unobserved heterogeneity in our estimates of the effect of *CDS trading* on *vega*, we use a set of fixed effects. First, we include industry–year fixed effects, denoted *Industry · year*. This inclusion ensures that we are comparing CDS and non-CDS firms within the same industry at the same point in time, allowing us to difference away unobserved changes in industry conditions. In addition, we control for firm fixed effects, denoted D_i , to remove unobserved time-invariant differences between CDS and non-CDS firms. In more stringent specifications, we replace firm fixed effects with CEO–firm fixed effects to absorb any unobserved CEO and firm heterogeneity that is fixed during the tenure of a given CEO. Using the latter fixed effects, we can observe within-CEO–firm variation, that is, the change in the vega of the same CEO working for the same firm for multiple years during which the firm initiates CDS trading. This setting increases the likelihood that any difference in CEO vega is due to the onset of CDS trading.

Although we control for a broad set of firm, CEO, and governance characteristics and use a variety of fixed effects, unobserved time-varying factors, such as a major shift in the firm’s corporate strategy, could still be driving our results. To mitigate any remaining endogeneity concerns, we employ two approaches, including a matching analysis and an IV approach, which are discussed in more detail below.

2.3. Descriptive statistics

Insert Table 1 about here

Table 1 presents the descriptive statistics of the variables used in our baseline analysis. The dependent variable *Vega* has a mean value of \$188,925, which is comparable to the reported mean of \$149,453 in Table 1 of Hayes et al. (2012). The mean option compensation is \$1,677,698. In 10.5% of the firm–years, CDS contracts are trading. An average firm in our sample has a sales revenue of \$7.908 billion, a return on assets of 14.1%, a Tobin’s *q* of 1.813, a stock return of 13.8%, stock return volatility of 0.343, a Z-score value of 0.068, a KZ index value of 1.981, institutional ownership of 77.5%, a fraction of independent directors of 75.9%, and an E-index value of 2.567. In addition, 2.6% of the CEOs are female. The average CEO is 56 years old, has a tenure of seven years and a total compensation of \$5.978 million, 66.9% of which is equity-based compensation. The summary statistics for our controls are consistent with those reported by Hayes et al. (2012), Custódio et al. (2013), Fernandes et al. (2013), Bakke et al. (2016).

Insert Table 2 about here

Comparing the CDS and non-CDS samples in Table 2 provides useful insights. Compared to non-CDS firms, CDS firms offer much stronger risk-taking incentives in managerial compensation. On average, CEOs at CDS firms gain \$412,424 when there is a 0.01 increase in the firm’s stock return volatility, more than twice as much as the corresponding gain of \$162,780 for CEOs at non-CDS firms. In addition, the mean option compensation for CEOs at CDS firms is \$2,678,599, whereas it is \$1,560,612 for those at non-CDS firms. Further, CDS firms are larger and show lower performance in terms of Tobin’s *q*.

3. CDS trading and the sensitivity of CEO wealth to firm risk

3.1. Changes in managerial risk-taking incentives and firm leverage around CDS introduction

Before the multivariate regression analysis, we examine the validity of our main hypotheses at the univariate level. We first sort our sample into CDS (treatment) and non-CDS (control) firms and into periods around CDS introduction. Then we compare the main outcome variables, including risk-taking incentive measures and firm leverage, over time and across treatment and control groups. To mitigate any bias introduced by firms self-selecting into CDS and non-CDS status, we match treatment firms to control firms that have similar characteristics.

Specifically, we define the year of CDS trade initiation as event year t and require CDS firms and their potential control firms to have non-missing data on the outcome variables from year $t - 1$ to year $t + 1$ and from year $t - 1$ to year $t + 2$, respectively, depending on the event window used. We construct a control sample of non-CDS firms based on propensity scores one year prior to CDS introduction. Propensity scores are obtained by estimating a logit model of the likelihood of CDS trading where the independent variables include all the control variables in our baseline model, as well as industry and year fixed effects. Each CDS firm is matched to a non-CDS firm with the closest propensity score. To ensure that CDS firms and their matched control firms are sufficiently indistinguishable, we require that the maximum difference between the propensity score of a CDS firm and that of its matched control firm does not exceed 0.01 in absolute value. Eventually, we identify matches for 77 firms with CDS trade initiation during the sample period.⁷

⁷ One potential concern is that if CDS contracts on underlying borrowers are not actively traded upon CDS availability, then the effect of CDS trading would be called into question. To rule out this concern, we compare our sample CDS firms to the Depository Trust & Clearing Corporation (DTCC) universe in terms of CDS trading activity. DTCC is a dataset that contains transaction level data on credit derivatives. Its coverage amounts to 95% of single-name CDSs based on the number of contracts, and 99% of single-name CDSs with respect to notional amounts (See Gehde-Trapp et al., 2015, for a more detailed description of this dataset).

Insert Table 3 about here

We perform a diagnostic test to verify that the treatment and matched control firms are indistinguishable. The results presented in Appendix B suggest that, in the matched sample, the two groups are balanced across observable characteristics and no significant differences remain.

The first four columns of Table 3 present the means and average changes of the two risk-taking incentive measures for the periods around CDS introduction. On average, treatment firms experience increases in CEO vega and option compensation after the onset of CDS trading. By contrast, the average changes for control firms are negative. As a result, the differences in the changes between CDS and matched control firms for both event windows are positive and significant, indicating that the positive effect of CDS trading on risk-taking incentives is likely to be persistent.

The observed decline in pay convexity and option compensation in the post-treatment period for non-CDS firms may reflect the fact that the change in the accounting treatment of stock options following the implementation of the Financial Accounting Standard (FAS) 123R in 2005 has subsequently reduced the attractiveness of options. Under the new regulation, firms are required to expense executive stock options at fair value, which results in a significant cutback in option pay, reducing the sensitivity of CEO wealth to stock return volatility (Hayes et al., 2012; Bakke et al., 2016).⁸ While it is not the focus of this paper to examine how the accounting treatment of stock options affect their use, it does evoke the

Untabulated results suggest that, on average, our sample CDS firms have larger transaction amounts and higher numbers of traded contracts, mitigating the concern about infrequent transactions.

⁸ Prior to the implementation of FAS 123R, firms were allowed to expense stock options at their intrinsic value. Since nearly all firms granted stock options at-the-money, no expenses for option-based compensation were reported on the income statement. FAS 123R required firms to begin expensing option-based compensation at its fair value, thereby eliminating accounting advantages associated with stock options. Consequently, firms significantly reduced their usage of option-based compensation after the adoption of FAS 123R.

importance of using a control sample of non-CDS firms to filter out this time trend in order to draw accurate inferences, which we do.

The remaining columns of Table 3 report the results for book leverage and market leverage. Consistent with Saretto and Tookes (2013), we observe a positive role for CDSs in affecting leverage decisions. The differences in changes between CDS and matched control firms are positive and statistically significant for both the $t - 1$ to $t + 1$ and $t - 1$ to $t + 2$ horizons, suggesting that firms with traded CDS contracts on their debt are able to maintain higher leverage ratios.

3.2. Impact of CDS trading on managerial risk-taking incentives

In Panel A of Table 4, we establish the empirical relation between CDS trading and CEO vega. Columns (1) and (2) present the results of firm and CEO–firm fixed effects models, respectively. In both specifications, the coefficient estimates for *CDS trading* are positive and statistically significant at the 5% level, suggesting that CDS trade initiation has a positive effect on vega.

Insert Table 4 about here

The economic magnitudes are also substantial. For example, the coefficient of *CDS trading* in the CEO–firm fixed effect specification in column (2) of Panel A Table 4 is 0.291, which implies that vega increases by 29.1% following the onset of CDS trading. This result is not driven by unobserved CEO traits, providing additional confidence for a causal interpretation of our findings. Absorbing unobserved CEO heterogeneity also addresses the concern that endogenous CEO–firm matching could bias our results.

Another potential concern about the interpretation of our baseline results pertains to reverse causality: if, observing firms' managerial compensation decisions, creditors initiate

hedging contracts and CDS markets emerge, then our results would be driven by reverse causation. To rule out this possibility, we perform additional empirical analyses to examine the dynamics of the CDS effect. Specifically, we replace *CDS trading* with a set of four dummy variables indicating the year prior to CDS introduction ($CDS\ trading^{-1}$), the year of CDS introduction ($CDS\ trading^0$), the first year after CDS introduction ($CDS\ trading^{+1}$), and two or more years after CDS introduction ($CDS\ trading^{\geq+2}$). If our results are affected by reverse causation, the likelihood of CDS trading might already be correlated with CEO vega before the inception of CDS trading. In that case, we should observe a positive and significant coefficient for $CDS\ trading^{-1}$.

The results in columns (3) and (4) of Panel A alleviate concerns about reverse causation or pre-existing trends since, in both specifications, the coefficients of $CDS\ trading^{-1}$ are insignificant. Interestingly, we find that the coefficient of $CDS\ trading^0$ is also insignificant and the coefficients of both $CDS\ trading^{+1}$ and $CDS\ trading^{\geq+2}$ are positive and statistically significant. These results indicate that it is only one year after the initiation of CDS trading that the positive effect on vega becomes large and significant. Overall, these findings suggest that the observed effect of *CDS trading* on *Vega* does not reflect reverse causation.

In Panel B of Table 4, we repeat the regressions in Panel A using CEO option pay as an alternative measure of risk-taking incentives. We find a positive relation between CEO option pay and the initiation of CDS trading, indicating that CEOs receive more option compensation in the post-CDS period. The patterns in columns (3) and (4) of Panel B suggest that the observed positive relation cannot be explained by reverse causation.

3.3. Robustness checks

We conduct a number of tests to ensure the robustness of our baseline results. First, we find similar results when we remove the 2007–2008 crisis period from our sample. Second,

we exclude firms that had never been referenced by CDS trading from the sample and find qualitatively the same results. Third, we test whether the results are robust to alternative clustering and industry classifications. The regressions in Table 4 include industry–year fixed effects based on the Fama–French 49 industry classifications, with standard errors clustered by firm. We confirm that our findings are robust to the two-digit Standard Industrial Classification (SIC) and the three-digit North American Industry Classification System (NAICS) industry classifications, the exclusion of industry–year fixed effects, clustering by industry and year, and double clustering by industry and year.

Moreover, one might be concerned that the results are driven by the changes in accounting rules imposed by FAS 123R. To the extent that industry–year fixed effects and a control sample of non-CDS firms capture trends in compensation practices and relevant accounting requirements over time, this concern is mitigated. Nevertheless, we reestimate our baseline specifications after limiting the sample to the pre-FAS 123R period (i.e., end the sample period in 2004). The positive CDS effect on vega remains, albeit less significantly so.

3.4. Instrumental variables approach

To address the concern of any remaining time-varying unobserved heterogeneity across firms or CEOs affecting our results, we use the instrumental variables approach to extract the exogenous component of *CDS trading* and use it to explain CEO vega. As sources of exogenous variation, we use three instrumental variables initially proposed by Saretto and Tookes (2013) and Subrahmanyam et al. (2014). First, *Lender FX Hedging* is the average notional amount of foreign exchange derivatives used for hedging purposes, relative to total assets, across the banks that have served as either lenders or bond underwriters for our sample

firms over the previous five years.⁹ Second, *Lender Tier 1 Capital* is the average Tier 1 capital ratios across the banks that have served as either lenders or bond underwriters for our sample firms over the previous five years. We use the Tier 1 capital ratio data from the Compustat bank files to construct this instrument. Third, *TRACE Coverage* is the number of bond issues of a firm that have been covered by TRACE. These instruments should be economically sound because they are associated with the overall hedging interest of lenders or credit suppliers. For example, prior literature suggests that lenders with larger hedging positions are more likely to trade the CDSs of their borrowers (Minton et al., 2009), and that banks with lower capital ratios have greater incentives to hedge the credit risk of their borrowers using CDSs (Subrahmanyam et al., 2014, 2017). In addition, Subrahmanyam et al. (2014) indicate that the likelihood of CDS trading increases after the implementation of TRACE. Meanwhile, the instruments we use are expected to be uncorrelated with CEO vega, except through their impact on CDS trading. As evidence that this condition is likely to hold, we add the instruments to the ordinary least squares (OLS) regressions of vega both separately and together and find that they are not significant.

Insert Table 5 about here

Column (1) of Table 5 presents the results of the first-stage regression, where the dependent variable is *CDS trading*. We add the most stringent set of fixed effects that includes both CEO-firm and industry-year fixed effects. We find that the coefficient estimates for the instruments have the expected sign and are frequently significant. We then conduct two additional tests to verify their validity. First, we test the joint significance of the

⁹ Following Saretto and Tookes (2013) and Subrahmanyam et al. (2014), to construct the variable, we first identify the lenders and bond underwriters for our sample firms based on data from DealScan and Bloomberg. We then supplement this information to include data on the foreign exchange derivative positions of these lenders and bond underwriters, obtained from the bank regulatory data set. In our sample, the mean (standard deviation) of *Lender FX Hedging* is 2.73% (2.41%), which is similar to the 1.85% (1.40%) reported by Saretto and Tookes.

three instruments and find that the values of the F -test are large and highly significant (p -value < 0.001). Second, the p -values for Hansen's (1982) J overidentification test are large (0.896), implying that the hypothesis that the instruments are valid cannot be rejected. Importantly, the second-stage regression results reported in column (2) show that *CDS trading* has a positive and significant impact on *Vega* after accounting for the potential endogeneity of managerial incentive contracts, confirming our prior results in Tables 3 and 4.

3.5. Heterogeneity in the effect of CDS introduction on vega

Our empirical analysis so far suggests a positive effect of CDS introduction on CEO vega. In this section, we explore whether this positive effect varies with the CEO's firm's risk-shifting incentives to shed further light on the mechanism through which CDS trading affects managerial incentive contracts.

Table 6 presents the results. For brevity, we report only the coefficients of *CDS trading*, although the same set of control variables as in Table 4 is included. First, we split the sample based on whether a firm's institutional ownership is above or below the sample median and estimate the vega regressions separately for firms with high and low institutional ownership. The results reported in columns (1) to (4) of Panel A show that the coefficients of *CDS trading* are positive and statistically significant in the high institutional ownership subsample, but insignificant in the low institutional ownership subsample. These findings suggest that the boards of firms with larger institutional holdings tend to act in the interests of shareholders by offering managers greater risk-taking incentives following a decline in creditor monitoring. In addition to the split-sample analysis, we interact *CDS trading* with *Institutional ownership* in columns (5) and (6) based on the whole sample. The coefficient on the interaction term is positive as expected in both specifications, supporting the results of the split-sample analysis (albeit one of them is statistically insignificant).

Insert Table 6 about here

Second, we investigate whether the positive effect of *CDS trading* on vega is more pronounced in financially distressed firms. Eisdorfer (2008) indicates that financially distressed firms have stronger risk-shifting incentives. Thus, the managers of such firms might be motivated, via more convex incentive structures, to take greater risks after a decrease in creditor monitoring, particularly when their firms are closer to financial distress or operating under stringent financial constraints. To test this conjecture, we estimate the vega regressions separately for distressed and non-distressed firms. We use *Z-score*, proposed by Altman (1968), and *KZ index*, proposed by Kaplan and Zingales (1997), to measure the severity of financial distress facing a firm. The lower (higher) the *Z-score* (*KZ index*), the more financially distressed or constrained the firm. The split-sample analysis results in Panels B and C of Table 6 show that, using both measures, the positive effect of *CDS trading* on vega is concentrated on financially distressed firms, consistent with our prediction. Interacting *CDS trading* with the financial distress measures, we find that the coefficient on the interaction term has the expected sign and is frequently significant across specifications, which confirms the split-sample analysis results.

4. Managerial risk appetite and exacting creditors

Next, we examine whether CDS trade initiation mitigates the impact of vega on firm leverage. CDS-protected creditors tend to be tougher in renegotiation, making distressed borrowers more vulnerable to bankruptcy (Bolton and Oehmke, 2011; Subrahmanyam et al., 2014). Given the significant personal costs associated with corporate bankruptcy, risk-averse, rational CEOs may attempt to avoid renegotiation with exacting creditors by making less aggressive capital structure decisions. Therefore, the decline in managerial risk appetite due to the exacting creditor threat could offset the observed increase in risk-taking incentives

embedded in CEO compensation, resulting in a lower sensitivity of leverage to vega after the inception of CDS trading.

Insert Table 7 about here

We test this conjecture by including an interaction term between *CDS trading* and $\ln(1 + Vega)$ in the leverage regressions. Table 7 presents the results. Using both book and market leverage, we find that the coefficients of $CDS\ trading \times \ln(1 + Vega)$ are negative and frequently significant, offsetting the positive baseline effect of vega on leverage. The reduced sensitivity of leverage to vega after CDS introduction suggests that the presence of CDS-induced exacting creditors reduces managerial risk appetite.

5. Alternative explanations and discussion

Another potential channel through which CDS markets may affect managerial risk-taking incentives is by revealing new information about firms. CDS spreads represent more timely and cleaner market information for equity risk premia that are not otherwise revealed (Friewald et al., 2014). If the additional information and thereby greater transparency make equity compensation more desirable, then the informational role of CDS markets could contribute to the observed increase in CEO vega in the post-CDS period. A further prediction is that the positive effect of CDS introduction on vega should be more pronounced for informationally opaque firms where the informational advantage of CDS markets are more important.

To investigate whether the impact of CDS trading on vega varies with the transparency of firms, we consider three proxies for firm transparency: firm size, $\ln(Sales)$, defined as the natural logarithm of sales; *Analyst coverage*, defined as the number of stock analysts; and *Number of segments*, a measure of firm complexity, defined as the number of a firm's

business segments. Informationally opaque firms are those that are smaller, or more complex, or have less analyst coverage. In untabulated tests, we sort firms into *High* and *Low* groups based on the median of each transparency measure and estimate our baseline regressions separately for *High* and *Low* subsamples. We also estimate vega regressions that include an interaction term between *CDS trading* and the transparency measures. Overall, the positive CDS effect is pervasive across firms with different levels of transparency, which contradicts the view that CDS trading and vega are related via the improved information environment following CDS trade initiation.

Several prior studies report evidence that pay convexity increases the firm's cost of capital because creditors understand and account for the effect of incentives on risk-taking (Daniel et al., 2004; Billett et al., 2010; Brockman et al., 2010). If boards are aware that pay-risk incentives in managerial compensation affects cost of capital, then they may factor in this hidden, indirect cost of volatility sensitivity when setting pay, putting downward pressure on incentive provision. Therefore, this effect should work against finding a positive, significant impact of CDS trading on risk-taking incentives, suggesting that our results can be viewed as conservative estimates of the CDS-vega relation.

Nevertheless, we conduct additional analyses and find that our main results are robust to including *High refinancing needs* and its interaction with *CDS trading* as additional controls, and to excluding firms with high refinancing needs. *High refinancing needs* is a dummy variable equals one if *ST3* and *Book leverage* are above the sample median for that fiscal year and zero otherwise, where *ST3* is the book value of the debt maturing within the next 3 years scaled by the book value of total debt. Debt maturity information is obtained from Capital IQ. In addition, we fail to find evidence that the relation between CDS trading and vega varies with firm refinancing needs. If our results are somehow driven by debt governance, then we would expect creditors of firms with high refinancing needs to have

greater impact on the borrowing firm's incentive provision. We do not observe this heterogeneity in the CDS effect in our data.

However, we wish to emphasize that these additional analyses do not allow us to completely rule out alternative interpretations in general. Rather, we argue based on our evidence that the relation between CDS introduction and vega is more consistent with the creditor monitoring explanation.

6. Conclusion

This paper investigates the impact of CDS trade initiation on reference firms' managerial compensation policies. We find significant evidence that the introduction of CDS trading on a firm's debt increases the vega of the firm's CEO. This finding prevails even after we control for the potential endogeneity of the timing of CDS introduction using matching and IV estimation. In the cross-section, we show that the positive CDS effect on vega is stronger when institutional ownership is higher and when firms are in financial distress. These findings imply that boards offer pay packages that encourage greater risk taking to take advantage of the decline in creditor monitoring in the post-CDS period. Finally, we find that the onset of CDS trading attenuates the effect of vega on leverage, consistent with the view that CDS-induced exacting creditors pose a potential threat to managers and restrain their risk taking.

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Table 1
Descriptive statistics

This table presents the summary statistics for the variables used in our baseline analysis. *Vega* is defined as the change in the value of the CEO's wealth due to a 0.01 increase in the annualized standard deviation of the firm's stock return. *Option pay* is the CEO option compensation. *CDS trading* is an indicator variable that equals one for a CDS firm after the inception of the firm's CDS trading and zero prior to it. *Sales* is the sales revenue. *ROA* is earnings before interest and taxes divided by total assets. *Tobin's q* is the sum of total assets plus market value of equity minus book value of equity divided by total assets. *Stock return* is the annual returns over the past year. *Volatility* is the annualized standard deviation of monthly stock return over the past year. *Age* is the age of the CEO in years. *Z-score* is a measure of firm distress risk based on the Z-score model of Altman (1968). *KZ index* is an index of financial constraints proposed by Kaplan and Zingales (1997). *Bank debt* is a dummy variable equals one if the firm has bank debt, and zero otherwise. *Book leverage* is the sum of debt in current liabilities plus long-term debts and divided by total assets. *Market leverage* is the sum of debt in current liabilities plus long-term debts and dividend by firm value, where firm value is defined as book value of total assets plus market value of equity minus book value of common equity. *Tenure* is the number of years as CEO in the current position. *Female CEO* is a dummy variable equal to one if CEO is female, and zero otherwise. *Delta* is defined as the change in the value of the CEO's wealth due to a 1% increase in the firm's stock price. *Total pay* is the total CEO pay, which consists of salary, bonus, restricted stocks, options, long-term incentive plans, and other compensation. *Equity mix* is the CEO equity pay divided by total pay, where equity pay is the sum of restricted stocks and options. *Board independence* is the fraction of independent directors on the board. *Institutional ownership* is the number of shares owned by institutional investors divided by total number of shares outstanding. *E index* is the Bebchuk et al. (2009) entrenchment index.

	Obs.	Mean	Stdev	25%	50%	75%
Vega (thousand \$)	9176	188.925	348.391	22.501	82.202	216.658
Option pay (thousand \$)	9176	1,677.698	3,871.918	0.000	669.843	2,021.816
CDS trading	9176	0.105	0.306	0.000	0.000	0.000
Sales (million \$)	9176	7,907.888	23,519.970	844.082	2,061.625	6,068.784
ROA	9176	0.141	0.074	0.094	0.133	0.181
Tobin's q	9176	1.813	0.914	1.204	1.526	2.104
Stock return	9176	0.138	0.393	-0.097	0.117	0.331
Volatility	9176	0.343	0.184	0.215	0.298	0.422
Z-score	9176	0.068	0.324	0.003	0.005	0.010
KZ index	9176	1.981	3.284	0.455	1.362	2.678
Bank debt	9176	0.739	0.427	1.000	1.000	0.000
Book leverage	9176	0.237	0.150	0.125	0.232	0.334
Market leverage	9176	0.161	0.125	0.066	0.140	0.235
Age	9176	55.900	6.665	51.000	56.000	60.000
Tenure	9176	6.750	6.667	2.000	5.000	9.000
Female CEO	9176	0.026	0.158	0.000	0.000	0.000
Delta (thousand \$)	9176	971.496	8,939.381	100.654	255.437	621.165
Total pay (thousand \$)	9176	5,978.463	6,851.350	2,073.629	4,084.310	7,436.689
Equity mix	9176	0.669	0.242	0.556	0.750	0.850
Board independence	9176	0.759	0.138	0.667	0.778	0.875
Institutional ownership	9176	0.775	0.171	0.672	0.790	0.889
E index	9176	2.567	1.232	2.000	3.000	3.000

Table 2
Univariate analysis

This table compares the means and medians of firm, CEO and governance characteristics for firm-years with CDS contracts and the number of observations is 9178. All variables are defined in Appendix A. t-tests (Wilcoxon-Mann-Whitney tests) are conducted to test for differences in means (medians). ***, ** and * indicate significance at the 1%, 5%, and 10% level, respectively.

	CDS		Non-CDS		Mean	D
	Mean	Median	Mean	Median		
Vega (thousand \$)	412.424	261.039	162.780	73.083	249.644	*
Option pay (thousand \$)	2,678.599	1,753.738	1,560.612	600.545	1,117.987	*
CDS trading	1.000	1.000	0.000	0.000	1.000	*
Sales (million \$)	30,089.320	15,259.000	5,313.078	1,792.400	24,776.242	*
ROA	0.143	0.139	0.140	0.133	0.002	
Tobin's q	1.664	1.459	1.830	1.534	-0.165	*
Stock return	0.133	0.122	0.139	0.116	-0.006	
Volatility	0.284	0.249	0.350	0.304	-0.066	*
Z-score	0.023	0.004	0.073	0.005	-0.050	*
KZ index	2.463	1.722	1.924	1.313	0.538	*
Bank debt	0.758	1.000	0.732	1.000	0.026	
Book leverage	0.271	0.257	0.233	0.227	0.038	*
Market leverage	0.179	0.166	0.159	0.135	0.019	*
Age	56.522	57.000	55.827	56.000	0.695	*
Tenure	5.875	5.000	6.852	5.000	-0.977	*
Female CEO	0.050	0.000	0.023	0.000	0.027	*
Delta (thousand \$)	1,301.375	542.575	932.906	231.313	368.469	
Total pay (thousand \$)	11,555.420	9,830.331	5,326.065	3,709.263	6,229.355	*
Equity mix	0.767	0.844	0.657	0.736	0.110	*
Board independence	0.802	0.833	0.754	0.778	0.048	*
Institutional ownership	0.738	0.760	0.779	0.795	-0.041	*
E index	2.477	2.000	2.577	3.000	-0.101	*

Table 3
Changes in vega and firm leverage around CDS introduction

This table presents univariate analysis of changes in vega and firm leverage before and after CDS introduction (year $t - 1$ to year t) for their matched control firms. The matched sample of non-CDS firms is chosen based on propensity scores obtained from a logit model of the likelihood of CDS trading. $Ln(1+Vega)$ is the natural logarithm of one plus *Vega*, where *Vega* is the change (in thousands of dollars) in firm wealth due to a 0.01 increase in the annualized standard deviation of the firm's stock return. $Ln(1+Option)$ is the natural logarithm of one plus the change in option compensation. *Book leverage* is the sum of debt in current liabilities plus long-term debts and divided by total assets. *Market leverage* is the sum of current liabilities plus long-term debts and divided by firm value, where firm value is defined as book value of total assets plus market value of common equity. We report the differences in changes for the CDS firms relative to their matched control firms with standard errors in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	$Ln(1+Vega)$		$Ln(1+Option)$		<i>Book leverage</i>	
	Treat	Control	Treat	Control	Treat	Control
$t - 1$	5.429	5.147	12.464	11.430	0.267	0.291
t	5.430	4.941	12.581	10.905	0.271	0.284
$t + 1$	5.642	4.807	12.662	9.931	0.267	0.264
$t + 2$	5.586	4.936	12.617	10.144	0.260	0.249
Change from $t - 1$ to $t + 1$	0.212	-0.340	0.198	-1.499	0.001	-0.026
Difference in changes: Treat-Control	0.552***		1.697*		0.027*	
	(0.166)		(0.884)		(0.016)	
Change from $t - 1$ to $t + 2$	0.156	-0.211	0.152	-1.286	-0.006	-0.041
Difference in changes: Treat-Control	0.452***		1.439*		0.035**	
	(0.133)		(0.803)		(0.017)	

Table 4
CDS trading and CEO's incentive contracts

This table examines the impact of the onset of CDS trading on risk-taking incentives in the CEO's compensation packages. The dependent variable for Panel A is the natural logarithm of one plus *Vega*, where *Vega* is the change (in thousands of dollars) in the value of the CEO's wealth due to a 0.01 increase in the annualized standard deviation of the firm's stock return. The dependent variable for Panel B is the natural logarithm of one plus the CEO's option compensation. The main variable of interest *CDS trading* is an indicator variable that equals one for a CDS firm after the inception of the firm's CDS trading and zero prior to it. *CDS trading*⁻¹, *CDS trading*⁰, *CDS trading*⁺¹, and *CDS trading*^{≥+2} are indicator variables for the year prior to, the year of, the first year after, and two or more years after the CDS introduction, respectively. Other variables are defined in Appendix A. Industry-year fixed effects are constructed based on the Fama-French 49-industry classifications. Statistical significance is based on the heteroskedasticity robust firm-clustered standard errors reported in parentheses. ***, **, and * indicate significant at the 1%, 5%, and 10% levels, respectively.

Panel A. CDS trading and CEO vega

	Dependent variable: $\ln(1+Vega)$			
	(1)	(2)	(3)	(4)
CDS trading	0.328** (0.136)	0.291*** (0.110)	—	—
CDS trading ⁻¹	—	—	0.234 (0.195)	0.273 (0.182)
CDS trading ⁰	—	—	0.302 (0.287)	0.401 (0.248)
CDS trading ⁺¹	—	—	0.389 (0.228)	0.519** (0.239)
CDS trading ^{≥+2}	—	—	0.586** (0.285)	0.673*** (0.254)
Ln(Sales)	0.404* (0.218)	0.012 (0.198)	0.409* (0.218)	0.019 (0.198)
ROA	-0.656 (0.438)	-0.439 (0.384)	-0.674 (0.438)	-0.470 (0.384)
Tobin's q	-0.098** (0.047)	-0.063 (0.039)	-0.097** (0.047)	-0.061 (0.039)
Stock return	-0.097** (0.041)	-0.069** (0.035)	-0.097** (0.041)	-0.070** (0.035)
Volatility	0.046 (0.113)	0.083 (0.095)	0.042 (0.113)	0.077 (0.094)
Z-score	-0.023 (0.063)	-0.025 (0.057)	-0.022 (0.063)	-0.025 (0.057)
KZ index	0.002 (0.006)	0.010* (0.005)	0.002 (0.006)	0.010* (0.005)
Bank debt	-0.047 (0.048)	-0.028 (0.041)	-0.048 (0.048)	-0.028 (0.041)
Age	-0.016** (0.006)	-0.015*** (0.005)	-0.016*** (0.006)	-0.015*** (0.005)
Tenure	-0.018** (0.007)	-0.029*** (0.006)	-0.018** (0.008)	-0.029*** (0.006)
Female CEO	-0.182 (0.212)	0.135 (0.157)	-0.186 (0.213)	0.131 (0.157)
Ln(1+Delta)	0.403*** (0.040)	0.292*** (0.035)	0.402*** (0.040)	0.291*** (0.035)
Ln(Total pay)	0.083* (0.047)	0.013 (0.038)	0.084* (0.047)	0.014 (0.038)

Equity mix	0.031 (0.121)	0.044 (0.106)	0.030 (0.121)	0.043 (0.106)
Board independence	0.556** (0.222)	0.339* (0.196)	0.559** (0.222)	0.343* (0.195)
Institutional ownership	-0.082 (0.220)	0.061 (0.185)	-0.082 (0.219)	0.060 (0.185)
E index	0.012 (0.032)	-0.008 (0.027)	0.012 (0.032)	-0.009 (0.027)
Firm FE	Yes	No	Yes	No
CEO-Firm FE	No	Yes	No	Yes
Industry-Year FE	Yes	Yes	Yes	Yes
N	9176	9176	9176	9176
Adjusted R ²	0.202	0.126	0.202	0.127

Panel B. Using an alternative measure of managerial risk-taking incentives

	Dependent variable: $\ln(1+Option)$			
	(1)	(2)	(3)	(4)
CDS trading	1.469** (0.705)	1.347** (0.635)	—	—
CDS trading ⁻¹	—	—	-0.355 (1.011)	-0.449 (1.012)
CDS trading ⁰	—	—	0.668 (1.325)	-0.018 (1.248)
CDS trading ⁺¹	—	—	1.207 (1.228)	1.698* (1.025)
CDS trading ^{≥+2}	—	—	2.098* (1.221)	2.138** (1.068)
All controls	Yes	Yes	Yes	Yes
Firm FE	Yes	No	Yes	No
CEO-Firm FE	No	Yes	No	Yes
Industry-Year FE	Yes	Yes	Yes	Yes
N	8987	8654	8987	8654
Adjusted R ²	0.073	0.081	0.073	0.082

Table 5
Instrumental variables approach

Table 5 presents estimates of the instrumental variables method using two-stage least squares (2SLS) panel regressions. The dependent variable is *CDS trading* and $\ln(1+Vega)$ for the first- and second-stage regressions, respectively. *CDS trading* is an indicator variable that equals one for a CDS firm after the inception of the firm's CDS trading and zero prior to it. $\ln(1+Vega)$ is the natural logarithm of one plus *Vega*, where *Vega* is the change (in thousands of dollars) in the value of the CEO's wealth due to a 0.01 increase in the annualized standard deviation of the firm's stock return. The instrumental variables are as follows. *Lender FX Hedging* is constructed as the average notional amount of foreign exchange derivative contracts used for hedging purposes, relative to total assets, across all banks that have been identified as either leading lenders or bond underwriters for our sample firms over the previous five years. *Lender Tier 1 Capital* is defined as the average of Tier One capital across all banks that have served as either leading syndicate loan lenders or bond underwriters for our sample firms over the previous five years. *TRACE coverage* is defined as the total frequency of a firm's corresponding bond issuance deals that are reported by the TRACE in year t . All other variables are defined in Appendix A. Industry-year effects are constructed based on the Fama-French 49-industry classification. Statistical significance is based on the heteroskedasticity robust firm-clustered standard errors reported in brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	Dependent Variables:	
	<i>CDS trading</i>	$\ln(1+Vega)$
	First stage (1)	Second stage (2)
Lender FX Hedging, z_1	0.180 (0.162)	—
Lender Tier 1 Capital, z_2	-0.637** (0.319)	—
TRACE Coverage, z_3	0.011*** (0.003)	—
CDS trading	—	2.827** (1.326)
Ln(Sales)	0.033 (0.038)	-0.242 (0.278)
ROA	-0.020 (0.079)	-0.065 (0.673)
Tobin's q	-0.008 (0.010)	-0.085 (0.076)
Stock return	0.004 (0.014)	-0.176** (0.070)
Volatility	-0.038 (0.037)	0.226 (0.209)
Z-score	0.004 (0.013)	0.070 (0.101)
KZ index	0.001 (0.001)	0.005 (0.008)
Bank debt	-0.008 (0.010)	-0.014 (0.069)

Age	0.000 (0.001)	-0.034*** (0.010)
Tenure	-0.001 (0.002)	-0.008 (0.011)
Female CEO	-0.017 (0.025)	0.122 (0.275)
Ln(1+Delta)	0.009* (0.005)	0.272*** (0.055)
Ln(Total pay)	-0.002 (0.010)	-0.043 (0.072)
Equity mix	0.031 (0.027)	0.251 (0.196)
Board independence	0.036 (0.060)	0.333 (0.332)
Institutional ownership	-0.137** (0.061)	0.627* (0.363)
E index	-0.003 (0.007)	-0.026 (0.044)
CEO-Firm FE	Yes	Yes
Industry-Year FE	Yes	Yes
N	3765	3765
F-statistics ($z_1=z_2=z_3=0$)	8.890***	—
Hansen's <i>J</i> test <i>p</i> -value	—	0.896

Table 6
Heterogeneity in the effect of CDS introduction on vega

This table presents the heterogeneity in the effect of CDS introduction on CEO vega. The dependent variable is the natural log of CEO wealth. *Vega* is the change (in thousands of dollars) in the value of the CEO's wealth due to a 0.01 increase in the annualized standard deviation of the firm's stock return. Our main variable of interest *CDS trading* is an indicator variable that equals one for a CDS firm after the inception of CDS prior to it. We include the same set of control variables as in Table 4. The coefficient estimates for the control variables are suppressed. We partition the sample based on whether the split variable is above or below the sample median. In addition to the split-sample results from estimating specifications that include interaction terms based on the whole sample. *Institutional ownership* is the percentage of shares held by institutional investors divided by total number of shares outstanding. *Z-score* and *KZ index* are measures of financial distress based on Altman (1968) and Zingales (1997), respectively. *Age* is the age of CEO in years. Industry-year effects are constructed based on the Fama-French industry returns. Statistical significance is based on the heteroskedasticity robust firm-clustered standard errors reported in brackets. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Dependent variable: $\ln(1+Vega)$				
<i>Panel A: Based on institutional ownership</i>				
	High institutional ownership		Low institutional ownership	
	(1)	(2)	(3)	(4)
CDS trading	0.454** (0.176)	0.342* (0.185)	0.328 (0.208)	0.205 (0.152)
CDS trading × Institutional ownership	—	—	—	—
Institutional ownership	-0.520 (0.413)	-0.348 (0.316)	0.758* (0.423)	0.691* (0.356)
All controls	Yes	Yes	Yes	Yes
Firm FE	Yes	No	Yes	No
CEO-Firm FE	No	Yes	No	Yes
Industry-Year FE	Yes	Yes	Yes	Yes
N	4588	4588	4588	4588
Adjusted R ²	0.179	0.159	0.241	0.149

Panel B: Based on Altman Z-score

	High Z-score: Non-distressed		Low Z-score: Distressed	
	(1)	(2)	(3)	(4)
CDS trading	0.200 (0.163)	0.100 (0.125)	0.348** (0.167)	0.503*** (0.168)
CDS trading \times Z-score	—	—	—	—
Z-score	-0.058 (0.071)	-0.039 (0.062)	29.022 (48.493)	1.205 (44.062)
All controls	Yes	Yes	Yes	Yes
Firm FE	Yes	No	Yes	No
CEO-Firm FE	No	Yes	No	Yes
Industry-Year FE	Yes	Yes	Yes	Yes
N	4588	4588	4588	4588
Adjusted R ²	0.132	0.103	0.272	0.189

Panel C: Based on KZ index

	High KZ index: Distressed		Low KZ index: Non-distressed	
	(1)	(2)	(3)	(4)
CDS trading	0.335* (0.186)	0.370*** (0.148)	0.149 (0.228)	0.112 (0.170)
CDS trading \times KZ index	—	—	—	—
KZ index	0.011 (0.012)	0.014 (0.009)	-0.024 (0.029)	-0.010 (0.024)
All controls	Yes	Yes	Yes	Yes
Firm FE	Yes	No	Yes	No
CEO-Firm FE	No	Yes	No	Yes
Industry-Year FE	Yes	Yes	Yes	Yes
N	4588	4588	4588	4588
Adjusted R ²	0.267	0.182	0.135	0.126

Table 7
CDS trading and the relationship between CEO vega and leverage

This table examines whether CDS trading affects the relationship between vega and leverage. The dependent variables are *book leverage* and *market leverage*. The former is defined as the sum of current liability and long-term debt scaled by total assets. The latter is defined as the sum of current liability and long-term debt scaled by firm value, where firm value is the book value of total assets, plus the market value of equity, minus the book value of common equity. *CDS trading* is an indicator variable that equals one for a CDS firm after the inception of the firm's CDS trading and zero prior to it. $\ln(1+Vega)$ is the natural logarithm of one plus *Vega*, where *Vega* is the change (in thousands of dollars) in the value of the CEO's wealth due to a 0.01 increase in the annualized standard deviation of the firm's stock return. The other variables are defined in Appendix A. Industry-year effects are constructed based on the Fama-French 49-industry classification. Statistical significance is based on the heteroskedasticity robust firm-clustered standard errors reported in brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	Dependent variable: <i>Book leverage</i>		Dependent variable: <i>Market leverage</i>	
	(1)	(2)	(3)	(4)
Ln(1+Vega)	0.001 (0.001)	0.002 (0.002)	0.001 (0.001)	0.002* (0.001)
Ln(1+Vega) × CDS trading	-0.006** (0.003)	-0.002 (0.003)	-0.004** (0.002)	-0.003* (0.002)
CDS trading	0.040** (0.019)	0.023 (0.017)	0.023* (0.014)	0.010 (0.013)
Ln(Sales)	0.024 (0.016)	0.014 (0.017)	0.060*** (0.012)	0.060*** (0.013)
ROA	-0.137*** (0.036)	-0.116*** (0.036)	-0.181*** (0.027)	-0.152*** (0.028)
Tobin's q	-0.001 (0.004)	-0.002 (0.005)	-0.014*** (0.003)	-0.013*** (0.003)
Stock return	-0.015*** (0.004)	-0.012*** (0.003)	-0.017*** (0.003)	-0.014*** (0.002)
Volatility	0.013 (0.011)	0.014 (0.010)	0.014 (0.009)	0.012 (0.009)
Z-score	-0.031*** (0.006)	-0.023*** (0.006)	-0.013*** (0.004)	-0.008** (0.003)
KZ index	0.007*** (0.001)	0.005*** (0.001)	0.004*** (0.001)	0.003*** (0.001)
Bank debt	0.009** (0.004)	0.007* (0.004)	0.007** (0.003)	0.005* (0.003)
Age	0.001 (0.001)	0.001 (0.001)	0.001 (0.001)	0.000 (0.000)
Tenure	0.001*** (0.000)	0.001** (0.000)	0.001*** (0.000)	0.001** (0.000)
Female CEO	0.010 (0.018)	-0.009 (0.017)	0.010 (0.011)	0.005 (0.008)
Ln(1+Delta)	-0.003 (0.002)	-0.005** (0.002)	-0.006*** (0.002)	-0.007*** (0.002)
Ln(Total pay)	-0.010** (0.004)	-0.002 (0.004)	-0.004 (0.003)	-0.001 (0.002)

Equity mix	0.016 (0.011)	-0.005 (0.010)	0.004 (0.007)	-0.005 (0.007)
Board independence	-0.026 (0.016)	-0.025 (0.017)	-0.020 (0.012)	-0.015 (0.013)
Institutional ownership	0.009 (0.017)	0.004 (0.018)	0.001 (0.014)	0.001 (0.014)
E index	-0.001 (0.002)	0.001 (0.002)	-0.001 (0.001)	0.001 (0.001)
Firm FE	Yes	No	Yes	No
CEO-Firm FE	No	Yes	No	Yes
Industry-Year FE	Yes	Yes	Yes	Yes
N	9175	9175	9175	9175
Adjusted R ²	0.165	0.156	0.263	0.250

Appendix A. Variable definition

Variables	Description
<u>Main variables</u>	
Ln (1+Vega)	Natural logarithm of one plus CEO vega, where vega is defined as the change in the value of the CEO's wealth due to a 0.01 increase in the annualized standard deviation of the firm's stock return.
Ln (1+Option)	Natural logarithm of one plus the CEO's option compensation.
CDS trading	Dummy variable that equals one for a CDS firm after the inception of CDS trading and zero prior to it.
<u>Firm characteristics</u>	
Ln(Sales)	Natural logarithm of sales.
ROA	Earnings before interest and taxes divided by total assets
Tobin's q	Sum of total assets plus market value of equity minus book value of equity divided by total assets
Stock return	Annual stock returns over the past year.
Volatility	Annualized standard deviation of monthly stock return over the past year
Z-score	A measure of firm distress risk based on the Z-score model of Altman (1968). The Z-score is computed as: $1.2 \times (\text{working capital}/\text{total assets}) + 1.4 \times (\text{retained earnings}/\text{total assets}) + 3.3 \times (\text{earnings before interest and taxes}/\text{total assets}) + 0.999 \times (\text{market value of equity}/\text{book value of liabilities}) + 0.999 \times (\text{net sales}/\text{total assets})$
KZ index	An index of financial constraints based on the work of Kaplan and Zingales (1995). The KZ index is computed as $-1.002 \times \text{Cash flow}/K + 0.283 \times \text{Tobin's } q - 1.315 \times \text{Leverage} - 39.368 \times \text{dividends}/K - 1.315 \times \text{cash holdings}/K$, where <i>Cash flow</i> is the sum of income before extraordinary items and depreciation. <i>K</i> is the book value of year capital defined as net property, plant & equipment. <i>Tobin's Q</i> is computed as the sum of total assets and the market value of equity less the sum of the book value of equity and deferred taxes, all divided by total assets. <i>Leverage</i> is the sum of long-term debt and debt in current liabilities, divided by the sum of long-term debt, short-term debt in current liabilities and total stockholders' equity. <i>Dividends</i> is the sum of common and preferred dividends. <i>Cash holdings</i> is the cash and short-term investments.

Bank debt	A dummy variable that equals one if the firm has bank debt, and zero otherwise.
Book leverage	Sum of debt in current liabilities plus long-term debts and divided by total assets.
Market leverage	Sum of debt in current liabilities plus long-term debts and divided by firm value, where firm value is defined as book value of total assets plus market value of common equity minus book value of common equity.

CEO characteristics

Age	Age of CEO in years.
Tenure	Number of years as CEO in the current position.
Female CEO	A dummy variable that takes a value of one if CEO is female, and zero otherwise.
Ln (1+Delta)	Natural logarithm of one plus CEO delta, where delta is defined as the change in the value of the CEO's wealth due to a 1% increase in the firm's stock price.
Ln (Total pay)	Natural logarithm of CEO total pay, where total pay consists of salary, bonus, restricted stocks, options, long-term incentive plans, and other compensation.
Equity mix	CEO equity pay divided by total pay, where equity pay is the sum of restricted stocks and options.

Corporate governance variables

Board independence	Number of independent directors divided by board size.
Institutional ownership	Number of shares owned by institutional investors divided by total number of shares outstanding.
E index	Entrenchment index based on six antitakeover provisions: staggered board, supermajority requirements for mergers and charter amendments, poison pills, golden parachutes, and supermajority requirements for mergers and charter amendments. The index measures the number of antitakeover provisions in place.

Appendix B

Diagnostic test results for the propensity score matching approach

The table reports the diagnostic test results for the propensity score matching approach employed in Table 3. Specifically, we report the univariate comparisons of firm characteristics between CDS firms and their matched control firms, as well as the corresponding *t*-statistics. *Ln(Sales)* is the natural logarithm of sales. *ROA* is the earnings before interest and taxes divided by total assets. *Tobin's q* is the sum of total assets plus market value of equity minus book value of equity divided by total assets. *Stock return* is the annual returns over the past year. *Volatility* is the annualized standard deviation of monthly stock return over the past year. *Age* is the age of CEO in years. *Tenure* is the number of years as CEO in the current position. *Female CEO* is a dummy variable equal to one if CEO is female, and zero otherwise. *Ln(1+Delta)* is the natural logarithm of one plus *Delta*, where *Delta* is the change (in thousands of dollars) in the value of the CEO's wealth due to a 1% increase in the firm's stock price. *Ln(Total pay)* is the natural logarithm of CEO total compensation. *Equity mix* is CEO equity pay divided by total pay. *Board independence* is the fraction of independent directors on the board. *Institutional ownership* is the number of shares owned by institutional investors divided by total number of shares outstanding. *E index* is the Bebchuk et al. (2009) entrenchment index. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	CDS Firms	Control Firms	Differences	<i>t</i> -statistics
Ln(Sales)	6.948	6.908	0.039	0.427
ROA	0.145	0.145	0.000	0.009
Tobin's q	1.795	1.678	0.117	0.882
Stock return	0.006	-0.004	0.011	0.171
Volatility	0.341	0.379	-0.038	-1.273
Z-score	0.007	0.035	-0.028	-1.445
KZ index	2.642	2.380	0.262	0.477
Bank debt	0.595	0.662	-0.068	-0.847
Age	55.689	56.932	-1.243	-1.145
Tenure	5.795	4.597	1.197	1.221
Female CEO	0.027	0.000	0.027	1.424
Ln(1+Delta)	6.258	6.125	0.133	0.756
Ln(Total pay)	8.687	8.782	-0.095	-0.620
Equity mix	0.640	0.662	-0.022	-0.553
Board independence	0.718	0.722	-0.004	-0.154
Institutional ownership	0.724	0.696	0.028	1.093
E index	2.568	2.446	0.122	0.608

Supporting Documentation
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Results Available From the Author on Request

Table A.1
Section 3.3. Robustness checks

This table presents the results of the robustness checks discussed in Section 3.3 of the paper. The dependent variable is the natural log of the change (in thousands of dollars) in the value of the CEO's wealth due to a 0.01 increase in the annualized standard deviation of the firm's stock returns. The coefficient estimates on *CDS trading* are reported. *CDS trading* is an indicator variable that equals one for a CDS firm after the first CDS trading event and zero prior to it. All regressions include the same set of controls as in Table 4. Industry-year effects based on the Fama-French 49 industry classification are reported, unless otherwise stated. Standard errors are clustered at the firm level unless otherwise stated. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Dependent Variable
	Firm FE
(1) Exclude 2007 and 2008 crisis period from sample	0.312** (0.151)
(2) Exclude firms never been referenced by CDS trading from sample	0.378* (0.219)
(3) Industry-year FE based on the 2-digit SIC industry classification	0.371** (0.151)
(4) Industry-year FE based on the 3-digit NAICS industry classification	0.331** (0.160)
(5) Replace industry-year with year FE	0.234* (0.113)
(6) Cluster by industry	0.328** (0.152)
(7) Cluster by industry and year	0.328** (0.139)

Table A.2
Firm transparency and the relation between CDS introduction and vega

This table examines whether firm transparency affects the relation between CDS introduction and CEO vega. The dependent variable is *Vega*, where *Vega* is the change (in thousands of dollars) in the value of the CEO's wealth due to a 0.01 increase in the annual return. Our main variable of interest *CDS trading* is an indicator variable that equals one for a CDS firm after the inception of the CDS market. We include the same set of control variables as in Table 4. The coefficient estimates for the control variables are suppressed for brevity, based on whether the split variable is above or below the sample median. In addition to the split-sample analysis results, we report specifications that include interaction terms based on the whole sample. *Ln(Sales)* is the natural logarithm of sales. *Analyst coverage of segments* is the number of a firm's business segments. We collect analyst coverage data from the I/B/E/S database and business year effects are constructed based on the Fama-French 49-industry classification. Statistical significance is based on the heteroskedastic errors reported in brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	Dependent variable: $\ln(1 + Vega)$			
<i>Panel A: Based on firm size</i>	Large firm		Small firm	
	(1)	(2)	(3)	(4)
CDS trading	0.461*** (0.169)	0.234* (0.135)	0.622*** (0.215)	0.898** (0.268)
CDS trading \times Ln(Sales)	—	—	—	—
Ln(Sales)	0.238 (0.403)	-0.214 (0.357)	0.595** (0.236)	0.337 (0.248)
All controls	Yes	Yes	Yes	Yes
Firm FE	Yes	No	Yes	No
CEO-Firm FE	No	Yes	No	Yes
Industry-Year FE	Yes	Yes	Yes	Yes
N	4588	4588	4588	4588
Adjusted R ²	0.220	0.135	0.214	0.164

Panel B: Based on analyst coverage

	High analyst coverage		Low analyst coverage	
	(1)	(2)	(3)	(4)
CDS trading	0.406** (0.176)	0.269* (0.145)	0.330* (0.188)	0.576** (0.268)
CDS trading × Analyst coverage	—	—	—	—
Analyst coverage	0.009 (0.010)	0.009 (0.010)	0.015 (0.014)	0.019 (0.014)
All controls	Yes	Yes	Yes	Yes
Firm FE	Yes	No	Yes	No
CEO-Firm FE	No	Yes	No	Yes
Industry-Year FE	Yes	Yes	Yes	Yes
N	4536	4536	4572	4572
Adjusted R ²	0.213	0.149	0.244	0.158

Panel C: Based on the number of segments

	High number of segments		Low number of segments	
	(1)	(2)	(3)	(4)
CDS trading	0.381* (0.208)	0.471*** (0.157)	0.428** (0.209)	0.297 (0.208)
CDS trading × Number of segments	—	—	—	—
Number of segments	0.001 (0.021)	-0.003 (0.020)	0.142* (0.081)	0.102 (0.081)
All controls	Yes	Yes	Yes	Yes
Firm FE	Yes	No	Yes	No
CEO-Firm FE	No	Yes	No	Yes
Industry-Year FE	Yes	Yes	Yes	Yes
N	3677	3677	4388	4388
Adjusted R ²	0.234	0.173	0.191	0.154

Table A.3
Restricting the sample to the pre-FAS 123R period

This table reestimates our baseline regressions after restricting the sample to the pre-FAS 123R period. The dependent variable is the natural logarithm of one plus *Vega*, where *Vega* is the change (in thousands of dollars) in the value of the CEO's wealth due to a 0.01 increase in the annualized standard deviation of the firm's stock return. Our main variable of interest *CDS trading* is an indicator variable that equals one for a CDS firm after the inception of the firm's CDS trading and zero prior to it. We include the same set of control variables as in Table 4. The coefficient estimates for control variables are suppressed for brevity. Industry-year effects are constructed based on the Fama-French 49-industry classification. Statistical significance is based on the heteroskedasticity robust firm-clustered standard errors reported in brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	Dependent variable: $\ln(1+Vega)$	
	(1)	(2)
CDS trading	0.125 (0.110)	0.148** (0.068)
All controls	Yes	Yes
Firm FE	Yes	No
CEO-Firm FE	No	Yes
Industry-Year FE	Yes	Yes
N	1918	1918
Adjusted R ²	0.090	0.116

Table A.4
Firm refinancing needs and the relation between CDS introduction and vega

This table examines whether firm refinancing needs affect the relation between CDS introduction and CEO vega. The dependent variable is $\ln(1 + Vega)$, where $Vega$ is the change (in thousands of dollars) in the value of the CEO's wealth due to a 0.01 increase in the annual return. Our main variable of interest *CDS trading* is an indicator variable that equals one for a CDS firm after the inception of the CDS program. We include the same set of control variables as in Table 4. The coefficient estimates for control variables are suppressed for brevity. Columns (1) and (2) show results for firms with high refinancing needs. In columns (3) and (4), we include *High refinancing needs* and its interaction with *CDS trading* as additional control variables. *High refinancing needs* is a dummy variable equals one if *ST3* and *Book leverage* are above the sample median for that fiscal year and zero otherwise, where *ST3* is a dummy variable equals one if a firm is in the top tercile of *ST3* within the next 3 years scaled by the book value of total debt. We obtain the debt maturity information from Capital IQ. Industry classification is based on the Fama-French 49-industry classification. Statistical significance is based on the heteroskedasticity robust firm-clustered standard errors. Asterisks indicate significance at the 1%, 5%, and 10% level, respectively.

	Dependent variable: $\ln(1 + Vega)$		Control variables
	Excluding firms with high refinancing needs	Excluding firms with high refinancing needs	
	(1)	(2)	
CDS trading	0.209** (0.104)	0.126* (0.074)	0.000
High refinancing needs	—	—	—
CDS trading × High refinancing needs	—	—	—
All controls	Yes	Yes	
Firm FE	Yes	No	
CEO-Firm FE	No	Yes	
Industry-Year FE	Yes	Yes	
N	7054	7054	
Adjusted R ²	0.186	0.134	

Table A.5
Descriptive statistics for CDS trading-activity variables

This table shows a comparison of our CDS sample to the full DTCC universe. *Gross notional* is the weekly gross notional amount of CDS transactions in US dollars. *Number of traded contracts* is the weekly number of traded contracts.

	Gross notional (US dollars)		Number of traded contracts	
	DTCC	Our CDS sample	DTCC	Our CDS sample
Mean	93,412,080	138,701,497	19	28
Median	69,709,111	124,418,974	15	24
Standard deviation	78,916,837	62,222,922	16	13
Minimum	2,000,000	21,950,862	1	4
Maximum	526,097,985	336,023,149	120	68
5 th percentile	17,669,970	59,566,064	4	13
95 th percentile	249,227,640	249,198,823	50	55