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Hyun A. Hong

Ji Woo Ryou
The University of Texas Rio Grande Valley

Anup Srivastava

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Managerial incentives and changes in corporate investments following the inception of credit default swap trade

Hyun A Hong[a], Ji Woo Ryou[b], Anup Srivastava[c]

[a]*University of California, Riverside, School of Business Administration*

[b]*University of Texas Rio Grande Valley, College of Business and Entrepreneurship*

[c]*Dartmouth College, Tuck School of Business*

Abstract: A credit default swap (CDS) enables a lender to hedge its risk exposure on a loan given to reference client. The lender then reduces the monitoring of the client's activities as well as aiding the distressed client. Two contrasting predictions can be made about how the borrower would respond to the altered lender-borrower relationship. (1) The borrower reduces risky investments to lower its vulnerability to financial distress. (2) The borrower pursues volatility-enhancing projects to increase the value of call options built into its shareholder investments. We find that a borrower shifts to a more conservative policy when its managers have low portfolio sensitivity to stock volatility (vega). A borrower with high managerial vega, however, seeks volatility-enhancing projects. Shareholders then increase vega incentives for managers to maintain investments in risky, positive NPV projects at pre CDS levels. This action, however, also results in higher bankruptcy risk. Our study shows a unique interaction between the manager-shareholder and lender-shareholder conflicts arising from CDS inception, which alters the course of the borrower's operating policy.

JEL classification: G32, G33; M41; M48
Keywords: Credit default swap (CDS); Agency conflict; Managerial compensation; Operating risks; Investment policy; Asset substitution; Bankruptcy

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Corresponding author. Anup Srivastava. Email: anup.srivastava@tuck.dartmouth.edu. Tel: 603-646-1097.

1. Introduction

The lender-borrower relationship changes significantly at credit default swap (CDS) inception; that is, when a lender obtains insurance on a loan given to a client via a CDS. The "empty" lender continues to possess all of the legal rights attached to the loan but has little skin left in the game (Hu and Black, 2008; Bolton and Oehmke, 2011). It could refuse debt workouts to the client, who initially borrowed money expecting renegotiation and accommodation in future, tough times (Roberts and Sufi, 2009; Danis, 2016). The increased lender intransigence makes the borrower more vulnerable to bankruptcy (Subrahmanyam, Tang, and Wang, 2014). The lender also reduces the vigilance of the borrower's activities (Martin and Roychowdhury, 2015; Amiram, Beaver, Landsman, and Zhao, 2016). In this study, we examine how the borrower changes its investment activities in response to the altered dynamics of the lender-borrower relationship post–CDS inception.[1]

Upon observing the lender's increased intransigence but reduced monitoring, the borrower can change its investment policies in two contrasting ways. On one hand, it could lower its risky investments because of the lender's more credible threat of foreclosure (Arping, 2014; Augustin, Subrahmanyam, Tang, and Wang, 2014). On the other hand, upon observing the lender's weakened vigilance and monitoring, the borrower could enhance asset volatility to increase the value of call options built into its shareholder investments (Jensen and Meckling, 1976). We do not find economically significant changes in investment policies post–CDS inception. Yet, we observe nuanced patterns after considering the interaction between manager-shareholder and lender-shareholder conflicts arising from CDS inception. The ex post changes in

[1] Anecdotal evidence suggests that firms react upon observing the onset of CDS trading. See "Too big to ignore: Debt derivatives markets are encroaching on corporate finance decisions" in *CFO Magazine*, available at http://www.cfo.com/printable/article.cfm/9821507.

firms' operating policies differ based on the convexity in managerial compensation (vega), a factor that motivates managers to enhance asset volatility consistent with shareholder interests but contrary to lender interests (e.g., Smith and Stulz, 1985; Guay, 1999). Managers with low vega shift to safer investments, nullifying the impact of lender intransigence on bankruptcy risk. Managers with high vega, however, maintain or even enhance risky investments, worsening the heightened bankruptcy risk. We contribute to the literature by showing divergent shifts in borrowers' investment policies depending on the interplay of rival lender, borrower, and shareholder forces post–CDS inception.

The literature provides ex ante opposite predictions about how CDS inception would affect borrower's risk-taking behavior. A theoretical framework by Arping (2014) predicts that lenders would pursue a more conservative operating policy. Having hedged its credit exposure upon CDS inception, an empty lender would not derive the same benefits from the borrower's continuing existence as before. The empty lender might not provide additional loans and refuse out-of-court restructurings when the borrower faces financial distress, thus causing the borrower's suboptimal termination. A lender might even encourage foreclosure when the expected insurance proceeds exceed the amount it can gain from the borrower's restructuring (Pollack, 2013; Subrahmanyam et al., 2014). Consistent with these predictions, Subrahmanyam et al. (2014) find increases in the frequency of borrower bankruptcy post–CDS inception. Faced with a more credible threat of foreclosure, the borrower could initiate actions to lower its vulnerability to financial distress, such as by increasing precautionary cash holdings (Subrahmanyam, Tang, and Wang, 2017). The literature thus predicts that the borrower would reduce investments that may yield large returns yet increase the likelihood of firm failure (risky investments).

A theoretical framework by Jensen and Mecking (1976) on asset substitution provides an opposite prediction. Shareholders prefer to substitute safe assets with more volatile ones. They have a call option built into their investment, because they capture all of the upside in the firm value beyond the face value of debt but have no obligation to meet the deficit when the firm value falls below the money owed to lenders. Asset volatility thus increases the value of equity, even if it leaves the expected value of future cash flow unchanged. Increased volatility, however, adversely impacts the value for lenders by increasing their downside risk. Lenders thus strive to constrain the borrower's risk-seeking behavior through active monitoring and covenants (Fama and Miller, 1972; Jensen and Meckling, 1976; Smith and Warner, 1979; Rajan and Winton, 1995).

However, monitoring and covenant enforcement require costly efforts (Holmstrom and Tirole, 1997; Sufi, 2007; Arentsen, Mauer, Rosenlund, Zhang, and Zhao, 2015). Having hedged its credit exposure upon CDS inception, the empty lender would not derive the same benefit from monitoring as before (Morrison, 2005; Arentsen et al., 2015). At the margin, the lender can start shirking its monitoring responsibility and could impose lesser discipline upon a borrower in the event of a covenant violation (Chakraborty, Chava, and Ganduri, 2015).[2] A borrower would detect the weakening of the lender's vigilance (Martin and Roychowdhury, 2015). It can then take actions that improve shareholder wealth, such as pursuing risky innovation (Chang, Chen, Wang, Zhang, and Zhang, 2017), which were previously constrained by lender monitoring. Thus, the asset substitution problem could worsen post–CDS inception.

[2] In addition, the lender's asset is now assigned the risk of the CDS guarantor instead of that of the borrower (Basel II, page 49, Article 141). The resultant change of the counterparty risk from borrower to CDS writer reduces the lender's regulatory capital requirement, allowing it to expand its loan portfolio (Shan, Tang, and Yan, 2014). Such a portfolio expansion further dilutes the lender's monitoring effort per client.

Given the two ex-ante competing predictions, an empirical question remains whether the borrower pursues more conservative or more risky operating investment policies after the onset of CDS trading. We investigate the changes in corporate investments of 546 firms whose CDSs started trading during the period 1992 to 2014. We consider mergers and acquisitions (M&As) and research and development (R&D) activities as proxies for risky investments, relative to capital expenditures (CAPEX). The motivation comes from studies which find that M&As and R&D are associated with higher risks than are capital investments (Berkovitch and Kim, 1990; Kothari, Laguerre, and Leone, 2002; Shi, 2003; Coles, Daniel, and Naveen, 2006; Acharya and Subramanian, 2009; Acharya, Amihud, and Litov, 2011).[3] In addition, we consider outlays reported in selling, general, and administrative expenses (SG&A) to be volatility enhancing, relative to cost of goods sold (COGS). Prior studies show that SG&A enhances operating leverage, which, in turn, causes asset volatility (Schwert and Strebulaev, 2014; Choi and Richardson, 2016; Enache and Srivastava, 2017). We find a reduction, or no significant change, in the risky investment policy after CDS inception depending on the proxy we employ. We find no shift toward riskier policies or support for the asset substitution idea, on average.

Our competing predictions, based on lenders-shareholder conflict, do not include all forces that affect the corporate investment policy. Our predictions ignore the utility function of managers, a key stakeholder in modern corporations characterized by separation of ownership and control rights (Jensen and Meckling, 1976; Myers, 1977; Harris and Raviv, 1991). In such organizations, the confluence of the triad of lender, shareholder, and managerial interests determines the borrower's investment policy.

[3] Relative to investments in tangible assets, corporate innovation is a highly risky and multi-stage endeavor with unpredictable returns (Holmstrom, 1989). For creditors, the risks of R&D dominates their benefits (Shi 2003)." While no direct evidence exists of debt covenants constraining R&D expenditures, studies show that strong creditor rights are associated with reduced R&D spending (Acharya et al., 2011; Seifert and Gonenc, 2012).

The literature provides strong theoretical and empirical guidance that managerial incentives shape corporate investment policy (e.g., Coles et al., 2006; Armstrong and Vashishtha, 2012). Risk-averse managers' interests could align with as well as deviate from those of risk-neutral shareholders, depending on managers' incentives. Unlike shareholders who diversify their risk by holding a range of equities, managers, with their wealth being concentrated in their own firms, shun firm-specific risks and asset volatility (Coles et al., 2006). The volatility of firm assets generates upside potential but also downside risk, including default on debt obligations. Such adverse events impose a range of costs on managers, such as the likelihood of forced termination, the loss of labor market capital, and the devaluation of firm-specific investments, that diversified shareholders do not face (Eckbo, Thorburn, and Wang, 2016). Managers thus lose more than diversified shareholders with the adverse outcomes of asset volatility. With respect to pursuing volatility enhancing projects, thus, managers' interests align with those of lenders but differ from shareholders.

Shareholders reduce conflicts with managers and encourage them to pursue risky but positive net present value (NPV) projects by giving them stock options. The sensitivity of stock options' payoff to stock return volatility, or vega, motivates managers to enhance asset volatility, consistent with the call option feature built into shareholders' equity investments (Smith and Stulz, 1985; Milgrom and Roberts, 1992). As a result, vega is associated positively with risky investments and volatilities of stock price and operating profits (Guay, 1999; Core and Guay, 2002; Coles et al., 2006; Rajgopal and Shevlin, 2002; Armstrong and Vashishtha, 2012).[4] High vega managers may hence consider the reduced lender vigilance post–CDS inception as an

[4] Other components of managerial compensation could make managers more risk averse by magnifying their exposure to firm risk (John and John, 1993; Knopf, Nam, and Thornton, 2002). We control for total compensation in all our tests.

opportunity to enhance asset volatility and increase their vega payoffs. Vega, on one hand, makes managers act consistent with shareholder interests, on the other hand, makes managers act contrary to lender interests, causing higher risk premiums and shorter term structures of debt (Daniel, Martin, and Naveen, 2004; Brockman, Martin, and Unlu, 2010).

We find that managerial vega plays a pivotal role in investment policy becoming more conservative or more aggressive post–CDS inception. Using all three proxies of risky investments, we find that firms with low vega managers pursue less risky investments after the onset of CDS trading. Those firms decrease R&D relative to CAPEX, decrease SG&A relative to COGS, and conduct less frequent mergers and acquisitions post–CDS inception. Thus, the prediction of Arping (2014) on firms' post–CDS behavior holds most strongly for managers who have little to gain from increased asset volatility but stand most to lose from resulting financial distress. Furthermore, low vega firms do not experience any increase in bankruptcy likelihood post–CDS inception, indicating that their managers counterbalance the vulnerability created by enhanced lender inflexibility by reducing operating risks.[5]

In contrast, the greater the managerial vega, the higher the increase in R&D and SG&A outlays and the more frequent the mergers and acquisitions and bankruptcies post–CDS inception. High vega managers enhance risky investment or they do not reduce them enough to counterbalance the increased lenders' intransigence, intensifying the bankruptcy risk. Thus, we show that the finding of Subrahmanyam et al. (2014), of increase in bankruptcy risk post–CDS inception, holds only special cases of high vega firms.

[5] Our findings are similar to Low (2009), who shows that an exogenous shock, because of a new regulation on takeover provisions, causes firms to reduce risky investments. However, this shift is concentrated among firms with low managerial vega.

If the previous levels of risky projects with positive net present value were optimal for shareholders, then low vega managers would deviate from optimal levels post–CDS inception fearing increased foreclosure risk. CDS inception, thus, could increase manager-shareholder conflicts. Shareholders could minimize these deviations by altering the managerial compensation structure. We find, consistent with this proposition, an approximately 20% increase in managerial vega post–CDS inception.[6]

Even though a third party initiates CDS trading, CDS inception is not a random event, and it is determined by supply of and demand for CDS contracts to speculate on or hedge a reference firm's credit risk. Omitted factors affecting demand or supply can also affect firm's investment and compensation policy. We address this potential endogeneity problem (Ashcraft and Santos, 2009) by conducting all our tests using a difference-in-differences approach before and after CDS inception relative to propensity score matched non-CDS firms. [Subrahmanyam et al. (2014) and Martin and Roychowdhury (2015) use the same approach.] In addition, we use a three-stage least squares method (3SLS) to address the joint determination of vega, CDS inception, and investment policy and to address the concern of omitted correlated variables (e.g., Zellner and Theil, 1962; Martin and Roychowdhury, 2015). To strengthen our identification strategy with respect to reduced lender monitoring, we identify banks that are likely to have hedged their exposure upon CDS inception (Minton, Stulz, and Williamson, 2009; Subrahmanyam et al., 2014). Our results either are stronger or hold only for the subsample of borrowers associated with such lenders.

Our paper is related to a contemporaneous working paper (Bartram, Conrad, Lee, and Subrahmanyam, 2017) that finds a decrease in risky investments post–CDS inception in an

[6] In a work subsequent to ours, Lee, Oh, and Yermack (2017) analytically establish reasons for expecting increase in vega after the onset of CDS trading.

examination of varying creditor rights across countries. Our paper is also associated with Chang et al. (2017), who find an increase in innovation output post–CDS inception. Neither paper considers managers' incentives. Our study reconciles the seemingly opposite results of these two papers by emphasizing the critical role of managers' incentives in post–CDS investment policy changes.

Overall, we make two contributions to the literature. First, we show nuanced patterns of changes in borrowers' investment policy, following CDS inception, depending on the managerial incentives. Low vega managers pursue more conservative policies post–CDS inception. These changes negate the effect of increased lender intransigence on corporate bankruptcy risk. High vega managers behave in an opposite manner, worsening the heightened bankruptcy risk. Shareholders, nevertheless, increase managerial vega to motivate managers to maintain risky, positive NPV projects post–CDS inception. Our study, therefore, presents a fuller picture of shifts in rival lender, shareholder, and managerial forces that shape borrower's investment policies post–CDS inception, than has been considered in prior literature. Ours is a unique study examining the interaction between manager-shareholder and lender-shareholder conflicts arising from CDS inception. As such, we respond to the Stulz (2010) and Augustin et al. (2014) call for a thorough examination of corporate policy changes upon CDS inception. Second, we stipulate high managerial vega as an additional condition, and risky operating investments as an addition factor, for the increased bankruptcy risk following CDS inception.

2. Literature review and motivation of hypothesis.

The creation of CDS contracts is credited to J.P. Morgan, which sold the credit risk of Exxon Corporation in 1994 (Tett, 2009). Initially, CDS contracts were used to hedge the credit risk of bank loans. After the International Swaps and Derivatives Association (ISDA) standardized CDS contracts, other participants such as hedge funds and asset managers entered the CDS market. The notional amount of outstanding CDS contracts peaked at $62.2 trillion by the end of 2007. After the financial crisis of 2008–2009, the notional amount declined, but it remains at the double-digit trillion-dollar level (ISDA 2013).

Third parties initiate CDS trades, which offers the lender an opportunity to change its counterparty risk to one based on a more creditworthy CDS writer. Because CDSs can be written on any credit event, such as a default of interest or principal payment or a violation of a debt covenant, a lender can buy at least some insurance on its credit risk even if the CDS is not written on its original asset. Buying credit risk protection and transferring risk to a more creditworthy party, partially or fully, separates the creditor's control rights from its cash flow rights (Hu and Black, 2008; Bolton and Oehmke, 2011). Whether and how the altered debtor-creditor relation affects the borrower's corporate investment policies remains largely unexamined, in spite of prior research documenting a range of economic consequences of CDS contracts.[7]

We formulate ex ante two opposing predictions on whether the borrower would pursue a more risky or more conservative operating investment policy upon CDS inception. Both predictions come from the empty lender argument. First, an empty lender would have a reduced interest in the continuation of the debtor, would be less flexible in negotiations upon any credit event, would be less willing to provide additional loans to the borrower to ride out its temporary liquidity problems, and could push the borrower into inefficient bankruptcy or liquidation.

[7] Bartram et al. (2017) examine the joint impact of creditor rights and CDS trades on a country's financing and investment policies. Our paper differs from theirs because they investigate the effects of variations in creditor rights. They create a unique set of covariates to control for factors that determine corporate investment policy, arguably because of lack of data on foreign companies (see their Table 6). Data availability might also constrain them from addressing the endogeneity issues related to CDS inception, a universal feature of published papers examining the consequences of CDS inception.

Consistent with this idea, Subrahmanyam et al. (2014) find increases in bankruptcy risk after CDS trade inception. Faced with a more credible threat of foreclosure, the borrower would avoid actions that increase the likelihood of a credit event. It might reduce investments that have higher potential payoffs but also a higher likelihood of failure, relative to investments that provide more predictable returns. Additional motivation for this idea comes from Li and Tang (2016) and Subrahmanyam et al. (2017), who find that borrowers and their supply chain partners pursue more conservative cash holding and financing policies, respectively, post–CDS inception.

Second, lenders continue to bear monitoring responsibilities but do not retain the same incentives to ensure a timely repayment of loans. An empty lender is then less likely to continuously monitor clients' activities to protect the value of its claim (Morrison, 2005; Ashcraft and Santos, 2009; Subrahmanyam et al., 2014; Martin and Roychowdhury, 2015). Thus, the lender can reduce its costly monitoring and vigilance efforts with respect to the original borrower because these efforts provide no additional returns.[8] Furthermore, such efforts would be spread over a larger number of clients. This is because the change of the counterparty risk from borrower to CDS writer reduces the lender's regulatory capital requirement, allowing it to expand its loan portfolio (Shan, Tang, and Yan, 2014). The diluted vigilance on the part of the lender likely permits the original client to increase the operating activities that benefit other claim holders in the company but were previously constrained by lenders (Campello and Matta, 2012). For example, if rival lender and shareholder forces determine the corporate investment policies, then equilibrium would shift toward shareholder interests.

[8] Similar concerns arise when the lender subsequently sells (securitizes) the loan, but, then, the buyer of the loan assumes the monitoring responsibilities. Agency conflicts arguably are stronger in the presence of CDSs because banks obtain protection against their risk exposure without transferring control rights (Parlour and Winton, 2013).

In general, the value of residual claim holders can be viewed as a European call option on the firm's assets with the face value of debt being the strike price. Shareholders keep all of the upside in firm value beyond the face value of debt but, given their limited liability, do not have to compensate lenders when the firm value declines below the face value of debt. Hence, asset volatility improves the value of equity, even if it leaves the expected value of the firm's future cash flow unchanged. Shareholders thus have a strong incentive to increase asset volatility.

Meanwhile, asset volatility adversely impacts the value for creditors. For example, creditors suffer large losses when the firm fails. Lenders, which stand to lose when a firm shifts from safe to risky assets, attempt to prevent such action through covenants and active monitoring (Fama and Miller, 1972; Jensen and Meckling, 1976; Smith and Warner, 1979). Any decline in lender monitoring could shift the equilibrium from lender-shareholder forces toward shareholder preference, that is, toward higher asset volatility (Campello and Matta, 2012). Thus, the asset substitution argument implies that shareholders would shift toward riskier investment policies upon CDS inception, all else held equal. Consistent with this idea, Chang et al. (2017) find increase in corporate innovation post CDS inception.

We test these competing predictions concerning shifts in borrowers' investment policy post–CDS inception, in H1, stated as a null hypothesis.

H1. Borrowers do not change the nature of their operating investments upon CDS inception.

Discussion to motivate H1, which is based on the shareholder-lender relationship, ignores the interests of managers, a key stakeholder in modern corporations. The literature provides strong theoretical and empirical guidance that managers' incentives and executive compensation structure shape corporate investment policies. Managers directly control firms' daily operations.

Their interests with respect to investment policies could align with as well as differ from those of shareholders and lenders, depending on their compensation structures (Jensen and Mecking, 1976; Harris and Raviv, 1991).

Unlike for shareholders, who can easily diversify their firm-specific risks, managers' monetary capital and human capital are disproportionately invested in their firms (Aggarwal and Samwick, 1999). Managers can neither sell their stock options nor easily hedge the risks of decline in their stock and options' in-the-money values related to fluctuations in their own firms' stock prices.[9] Therefore, unlike for diversified investors, whose estimated option value increases with volatility, managers' utility from holding stock and in-the-money options can decline with stock price volatility (Pratt, 1964; Arrow, 1965; Carpenter, 2000). Managers holding a large amount of firm stock and in-the-money stock options can become highly risk averse (Lambert, Larcker, and Verrecchia, 1991; Wiseman and Gomez-Mejia, 1998). Furthermore, a credit default event or a corporate failure more adversely impacts managers than diversified shareholders and increases the likelihood of forced termination, the loss of labor market capital, and the devaluation of firm-specific investments (Eckbo et al., 2016). Therefore, managers would not increase firm risks post–CDS inception even when the equilibrium from rival lender-shareholder forces shifts in a manner permitting enhanced volatility.

At times, managers' interests could align with the volatility-enhancing interests of shareholders depending on their compensation incentives. When managers hold compensation packages with convex payoffs, that is, when their wealth increases with asset volatility sufficient enough to make up for their nondiversifiability of firm risks, they might increase firm risks.

[9] Managers are not permitted to take short positions in firm securities against their option holdings [Section 16(c) of the Securities and Exchange Act of 1934]. See Bettis, Bizjak, and Kalpathy (2015) for avenues available to managers for hedging their risks.

Numerous studies provide evidence for this proposition. Guay (1999) shows that stock return volatility is positively related to managerial vega. Rajgopal and Shevlin (2002) find that executive stock options induce oil and gas firm managers to invest in risky projects. Coles et al. (2006) conclude that firms with high managerial vega implement riskier policy choices, including higher investment in R&D and lower investment in capital expenditure. The proposition is also supported by studies that examine firms with low or even negative vega. Low (2009) finds that an exogenous increase in takeover protection in Delaware during the mid-1990s lowers firms' risky initiatives. However, this risk reduction is concentrated among firms with low managerial vega. Cassell, Huang, Sanchez, and Stuart (2012) show that managers with large inside debt holdings (indicative of negative vega) prefer less risky investment policies.

Therefore, changes in firms' investment policies post–CDS inception should be related to managerial vega. We state H2.

H2. Increase (decrease) in risky investments upon CDS inception occurs to a greater (lesser) extent for managers with high vega.

Increases in operating risks post–CDS inception, to the extent facilitated by managers' vega incentives, should increase bankruptcy risk by enhancing the likelihood of both large payoff and drastic failure. We thus propose an additional explanation for the increases in bankruptcy risk post–CDS inception.

H3. Increases in bankruptcy risk after CDS trade inception are positively associated with managers' vega.

3. Sample selection and descriptive statistics

In this section, we describe the selection of sample and control firms and discuss their key statistics.

3.1. Selection of CDS firms

We collect data from the Markit database, which covers CDS quotes of U.S. firms starting in 2001. Markit verifies its CDS data through a multistage scrubbing procedure that includes evaluating the legal relation between a reference entity and a reference obligation as well as corporate actions, CDS succession events, and credit events. We gather data on chief executive officer (CEO) compensation from Standard & Poor's (S&P) ExecuComp database. ExecuComp provides current and historical information on executive stock and option awards, pension plans, and executive compensation, and it covers the top five executive officers of more than 3,300 companies from 1992 onward. We collect financial and stock price data from Compustat North America and the Center for Research in Security Prices (CRSP), respectively. We merge the Markit data with information from ExecuComp, Compustat North America, and CRSP using the ticker, and by manually cross-validating the match between these data sets based on company names. We identify 546 U.S. firms that initiated trading on single-name CDS contracts during the sample period from 1992 to 2014.

3.2. Selection of control firms

The onset of CDS trading is arguably not an exogenous occurrence. For example, factors such as firms' credit risk and growth opportunities that affect the demand for and the supply of CDS contracts (Ashcraft and Santos, 2009) could also affect managerial compensation. We follow the extant literature to address this potential endogeneity issue. We employ a propensity score matching approach (Ashcraft and Santos, 2009; Martin and Roychowdhury, 2015), which identifies pairs of treatment and control firms based on similarity of observable firm characteristics (Dehejia and Wahba, 2002). We implement this procedure by first estimating a logit regression to model the probability of initiating CDS trading, using the samples of both treatment and control firms. We estimate the following logistic model to predict the onset of CDS trading:

$$\begin{aligned} Prob(CDS\_FIRM_{i,t}=1) = \alpha &+ \beta_1 INV\_GRADE_{i,t-1} + \beta_2 CREDIT\_RATE_{i,t-1} + \beta_3 LEV_{i,t-1} \\ &+ \beta_4 PROFITMARGIN_{i,t-1} + \beta_5 SIZE_{i,t-1} + \beta_6 STRETVOL_{i,t-1} \\ &+ \beta_7 MTB_{i,t-1} + \varepsilon, \end{aligned} \tag{1}$$

where *CDS_FIRM* is a dummy variable that equals one if the firm has a CDS contract traded anytime during our study period and zero otherwise. Firms' credit risk is proxied by *INV_GRADE, CREDIT_RATE, LEV,* and *PROFITMARGIN*. *INV_GRADE* is an indicator variable equal to one if a firm has an S&P credit rating above BB+ and zero otherwise. *CREDIT_RATE* is an indicator variable that takes a value of one if a firm has an S&P credit rating and zero otherwise. *LEV* is leverage, computed as the firm's total debt divided by total assets. *PROFITMARGIN* is net income divided by sales. We also include firm size (*SIZE*), return volatility (*STRETVOL*), and market-to-book ratio (*MTB*) to account for the effects of the overall information environment and growth opportunities on the demand and supply of CDS contracts. *SIZE* is the natural logarithm of market value of equity. *STRETVOL* is the standard deviation of monthly stock return within a fiscal year. *MTB* is the ratio of market value to book value of equity. The measurement of all variables is described in Appendix A. The sample period spans 1992 to 2014, and it includes firms with and without traded CDSs during this time, which are covered by Compustat North America. For firms with CDS contracts, only one year's observation, prior to the onset of CDS trading, is included in the sample.

Panel A of Appendix B reports the estimation results of the logit model in equation (1). Consistent with prior literature (Martin and Roychowdhury, 2015), the model reasonably predicts the onset of CDS trading. The proportion of concordant pairs is over 90%, and the proportion of discordant pair is under 10%. Firms that are larger, have higher credit ratings, and have lower stock return volatility are more likely to experience CDS trading. Consistent with Martin and Roychowdhury (2015), these findings indicate an adverse selection view that, in general, banks (potential protection buyers) have superior private information about the debt instruments they originate. Consequently, sellers offer CDS contracts mainly on firms that are relatively less risky and have more transparent information environments.

Having estimated parameters in equation (1), we then estimate the propensity scores for all non-CDS firms using the predicted parameters from the logit model. We match each CDS firm to a non-CDS firm by year and the Campbell (1996) industry classification using the nearest neighbor matching score. We use matching with replacement.[10] Hence, the number of control firms is lower than treatment firms.[11] Panel B of Appendix B provides the standardized differences in the key variables between CDS firms and non-CDS firms. The results show that the procedure is effective in removing most of the differences between the two samples except for a few variables.

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[10] Compared with matching without replacement, matching with replacement decreases bias and circumvents the potential problem that the results are subject to the order in which the treatment units are matched (Dehejia and Wahba, 2002). Dehejia and Wahba (2002, p. 154) contend that "[w]hen the treatment and comparison units are very different, finding a satisfactory match by matching without replacement can be very problematic. In particular, if there are only a handful of comparison units comparable to the treated units, then once these comparison units have been matched, the remaining treated units will have to be matched to comparison units that are very different. In such settings, matching with replacement is the natural choice."

[11] Reduction in the sample size for non-CDS firms is caused by performing propensity matching with replacement such that one control firm could be matched to multiple treatment firms, missing values in the control variables, and cessation of Compustat coverage due to various reasons, including bankruptcy and mergers and acquisitions by other firms.

3.3. Proxies for risky investments

We use three proxies for risky operating investments, that is, outlays that enhance asset volatility. The first proxy is R&D investments whose changes post–CDS inception are benchmarked against those of CAPEX, consistent with Coles et al. (2006). The motivation for this measure comes from Kothari et al. (2002), who show that future earnings variability is higher for R&D-intensive firms than CAPEX. They conclude that R&D investments generate future benefits that are far more uncertain than those of CAPEX. Supporting this idea, Shi (2003, p. 227) concludes that, "for creditors, the R&D risk dominates their benefits." Also, Acharya et al. (2011) show that strong creditor rights are associated with reduced R&D spending. For our empirical tests, we benchmark changes in R&D expenditures against those of capital expenditures. Our test variables, *R&D* and *CAPEX*, are divided by assets at the end of the fiscal year. *R&D* is set to zero when the value is missing from Compustat.

The second proxy for risky operating investments is SG&A outlays. This proxy is motivated by Choi and Richardson (2016), who show that operating leverage (SG&A to operating costs ratio) causes asset volatility. Also, Enache and Srivastava (2017) find that SG&A enhances the volatility of future profits. We benchmark changes in SG&A expenses against those of COGS, the other major component of operating costs. We scale both by operating expense to obtain *SG&A* and *COGS*.

The third proxy for risky operating investments is the frequency of M&A transactions, consistent with Bliss and Rosen (2001), Minnick, Unal, and Yang (2010), and Hagendorff and Vallascas (2011). Harford and Li (2007) argue that acquisition decisions may be the most important corporate resource allocation decisions that CEOs take. Yet, acquisition projects have highly uncertain NPV and alter acquiring firm's risk profile (Datta, Iskandar-Datta, and Raman, 2001).

In addition to these three proxies of risky operating investments, whose input amounts are controlled by managers, we investigate an outcome measure of risky investments—the volatility of the next three years' operating income (*OPINCVOL*), consistent with John, Litov, and Yeung (2008), Faccio, Marchica, and Mura (2011), Acharya, Amihud, and Litov (2011), Kothari et al. (2002) and Enache and Srivastava (2017). If a firm undertakes more risky investment projects, its operating income will increase in some periods when risky investment is translated into financial success and decrease in other periods when the risky investment is unsuccessful. Since we include industry fixed effects throughout multivariate regression models, these proxies for corporate risk taking are orthogonalized onto industry-specific idiosyncratic characteristics, thus allowing a cleaner analysis of firm-specific risk resulting from corporate operating and investment decisions.

3.4. Managers' risk-taking incentives

Guay (1999) establishes that managers' incentive to enhance volatility can be measured by the sensitivity of managers' wealth to the volatility of equity value. This measure, also referred to as convexity or vega, differs from the sensitivity of managers' wealth to equity value, which is referred to commonly as delta or slope. Guay (1999) cites Smith and Stulz (1985) and Milgrom and Roberts (1992) to reason that, by making adjustments to the slope and convexity of the wealth-performance relation, shareholders can reduce the likelihood that managers forgo positive NPV projects. Thus, holding the slope constant, a greater convexity in the wealth-performance relation is expected to shrink the gap between the risk-aversion effect and the wealth-enhancing effect of stock volatility. *VEGA* is measured by the change in the value of CEO's stock options for a 0.01 change in the annualized standard deviation of stock returns (Guay, 1999). It is derived from the Black-Scholes option valuation model (e.g., Yermack, 1995; Hall and Leibman, 1998; Aggarwal and Samwick, 1999; Guay, 1999; Cohen, Hall, and Viceira, 2000; Datta et al., 2001; Rajgopal and Shevlin, 2002; Core and Guay, 2002).

3.5. Sample distribution

Table 1 presents the sample distribution by year for CDS firms prior to and after CDS inception (pre–CDS and post–CDS contract subsamples). We also provide a yearly distribution of non-CDS firms that serve as a control sample for our tests. The number of observations for firms subsequent to CDS inception and the number of non-CDS firms monotonically increases up to 2004 and then decreases. Table 2 reports the sample distribution by industry, which is based on the Campbell (1987) industry classification. Our sample covers a range of industries, the most heavily represented being Basic (17.67% for the post–CDS contract subsample and 18.77% for the pre–CDS contract subsample), followed by Utilities (12.52% for the post–CDS contract subsample and 13.12% for the pre–CDS contract subsample) and Consumer durables (11.99% for the post–CDS contract subsample and 11.60% for the pre–CDS contract subsample).

[Insert Tables 1 and 2 near here]

3.6. Descriptive statistics

Table 3 reports descriptive statistics of the variables used in our analyses for CDS firms. Characteristics are presented separately for periods before and after the initiation of CDS trading for the CDS firms. Corporate investments in both intangible (*R&D*) and tangible (*CAPEX*) assets decrease following CDS inception, though the percentage decrease in *R&D* is larger. *COGS* and *SG&A* do not change significantly. Firms reduce M&As and financial leverage and increase cash savings, consistent with more cautionary investment and financing policies. While sales revenue increases, perhaps mechanically over time, market-to-book ratio, stock return, and revenue growth decrease subsequent to CDS trading initiation.

[Insert Table 3 near here]

4. Tests of hypotheses

This section presents tests of the hypotheses.

4.1. Tests of H1: Changes in risky operating investments upon CDS inception

H1 examines whether firms change their level of risky investments after CDS inception. We estimate the following regression to test this hypothesis:

$$RiskyInvestment_{i,t} = \beta_0 + \beta_1 CDS\_TRADE_{i,t} + \beta_2 CDS\_FIRM_i + \sum \beta_n Controls_{i,t} + \varepsilon_{i,t}, \quad (2)$$

where the dependent variable is one of the proxies for risky operating investments: *R&D* (contrasted against *CAPEX*), *SG&A* (contrasted against *COGS*), *M&A*, and *OPINCVOL*. Dummy variable *CDS_FIRM* takes a value of one for firms that have their CDSs traded during our study period. CDS-traded firms are considered the treatment group after CDS inception. Dummy variable *CDS_TRADE* takes a value of one after CDS inception for CDS firms and zero otherwise. Effectively, it is an interaction of two dummy variables: *CDS_FIRM* (a variable that takes a value of one for CDS firms and zero otherwise) × *POST_CDS* (a variable that takes a value of one for years after CDS inception for the treatment firms and their matched control firms and zero otherwise). Including both *CDS_TRADE* and *CDS_FIRM* provides a difference-in-differences research design to isolate the impact of CDS inception relative to contemporaneous changes for non-CDS firms. Hence, the variable *CDS_TRADE* captures the marginal impact of CDS introduction on the level of risky operating investments relative to the impact on non-CDS firms over the same time interval. If CDS firms increase (decrease) their risky investments following the onset of CDS trading, relative to non-CDS firms, then β_1 would be significantly positive (negative).

We include a set of firm-level and industry-level control variables that affect firms' investment decisions, consistent with prior research: firm size (*SALES*), growth opportunity (*MTB*), cash availability (*SURPLUSCASH*), sales growth (*SALESGROWTH*), stock return (*STRET*), net cash flow from operating activities (*CFO*), and product market competition for a given industry (*HHI*). We control for financial leverage (*DEBT*) that may change post–CDS inception (Saretto and Tookes, 2013). We use CEO tenure (*TENURE*), CEO age (*CEOAGE*), and total compensation (*TOT_COMP*) to control for executive characteristics. The above set of controls is consistent with those used by the literature (e.g., Coles et al., 2006). We include year and industry fixed effects to control for year and industry idiosyncratic characteristics throughout all regressions. Detailed variable definitions are in Appendix A.

The first column of Table 4 reports results of equation (2) with *R&D* as the dependent variable; the second column, with *CAPEX* as the dependent variable. The coefficient on *CDS_TRADE* is negative for *R&D* but not significant. The magnitude of the coefficient on *CAPEX* is much smaller and is also insignificant. Table 4 presents results with *SG&A* and *COGS* in the third and fourth column, respectively. The coefficients on *CDS_TRADE* are negative and positive, respectively, but neither one is significant. We present results using *M&A* in the fifth column. The coefficient on *CDS_TRADE* is negative and significant (p-value < 0.01). The last column, however, shows an insignificant coefficient on *CDS_TRADE* with *OPINCVOL* as the dependent variable.

[Insert Table 4 near here]

Overall, we do not find any significant change in the proxies for risky investment upon CDS inception except for *M&A*. Thus, the null hypothesis H1 is not rejected. In addition, no test shows a significant increase in risky investment that would support the asset substitution argument. Some support does exist for more cautionary investment policies subsequent to CDS inception, consistent with Bartram et al. (2017).

4.2. Tests of H2: The effect of managerial vega

We test H2 with *VEGA* as the risk-inducing factor, while controlling for *TOT_COMP*, in the following regression:

$$
\begin{aligned}
RiskyInvestment_{i,t} = {} & \beta_0 + \beta_1 CDS\_TRADE_{i,t} \\
& + \beta_3 VEGA_{i,t} \\
& + \beta_4 CDS\_TRADE_{i,t} \times VEGA_{i,t} \\
& + \beta_5 CDS\_FIRM_i + \sum \beta_n Controls_{i,t} + \varepsilon_{i,t}. \qquad (3)
\end{aligned}
$$

Equation (3) is essentially the same as equation (2) with additional terms of *VEGA* and its interaction with *CDS_TRADE,* which takes a value of one after CDS inception for CDS firms and zero otherwise. Also included is *TOT_COMP*, a natural logarithm of the sum of salary, bonus, long-term incentive plan payouts, the value of restricted stock grants, the value of options granted during the year, and any other annual pay for the CEO in the fiscal year. A CEO's risk aversion should increase with *TOT_COMP* because he or she would lose future stream of those amounts upon firm failure.

The coefficient on *CDS_TRADE* is negative and significant (p-value < 0.01) with *SG&A* and *M&A* as dependent variables and insignificant with *R&D* and *OPINCVOL* as dependent variables. It shows that, absent managerial convexity, borrowers either maintain investment policies or pursue more conservative investment policies post–CDS inception. The baseline result is thus that managers who have little to gain from asset volatility but stand to lose most from the resulting firm failure might reduce risky investments. This finding is consistent with

Bartram et al. (2017), who find a post–CDS inception decrease in risky investments, on average, in a global setting.

The coefficient of interest is on the interaction term *CDS_TRADE* × *VEGA*.[12] If vega induces managers to increase operating risks following the onset of CDS trading, then β_3 should be significantly positive when the dependent variable is risky corporate investments. Panel A of Table 5 presents results with different proxies of risky operating investments. The coefficient on the interaction term *CDS_TRADE* × *VEGA* is positive and significant. We find similar results with *R&D*, *SG&A*, *M&A*, and *OPINCVOL* as the dependent variables (all coefficients are positive and significant with p-value < 0.01). These results support the hypothesis that the post–CDS inception allocation of firm resources toward riskier avenues increases with managers' vega incentives, all else held equal. These results are not just about vega incentives, because they are conditional on CDS inception. Thus, managers with vega incentives appear to act differently post–CDS inception than managers with no such incentives, all else held equal. We do not find a risk-increasing effect of vega for relatively safe and tangible investments such as *CAPEX* and *COGS*. On the contrary, we find a negative coefficient on *COGS*, indicating a shift from COGS to SG&A post–CDS inception that increases with vega.

[Insert Table 5 near here]

To the extent that asset volatility improves the value of call options built into shareholder investments, and is contrary to lender interests, vega seems to promote shareholder interests post–CDS inception, all else held equal.

[12] We conduct an additional test using a dummy variable that takes the value one when *VEGA* is in the highest tercile for that industry and year. Untabulated results are similar with those obtained using a continuous variable.

4.3. H1 tests for two extreme terciles of managerial vega

We divide firms into terciles based on the managerial vega. Then, we estimate equation (1) for the lowest and highest vega groups, which have the least and greatest managerial incentives to increase asset volatility. Results are presented in Panel B of Table 5 with two columns each for the low and high vega groups with *R&D*, *SG&A*, *M&A*, and *OPINCVOL* as the dependent variables. The coefficient *CDS_TRADE* is negative and significant for the lowest vega group (p-value < 0.05) with *R&D*, *SG&A*, and *M&A* as dependent variables, but it is insignificant for the high vega group. These results indicate that, for low vega managers, the marginal cost from increased vulnerability to bankruptcy post–CDS inception dominates the gains from raising asset volatility to take advantage of reduced lender vigilance. These managers thus purse more conservative investment policies (Arping 2014; Subrahmanyam et al., 2017). These results are consistent with Low (2009), who finds that an exogenous regulatory shock to the takeover provision causes firms to reduce their risky investments. However, this shift is concentrated among firms with low managerial vega.

Coefficients for the highest vega group for *R&D*, *SG&A*, and *M&A* indicate a counterbalancing of two managerial incentives. That is, high vega managers appear unwilling to forgo the wealth-enhancing effect of risky investments even when faced with higher vulnerability to financial distress following CDS inception. They maintain the level of risky investments.

The results with *OPINCVOL* as the dependent variable differ from the other three variables. The volatility of operating profits increases post–CDS inception for high vega firms. Yet, no test in Table 5 supports the asset substitution argument for the low vega group.

4.4. Tests of H3: The joint effect of CDS inception and managerial interests on default risk

Results of subsections 4.2 and 4.3 show that vega could induce managers to increase risky investments post–CDS inception, at the margin. The resulting increase in operating risk could worsen bankruptcy risk. We test in H3 whether vega incentives are associated with increase in bankruptcy risk after CDS inception. We estimate

$$BANKRUPTCY_{i,t} = \beta_0 + \beta_1 CDS\_TRADE_{i,t}$$

$$+ \beta_3 VEGA_{i,t}$$

$$+ \beta_4 CDS\_TRADE_{i,t} \times VEGA_{i,t}$$

$$+ \beta_5 CDS\_FIRM_i + \sum \beta_n Controls_{i,t} + \varepsilon_{i,t}, \quad (4)$$

where *BANKRUPTCY* is an indicator variable that takes a value of one if a firm files for bankruptcy in the next five years after a given year *t*. As in H2 tests, our main interest is the coefficient on the interaction term *CDS_TRADE* × *VEGA*, which we expect to be positive based on H3. We follow Subrahmanyam et al. (2014) and include a vector of firm-level control variables, which are known to affect corporate bankruptcy risk: firm size (*MKV*), debt size (*DEBT*), stock return (*STRET*), stock return volatility (*STRETVOL*), and profitability (*ROA*). We also control for executive characteristics (Gormley, Matsa, and Milbourn, 2013; Switzer and Wang, 2013; Faccio, Marchica, and Mura, 2016) by including CEO total compensation (*TOT_COMP*) and CEO tenure (*TENURE*) as control variables.

The first and second columns of Table 6, Panel A, present results without and after considering vega incentives, respectively. In the first column, the coefficient on *CDS_TRADE* is significant and positive (p-value < 0.01), showing that firms' bankruptcy risk increases subsequent to CDS trading, consistent with Subrahmanyam et al. (2014). In the second column, the coefficient on *CDS_TRADE* becomes insignificant, indicating that, absent managers' vega incentives, no change in bankruptcy risk takes place post–CDS inception. The coefficient on the interaction term *CDS_TRADE* × *VEGA* is positive and significant (p-value < 0.05), supporting the view that, at the margin, managers with high vega incentives change firm policies in a manner that increases the likelihood of bankruptcy risk after the onset of CDS trading.

[Insert Table 6 near here]

We next estimate the effect of CDS inception on the likelihood of bankruptcy separately for high and low vega groups. Panel B shows that the increase in bankruptcy likelihood is confined to the high vega group. These results indicate that the effect of increased lender inflexibility upon CDS inception on bankruptcy likelihood is more nuanced than previously considered in the literature. Results are consistent with the idea that low vega firms change their operating policy [or change other firm policies such as precautionary cash (Subrahmanyam et al., 2017)] to potentially mollify the vulnerability created by lender inflexibility post–CDS inception. Large vega firms do not change their policies in the direction, or do not change them enough, to ward off the enhanced bankruptcy threat.

5. Changes in managerial compensation

H1–H3 test results indicate that, after CDS inception, low vega managers may forgo risky, positive NPV projects to a greater extent than before. If the previous levels of operational risk-return trade-offs were optimal for the shareholders, then low vega managers would deviate from shareholder-preferred policies. Firms with high vega might not forgo risky projects to the same extent. Shareholders may then alter managerial compensation by increasing managerial vega to enhance managers' risk-taking incentives (Lee et al., 2017). We test this idea by estimating

$$VEGA_{i,t} = \beta_0 + \beta_1 CDS\_TRADE_{i,t} + \beta_2 CDS\_FIRM_i + \sum \beta_n Controls_{i,t} + \varepsilon_{i,t}. \quad (5)$$

We follow prior literature in employing a vector of control variables (Coles et al., 2006): firm size (*SALES*), financial leverage (*DEBT*), growth opportunity (*MTB*), cash availability (*SURPLUSCASH*), sales growth (*SALESGROWTH*), CEO tenure (*TENURE*), total compensation (*TOT_COMP*), stock return (*STRET*), and stock return volatility (*STRETVOL*). Table 7 shows that the coefficient on *CDS_TRADE* is positive and significant (p-value < 0.01), indicating that shareholders increase CEO vega after CDS inception. The economic significance of this increase, relative to the change for non-CDS firms, over the same period is estimated by dividing the regression coefficient by the mean value post–CDS inception, which amounts to 20% (= 0.0525 / 0.2588) for *VEGA*. In unreported tests, we find that total compensation increases in a statistically, but not economically, significant manner [1% (= 0.1079 / 8.856) of its mean value]. So, the principal change in managers' compensation structure appears to be an increase in convexity, not the total value. In a work subsequent to ours, Lee et al (2017) predict increase in vega based on an analytical model.

[Insert Table 7 near here]

In sum, the outcome of CDS inception on operating policies that affect managerial and shareholder wealth is more nuanced than previously considered in the literature; that is, it depends on managerial incentives. We thus present a fuller picture of manager-shareholder and lender-shareholder conflicts and shifts in the rival lender, shareholder, and managerial forces that determine firms' investment and financing policies post–CDS inception. In this respect, we respond to the Augustin et al. (2014) call for a thorough examination of changes in corporate policy and stakeholder interests upon CDS inception.

6. Robustness checks

In this section, we examine whether our main findings are robust to alternative econometric specifications.

6.1. Identifying lender banks that most likely used CDS contracts

In Section 5 tests, we assume that a significant number of lenders buy protection via CDSs after they become available, an assumption that is consistent with previous empirical studies on the effects of CDSs. Our identification of altered borrower-lender relationship could improve if we could isolate cases of lenders buying CDS protection. However, CDS contracts are traded over the counter. Identifying banks that purchase credit insurance on the borrower is empirically challenging. Martin and Roychowdhury (2015) propose that a bank likely purchases CDS protection against a borrower's default risk if the bank increases its risk-based capital ratio in the same year in which the borrower's CDS trading was initiated. This argument is based on the proposition that a bank can increase its risk-based capital ratio upon hedging its credit risk. Hence, we expect that the phenomena we show in this paper are stronger for firms whose lender banks likely purchase CDS contracts.

We identify lenders to CDS and non-CDS firms in our sample using the Dealscan database, and we obtain banks' risk-based capital ratio from the Federal Reserve Y-9C reports. We divide the borrower sample into two groups: those with increases in their banks' risk-based capital ratio and those with decreases in the year of CDS inception. We then reestimate equation (3), examining the joint effect of CDS inception and managerial incentives on risky investment policies.

Table 8 presents results of this analysis. The coefficients on the interaction term *CDS_TRADE* × *VEGA* are significantly stronger for firms with banks experiencing increases in risk-based capital ratio for all dependent variables. For bankruptcy risk, the coefficient on the interaction term is significant only for firms with an increase in banks' risk-based capital ratio. Thus, the vega-induced risk-increasing effects are stronger when lenders hedge their client risks with traded CDSs and, hence, reduce their vigilance.

[Insert Table 8 here]

6.2. Endogenous choice of compensation and corporate investments: 3SLS specification

We examine the joint effect of CDS inception and vega on corporate investment policies, by assuming that the onset of CDS trading and managerial compensation are independent factors. However, they might reciprocally cause each other. Vega can exacerbate lender-shareholder conflict (Daniel et al., 2004) leading to greater lender demand for CDS. CDS inception might be followed by an increase in vega, as we find and as predicted theoretically by Lee et al. (2017). Furthermore, omitted firm characteristics may drive the firm's choice of risky investment and the equilibrium vega given to its managers (Core and Guay, 2002). These endogeneity issues can lead to biased coefficients in our main tests. We address these issues by employing a 3SLS model that provides efficient estimates when error terms are correlated across equations (Zellner and Theil, 1962).[13] We simultaneously estimate the system of following three regressions

$$Prob(CDS\_TRADE_{i,t}=1) = \beta_0 + \beta_1 VEGA_{i,t} + \beta_2\ RiskyInvestment_{i,t}$$

$$+ \beta_3 IPBTV_{i,t} + \beta_4\ IGSGF_{i,t} + \sum \beta_n Controls_{I,t} + \varepsilon, \quad (7)$$

$$VEGA = \beta_0 + \beta_1 CDS\_TRADE_{i,t} + \beta_2\ RiskyInvestment_{\,i,t} + \sum \beta_n Controls_{i,t} + \varepsilon, \quad (8)$$

and

$$RiskyInvestment_{i,t} = \beta_0 + \beta_1 CDS\_TRADE_{i,t} + \beta_3 VEGA_{i,t} + \beta_4 CDS\_TRADE_{i,t} \times VEGA_{i,t}$$

[13] In the first stage, instrumental variables are developed for all of the endogenous variables by combining the other endogeneous variables and the exogenous variables. In the second stage, the estimates are computed based on the residuals of the first-stage estimates for each equation. Finally, in the third stage, a generalized least squares estimation is done using the covariance matrix of the second stage and using the developed instrumental variables instead of the endogenous variables.

$$+ \beta_5 CDS\_FIRM_i + \sum \beta_n Controls_{i,t} + \varepsilon_{i,t}. \qquad (9)$$

Each of the three regressions includes the other two endogenous variables as regressors. Equation (7) includes *VEGA*, a proxy for corporate risk taking (*R&D*, *SG&A*, *M&A*, or *OPINCVOL*), all variables of the CDS determinant model specified in equation (1), and all control variables in equation (2) and equations (4)–(6). In addition, equation (7) includes two instrumental variables: *Industry Peers' Bond Trading Volume* and *Investment / Speculative Grade Frontier*. So, 3SLS combines the features of seemingly unrelated regressions, by simultaneously estimating the three equations, and a two-stage least squares (2SLS) approach, with inclusion of two instrumental variables.

The two instrumental variables predict the initiation of CDS trading but are likely to be unrelated to residuals in equation (7). The first variable proxies for the degree to which investors can hedge and speculate in the bond market in the absence of the CDS market.[14] Following prior studies, we compute this variable by the average of the industry peers' bond trading volume (Boehmer, Chava, and Tookes, 2015; Kim, Shroff, Vyas, and Wittenberg-Moerman, 2017). Bond trading volume should reduce the likelihood of CDS inception. Higher bond market liquidity alleviates trading friction, thereby reducing the demand for CDS contracts. We extract data on the bond trading volume for industry peers from the Trade Reporting and Compliance Engine (TRACE) database. We also collect data on the face value of traded bonds on the issue date from the Mergent database. We divide the dollar volume of a traded bond by its face value to estimate its trading volume. We then compute the average bond trading volume of industry peers per year. We convert this measure into a decile rank (*Industry Peers' Bond Trading Volume*).

[14] Oehmke and Zawadowski (2015) illustrate that credit investors choose the CDS market as the trading venue for their credit hedging and speculative objectives when they face trading frictions in the underlying bond market.

Our second instrumental variable, *Investment / Speculative Grade Frontier*, proxies for the demand for CDS trade. Qiu and Yu (2012) demonstrate an inverse U-shaped relation between CDS liquidity and credit rating. That is, bond investors' hedging demand is the lowest for bonds at the extreme values of investment and speculative grades. Bonds with very high credit quality have little hedging demand because of their high credit quality. For below investment grade bonds, credit protection is too costly. *Investment / Speculative Grade Frontier* is an indicator variable that takes a value of one if the credit rating of a firm's bonds is close to the crossover from investment to speculative grades; that is, the bonds have an average credit rating of BBB–, BBB, or BBB+. We obtain corporate long-term bond credit ratings from Compustat.

We present the results of the system of equations in Panels A–D of Table 9, with *R&D*, *SG&A*, *M&A*, and *OPINCVOL*, respectively, as a proxy for *RiskyInvestment*. The coefficient on the interaction term *CDS_TRADE* × *VEGA* is positive and significant for *R&D*, *SG&A*, and *M&A*, with p-value < 0.01. For *OPINCVOL*, the coefficient is significant at p-value < 0.10. Thus, our main results remain qualitatively unchanged using the 3SLS models, indicating that they are less likely affected by endogeneity issues.

7. Conclusion

In this study, we investigate whether and how a borrower changes its investment policy after its lender obtains insurance on its loaned assets via a credit default swap. Prior studies show that, upon obtaining insurance, the lender reduces its monitoring of the borrower's activities and less flexibly accommodates a financially distressed borrower's needs. We hypothesize that reduced monitoring can cause the borrower to increase risky investments, to improve the value of call options built into its shareholder investments. However, less lender flexibility can cause the borrower to pursue a more conservative investment policy to lower its vulnerability to financial distress.

We find that the borrower pursues a more conservative investment policy post–CDS inception when its managers have low convexity to stock price incentives. That is, when managers stand to lose their personal and employment capital from increased vulnerability to bankruptcy, but gain little from the additional asset volatility, they shift to more conservative investment policies (Arping 2014; Subrahmanyam et al., 2017). When managers have high vega, they do not reduce risky investments after CDS inception, indicating a counterbalance between the wealth-creating effect of asset volatility and the wealth-reducing effect of bankruptcy likelihood. Thus, we show a nuanced pattern of changes in the borrower's investment policy following CDS inception, depending on the interaction between the manager-shareholder and lender-shareholder conflicts. We thus present a fuller picture of shifts in the triad of lender, shareholder, and managerial forces that determine firms' investment policies post–CDS inception.

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Appendix A
Variable definitions

BANKRUPTCY = Dummy variable that takes a value of one if the firm files for bankruptcy in the next five years and zero otherwise. (Source: Securities Data Company Platinum bankruptcy database)

CAPEX = Capital expenditure net of sales of property, plant, and equipment, divided by assets at the end of fiscal year *t*. (Source: Compustat North America)

CDS_FIRM = Dummy variable that takes a value of one if the firm has traded CDSs anytime during our study period (1992–2014) and zero otherwise. (Source: Markit)

CDS_TRADE = Dummy variable that takes a value of one for the CDS firm in the year after its CDS starts trading and zero otherwise. (Source: Markit)

CEOAGE = Natural logarithm of CEO's age (Source: Compustat ExecuComp)

CFO = Net cash flow from operating activities divided by total assets at the end of fiscal year *t*. (Source: Compustat North America)

CFVOL = Standard deviation of firm's *CFO* from fiscal year $t-4$ to fiscal year *t*. (Source: Compustat North America)

COGS = COGS to operating costs (SALE − OIADP) ratio at the end of fiscal year *t*. (Source: Compustat North America)

CREDIT_RATE = Dummy variable that takes a value of one if the firm has an S&P credit rating and zero otherwise. (Source: Compustat North America)

DEBT = Natural logarithm of firm's total debt (short-term debt plus long-term debt) at the end of fiscal year *t*. (Source: Compustat North America)

DIV_RATIO = Dividend payout ratio; dividends paid to common shareholders over market value of equity. (Source: Compustat North America)

EVOL = Standard deviation of firm's *ROA* from fiscal year $t-4$ to fiscal year *t*. (Source: Compustat North America)

HHI = Herfindahl-Hirschman Index of two-digit Standard Industrial Classification (SIC) industry to which the firm belongs, measured at the end of fiscal year *t*. (Source: Compustat North America)

Industry Peers' Bond Trading Volume = Average annual bond trading volume for the firm's two-digit SIC industry peers. (Source: TRACE)

Investment / Speculative Grade Frontier = Indicator variable that takes a value of one if the firm's long-term bonds outstanding in a given year have an average credit rating of BBB-, BBB, or BBB+ and zero otherwise. (Source: Compustat North America)

INV_GRADE = Dummy variable that takes a value of one if the firm has an S&P credit rating above BB+ and zero otherwise. (Source: Compustat North America)

M&A = Natural logarithm of number of mergers and acquisitions, which are counted separately in the pre– and post–CDS periods. (Source: First Call)

MKV = Natural logarithm of firm's market value at the end of fiscal year *t*, calculated as (number of outstanding shares × market price). (Source: Compustat North America)

MTB = Market value divided by book value of equity at the end of fiscal year *t*. (Source: Compustat North America)

OPINCVOL = Standard deviation of firm's profitability ratio, operating income after depreciation over total assets, for fiscal year *t* to *t+3*. (Source: Compustat North America)

PRE_SFAS123R = Dummy variable that takes a value of one if the firm's data date is before the effective date of Statement of Financial Accounting Standards 123R (June 15, 2005) and zero otherwise. (Source: Compustat North America)

PROFITMARGIN = Net income divided by sales at the end of fiscal year *t*. (Source: Compustat North America)

R&D = Research and development expenditure divided by total assets at the end of fiscal year *t*. Set to zero if missing. (Source: Compustat North America)

Risk capital ratio = Lender's total risk-based capital divided by risk-weighted assets from Federal Reserve Y-9C reports. Risk-based capital requirement refers to a rule that establishes minimum required liquid reserves or regulatory capital for financial institutions. Risk-based capital requirements exist to protect financial firms, their investors, and their clients. Banks lending to CDS firms and non-CDS firms in the sample are identified using data obtained from the Loan Pricing Corporation Dealscan database. (Source: Federal Reserve Y-9C reports and Loan Pricing Corporation Dealscan)

ROA = Return on assets; net income before extraordinary items divided by total assets at the end of fiscal year *t*. (Source: Compustat North America)

S&P500 = Dummy variable that takes a value of one if the firm is in the S&P 500 index at the end of fiscal year *t* and zero otherwise. (Source: Compustat North America)

SALES = Natural logarithm of net sales at the end of fiscal year *t*. (Source: Compustat North America)

SALESGROWTH = Change in net sales in year *t* divided by net sales in year *t*−1. (Source: Compustat North America)

SG&A = SG&A to operating costs (SALE − OIADP) at the end of fiscal year *t*. (Source: Compustat North America)

SIZE = Natural logarithm of total assets at the end of fiscal year *t*. (Source: Compustat North America)

STRET = Firm's annual stock return for fiscal year *t*. (Source: Compustat North America)

STRETVOL = Standard deviation of the firm's monthly stock return in fiscal year *t*. (Source: Compustat North America)

SURPLUSCASH = Cash from assets-in-place divided by total assets (Coles et al., 2006). Calculated as operating activities net cash flow minus depreciation and amortization plus research and development expense at the end of fiscal year *t*. (Source: Compustat North America)

TENURE = Natural logarithm of the number of years the CEO held his or her position. Number of years is calculated as the difference between the current fiscal year and the year reported for "date became CEO" in Compustat ExecuComp. (Source: Compustat ExecuComp)

TOT_COMP = Natural logarithm of the sum of salary, bonus, long-term incentive plan payouts, the value of restricted stock grants, the value of options granted during the year, and any other annual pay for the CEO in fiscal year *t*. (Source: Compustat ExecuComp)

VEGA = Dollar change in the executive's wealth for a 0.01 change in standard deviation of returns. (Source: Compustat ExecuComp)

Appendix B

Implementing propensity matched score method

This table reports results using the propensity matching approach, which involves pairing treatment and control firms based on similar observable characteristics (Dehejia and Wahba, 2002). The dependent variable, *CDS_Firm*, equals one if a credit default swap (CDS) is traded on the firm any time during our study period (1992–2014) and zero otherwise. The independent variables are *INV_GRADE*, an indicator variable that equals one if the firm has a Standard & Poor's (S&P) credit rating above BB+ and zero otherwise; *CREDIT_RATE*, an indicator variable that equals one if the firm has an S&P credit rating and zero otherwise; *MTB*, the ratio of market value of equity to book value of equity; *PROFITMARGIN*, net income divided by sales; and *STRETVOL*, standard deviation of monthly stock return within a fiscal year. The other variables are defined in Appendix A. The sample includes firms with and without traded CDSs during the study period. For CDS firms, only firm-years prior to the onset of CDS trading are included in the sample. *t*-statistics in parentheses are based on robust standard errors clustered by industry and year. Panel A reports estimation results of a logistic model to predict the onset of CDS trading. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. Panel B reports the standardized differences between CDS firms and the matched non-CDS firms for covariate balancing. Standardized differences of 0.2, 0.5, and 0.8 correspond to small, medium, and large differences between the treatment sample and the control sample (Cohen, 1988).

Panel A: First-stage logit model

Variable	Estimate
Intercept	−7.592019
	(−14.63)***
INV_GRADE	0.2104
	(2.4192)**
CREDIT_RATE	1.0496
	(8.9653)***
DEBT	0.6891
	(3.5621)***
PROFITMARGIN	−0.0335
	(−0.1573)
SIZE	0.3462
	(13.0236)***
STRETVOL	−1.8892
	(−2.9139)***
MTB	−0.1052
	(−3.4763)***
Year fixed effects	Yes
Industry fixed effects	Yes
Number of observations	24,855
Chi-squared	1841.59 (*p*-value < 0.0001)
Percent concordant	91.5
Percent discordant	7.8

Panel B: Covariate balance analysis

	CDS firms		Non-CDS firms		Standardized difference	
Variable	Mean	Variance	Mean	Variance	Mean	Variance
VEGA	0.2045	0.0662	0.2022	0.0748	0.0088	0.8849
R&D	0.0179	0.0013	0.0150	0.0012	0.0837	1.0327
CAPEX	0.0545	0.0025	0.0500	0.0022	0.0933	1.1153
SG&A	0.1925	0.0350	0.1984	0.0342	−0.0321	1.0254
COGS	0.7393	0.0399	0.7324	0.0387	0.0351	1.0300
M&A	1.3907	0.9800	1.9526	1.1589	−0.5433	0.8456
OPINCVOL	0.0219	0.0011	0.0207	0.0008	0.0398	1.4009
TOT_COMP	8.5260	0.9110	8.5601	1.2627	−0.0327	0.7215
CEOAGE	4.0289	0.0107	4.0238	0.0142	-0.0168	0.8707
TENURE	1.6927	0.6995	1.7203	0.7087	−0.0330	0.9871
SALES	8.6103	1.6422	8.3778	1.8482	0.1760	0.8886
MTB	3.2234	10.8570	2.9638	10.1482	0.0801	1.0698
SURPLUSCASH	0.0385	0.0046	0.0306	0.0057	0.1097	0.8133
SALESGROWTH	0.0747	0.0329	0.0783	0.0404	−0.0185	0.8130
STRET	0.1624	0.1664	0.1730	0.1862	−0.0251	0.8936
STRETVOL	0.0893	0.0027	0.0925	0.0031	−0.0581	0.8646
DEBT	0.2767	0.0240	0.2911	0.0387	−0.0813	0.6204
ROA	0.0500	0.0035	0.0407	0.0038	0.1540	0.9255
CFO	0.0946	0.0038	0.1023	0.0045	0.1837	0.9217
HHI	0.0667	0.0004	0.0564	0.0029	0.0066	1.1315
S&P500	0.6380	0.2310	0.3554	0.2291	0.5892	1.0081

Table 1
Sample distribution by fiscal year

This table reports the sample distribution across years. The sample consists of 14,606 firm-year observations for the period between 1992 and 2014.

	Credit default swap (CDS) firms		
Year	Before CDS inception	After CDS inception	Non-CDS firms
1992	100		102
1993	245		243
1994	263		273
1995	291		281
1996	303		298
1997	317		310
1998	339		330
1999	349		324
2000	367		349
2001	236	147	339
2002	166	227	347
2003	97	300	363
2004	60	349	345
2005	31	370	338
2006	21	371	306
2007	14	378	308
2008	8	380	278
2009	7	376	264
2010	5	369	261
2011	3	368	259
2012	1	365	251
2013		358	251
2014		356	249
Total	3,223	4,714	6,669

Table 2
Sample distribution by industry (number of firm-years)

This table reports the sample distribution across the Campbell (1987) industry classifications. The sample consists of 14,606 firm-year observations for the period between 1992 and 2014.

	Credit default swap (CDS) firms		
Industry	Before CDS inception	After CDS inception	Non-CDS firms
Basic	605	833	770
Capital goods	361	502	705
Construction	93	155	96
Consumer durables	374	565	959
Food/tobacco	126	186	239
Leisure	96	137	173
Petroleum	204	272	352
Real estate and financial	233	585	1,257
Services	310	358	457
Textiles/trade	294	361	468
Transportation	80	115	182
Utilities	423	590	947
Other industries	24	55	64
Total	3,223	4,714	6,669

Table 3
Sample descriptive statistics for credit default swap (CDS) firms, before and after CDS inception

This table reports descriptive statistics for the sample firms. All variables are defined in Appendix A. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

	Before CDS inception		After CDS inception		After − before
Variable	Mean	Standard deviation	Mean	Standard deviation	Mean difference
VEGA	0.1243	0.1831	0.2591	0.2846	0.1348***
R&D	0.0212	0.0408	0.0156	0.0314	−0.0056***
CAPEX	0.0663	0.0542	0.0465	0.0446	−0.0199***
SG&A	0.1908	0.1879	0.1937	0.1866	0.0028
COGS	0.7387	0.1983	0.7398	0.2007	0.0011
M&A	1.5130	0.9843	1.3028	0.0143	−0.2102***
OPINCVOL	0.0229	0.0271	0.0212	0.0369	−0.0017**
BANKRUPTLCY	0.0031	0.0559	0.0135	0.1153	0.0104***
TENURE	1.7555	0.8766	1.6494	0.8056	−0.1062***
TOT_COMP	8.0392	0.9846	8.8562	0.7774	0.8169***
CEOAGE	4.0238	0.1191	4.0289	0.1035	0.0051**
SALES	8.0837	1.2486	8.9666	1.1778	0.8829***
MTB	3.5386	3.4774	3.0121	3.1429	−0.5265***
SURPLUSCASH	0.0343	0.0764	0.0413	0.0616	0.0070***
SALESGROWTH	0.1121	0.1978	0.0490	0.1653	−0.0631***
STRET	0.1932	0.4306	0.1422	0.3911	−0.0510***
STRETVOL	0.2752	0.1587	0.2774	0.1521	0.0023
LEV	0.0537	0.0597	0.0476	0.0595	−0.0061***
ROA	0.5883	0.4992	0.6719	0.4696	0.8169***
CFO	0.1023	0.0671	0.0946	0.0613	−0.0078***
HHI	0.0564	0.0518	0.0667	0.0669	0.013***
S&P500	0.4610	0.4985	0.5143	0.4998	0.0836***

Table 4
Corporate investment policy after the initiation of credit default swap (CDS) trading

This table reports the effect of CDS trading upon corporate investment policy: *R&D*, *CAPEX*, *SG&A*, *COGS*, *M&A*, and *OPINCVOL*. All variables are defined in Appendix A. The sample for *R&D*, *CAPEX*, *SG&A*, and *COGS* consists of 6,669 non-CDS firm-years and 7,937 CDS firm-years (3,223 firm-years for pre–CDS initiation and 4,714 firm-years for post–CDS initiation). The sample for *M&A* consists of 6,539 non-CDS firm-years and 7,843 CDS firm-years (3,146 firm-years for pre–CDS initiation and 4,697 firm-years for post–CDS initiation). The sample for *OPINCVOL* consists of 5,833 non-CDS firm-years and 7,247 CDS firm-years (3,128 firm-years for pre–CDS initiation and 4,119 firm-years for post–CDS initiation). Year and industry fixed effects are included. *t*-statistics based on robust standard errors clustered by year and industry are in parentheses. *, **, and *** denote significance at the 0.10, 0.05, and 0.01 level, respectively, two-tailed in control variables and one-tailed when discussing the results of hypothesis tests with predicted signs of coefficient estimates.

	Dependent variable					
Variable	*R&D*	*CAPEX*	*SG&A*	*COGS*	*M&A*	*OPINCVOL*
CDS_TRADE (*CDS_FIRM* × *POST_CDS*)	−0.0013	−0.0002	−0.0061	0.0009	−0.3569	0.0012
	(−0.72)	(−0.06)	(−0.40)	(0.06)	(−3.46)***	(0.61)
CDS_FIRM	0.0022	0.0010	−0.0219	0.0264	−0.4182	−0.0007
	(1.09)	(0.42)	(−2.55)**	(2.82)***	(−5.94)***	(−0.42)
TENURE	0.0008	0.0007	−0.0011	0.0019	−0.0206	−0.0009
	(1.89)*	(0.54)	(−0.21)	(0.32)	(−0.58)	(−1.74)*
TOT_COMP	0.0024	−0.0021	0.0230	−0.0298	0.1184	0.0003
	(2.53)**	(−2.53)**	(4.24)***	(−4.79)***	(1.63)	(0.42)
CEOAGE	−0.0055	−0.0016	−0.0003	−0.0045	−0.3744	−0.0042
	(−1.17)	(−0.21)	(−0.01)	(−0.13)	(−1.00)	(−1.37)
SALES	−0.0005	−0.0012	−0.0153	0.0226	0.1357	−0.0022
	(−0.49)	(−0.77)	(−2.04)**	(2.67)***	(2.85)***	(−3.49)***
MTB	0.0006	0.0004	0.0080	−0.0062	0.0001	0.0004
	(2.25)**	(1.15)	(3.93)***	(−3.06)***	(0.01)	(2.23)**
ROA	0.0367	0.0299	0.2828	−0.1850	−0.2208	−0.0123
	(1.84)*	(1.64)	(1.48)	(−1.06)	(−0.34)	(−1.42)
SURPLUSCASH	−0.5566	−0.1667	−1.0953	1.3895	−1.6042	−0.1259
	(−7.06)***	(−3.65)***	(−7.71)***	(12.08)***	(−2.89)***	(−7.57)***
SALEGLOWTH	0.0011	0.0045	−0.0030	−0.0023	0.2259	0.0028
	(0.74)	(0.98)	(−0.15)	(−0.10)	(1.23)	(1.72)*
DEBT	−0.0157	0.0070	−0.1218	0.0716	0.0297	0.0007
	(−2.66)***	(0.89)	(−3.00)***	(1.62)	(0.12)	(0.21)

HHI	−0.0509	0.0584	−0.2057	0.1988	−1.2084	0.0126
	(−2.72)***	(1.85)*	(−0.90)	(1.05)	(−1.99)**	(1.06)
STRET	0.0011	−0.0040	−0.0202	0.0267	0.0698	0.0022
	(0.80)	(−2.77)***	(−1.88)*	(2.46)**	(1.58)	(1.69)*
CFO	0.4889	0.3166	1.1414	−1.6458	1.3082	0.1406
	(6.97)***	(4.75)***	(7.00)***	(−9.14)***	(2.78)***	(6.86)***
Number of observations	14,606	14,606	14,606	14,606	14,382	13,080
Adj. *R*-squared	0.751	0.487	0.425	0.403	0.208	0.283

Table 5

Corporate investment policy after the initiation of credit default swap (CDS) trading, conditional on chief executive officer (CEO) compensation structure

Panel A reports the effect of chief executive officer compensation structure on corporate investment policy post–CDS inception: *R&D*, *CAPEX*, *SG&A*, *COGS*, *M&A*, and *OPINCVOL*. All variables are defined in Appendix A. The sample for *R&D*, *CAPEX*, *SG&A*, and *COGS* consists of 6,669 non-CDS firm-years and 7,937 CDS firm-years (3,223 firm-years for pre–CDS initiation and 4,714 firm-years for post–CDS initiation). The sample for *M&A* consists of 6,539 non-CDS firm-years and 7,843 CDS firm-years (3,146 firm-years for pre–CDS initiation and 4,697 firm-years for post–CDS initiation). The sample for *OPINCVOL* consists of 5,833 non-CDS firm-years and 7,247 CDS firm-years (3,128 firm-years for pre–CDS initiation and 4,119 firm-years for post–CDS initiation). Year and industry fixed effects are included. *t*-statistics based on robust standard errors clustered by year and industry are in parentheses. *, **, and *** denote significance at the 0.10, 0.05, and 0.01 level, respectively, two-tailed in control variables and one-tailed when discussing the results of hypothesis tests with predicted signs of coefficient estimates. Panel B reports the effect of CDS inception on risky operating investments, *R&D*, *SG&A*, *M&A*, and *OPINCVOL*, by the level of *VEGA*. All firms are divided into three groups by the level of *VEGA*. The results for the lowest and highest *VEGA* groups are presented in the first and second columns under the heading of each risky operating investment, respectively.

Panel A: Operating investments post-CDS inception, conditioned on VEGA

	Dependent variable					
Variable	*R&D*	*CAPEX*	*SG&A*	*COGS*	*M&A*	*OPINCVOL*
CDS_TRADE (*CDS_FIRM* × *POST_CDS*)	−0.0024	0.0007	−0.0251	0.0236	−0.4469	0.0007
	(−1.27)	(0.24)	(−4.60)***	(1.86)*	(−9.28)***	(1.26)
VEGA	0.0005	−0.0065	0.0363	−0.0384	0.1139	−0.0039
	(0.13)	(−1.22)	(4.52)***	(−4.22)***	(3.09)***	(−2.44)**
CDS_TRADE × *VEGA*	0.0039	−0.0021	0.0718	−0.0865	0.3337	0.0023
	(6.54)***	(−0.71)	(3.03)***	(−1.80)**	(5.05)***	(2.66)***
Firm-level controls	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	14,606	14,460	14,606	14,606	14,382	13,080
Adj. R-squared	0.752	0.489	0.436	0.414	0.213	0.284

Table 5 continued

Panel B: Operating investments post-CDS inception, examined separately for high and low vega groups

	Dependent variable							
	R&D		*SG&A*		*M&A*		*OPINCVOL*	
Variable	Lowest *VEGA* group	Highest *VEGA* group	Lowest *VEGA* group	Highest *VEGA* group	Lowest *VEGA* group	Highest *VEGA* group	Lowest *VEGA* group	Highest *VEGA* group
CDS_TRADE	−0.0021	−0.0034	−0.0235	−0.0151	−0.5700	−0.1547	0.0017	0.0070
(*CDS_FIRM* × *POST_CDS*)	(−2.46)**	(−1.53)	(−2.45)**	(−0.46)	(−3.76)***	(−1.47)	(0.66)	(2.24)**
Difference in	0.0029		0.0084		0.4153		0.0053	
CDS_TRADE	(1.66)**		(0.49)		(2.41)***		(1.84)**	
Firm-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	4,869	4,872	4,869	4,872	4,782	4,790	4,405	4,275
Adj. *R*-squared	0.751	0.720	0.279	0.418	0.218	0.253	0.322	0.213

Table 6
Likelihood of corporate bankruptcy after the initiation of credit default swap (CDS) trading

This table reports the joint effect of CDS inception and chief executive officer (CEO) compensation structure on the risk of bankruptcy. *BANKRUPTCY* is an indicator variable equal to one if the firm files for bankruptcy in the next five years and zero otherwise. *VEGA* is the dollar change in CEO wealth for a 1% change in standard deviation of returns. Control variables are defined in Appendix A. The sample consists of 6,396 non-CDS firm-years and 7,753 CDS firm-years (3,124 firm-years for pre–CDS initiation and 4,629 firm-years for post–CDS initiation). Panel A reports the effect of CDS inception on the risk of bankruptcy, conditioning on *VEGA.* All firms are divided into three groups by the level of *VEGA*. The results for the lowest and highest *VEGA* groups are presented in the first and second columns of Panel B under each heading, respectively. *t*-statistics based on robust standard errors clustered by year and industry are in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

Panel A: Bankruptcy risk post-CDS inception, conditioned on VEGA

Variable	Dependent variable: *BANKRUPTCY*	
CDS_TRADE (*CDS_FIRM* × *POST_CDS*)	0.0102	−0.0067
	(4.68)***	(−1.44)
VEGA		0.0113
		(1.41)
CDS_TRADE × *VEGA*		0.0651
		(2.24)**
CDS_FIRM	0.0032	0.0038
	(2.99)***	(1.75)*
TENURE	0.0070	0.0016
	(3.84)***	(0.49)
TOT_COMP	0.0020	−0.0008
	(2.38)**	(−0.56)
CEOAGE	0.0041	0.0051
	(1.15)	(0.77)
MKV	0.0021	−0.0008
	(3.38)***	(−0.57)
DEBT	0.0001	0.0009
	(0.33)	(0.99)
STRET	−0.0015	0.0006
	(−1.12)	(0.51)
STRETVOL	0.0049	0.0127
	(0.45)	(1.00)
MTB	−0.0002	−0.0004
	(−2.07)**	(−1.83)*
ROA	−0.0040	−0.0152
	(−0.27)	(−0.88)
CFO	0.0249	0.0135
	(2.72)***	(1.33)
SALEGLOWTH	0.0088	0.0074
	(2.19)**	(1.20)
Number of observations	14,149	14,149
Pseudo *R*-squared	0.030	0.060

Table 6 continued

Panel B: Bankruptcy risk post-CDS inception, conditioned on tercile rank of VEGA

	Dependent variable: *BANKRUPTCY*		
Variable	Lowest *VEGA* group		Highest *VEGA* group
CDS_TRADE (*CDS_FIRM* × *POST_CDS*)	0.0021		0.0130
	(1.42)		(2.02)**
Difference in *CDS_TRADE*		0.0109	
		(1.96)**	
CDS_FIRM	−0.0002		0.0163
	(−1.21)		(3.09)***
TENURE	0.0002		0.0234
	(0.09)		(3.79)***
TOT_COMP	0.0016		0.0031
	(1.65)*		(1.04)
CEOAGE	0.0055		0.0095
	(1.35)		(0.68)
MKV	−0.0009		0.0058
	(−1.59)		(2.44)**
DEBT	0.0006		0.0012
	(1.64)		(0.82)
STRET	−0.0002		−0.0018
	(−0.19)		(−0.37)
STRETVOL	0.0036		0.0194
	(0.30)		(0.40)
MTB	0.0001		−0.0009
	(1.26)		(−2.41)**
ROA	0.0023		−0.0037
	(0.71)		(−0.07)
CFO	0.0024		0.0817
	(1.01)		(2.44)**
SALEGLOWTH	0.0002		0.0211
	(0.36)		(1.44)
Number of observations	4,778		4,744
Pseudo *R*-squared	0.057		0.066

Table 7
Changes in chief executive officer (CEO) compensation structure after the initiation of credit default swap (CDS) trading

This table reports the effect of CDS trading on chief executive officer total compensation. *VEGA* is the dollar change in CEO wealth for a 1% change in standard deviation of stock returns. Control variables are defined in Appendix A. Sample consists of 6,539 non-CDS firm-years and 7,843 CDS firm-years (3,146 firm-years for pre–CDS initiation and 4,697 firm-years for post–CDS initiation). Year and industry fixed effects are included. *t*-statistics based on robust standard errors clustered by year and industry are in parentheses. *, **, and *** denote significance at the 0.10, 0.05, and 0.01 level, respectively, two-tailed in control variables and one-tailed when discussing the results of hypothesis tests with predicted signs of coefficient estimates.

	Dependent variable: *VEGA*
Variable	Full sample
CDS_TRADE	0.0525
	(3.12)***
CDS_FIRM	−0.0595
	(−1.91)*
TENURE	0.0460
	(5.02)***
TOT_COMP	0.1432
	(6.58)***
CEOAGE	0.1109
	(0.69)
SALES	0.0500
	(4.32)***
MTB	0.0102
	(2.95)***
DEBT	−0.1437
	(−1.62)
ROA	0.1228
	(0.83)
CFO	0.2686
	(1.09)
SURPLUSCASH	−0.3627
	(−1.93)*
SALEGLOWTH	0.0733
	(1.23)
STRET	−0.0635
	(−2.80)***
STRETVOL	0.0677
	(0.27)
HHI	−0.1859
	(−2.17)**
Year fixed effects	Yes
Industry fixed effects	Yes
Number of observations	14,382
Adj. *R*-squared	0.258

Table 8
Effect of credit default swap (CDS) inception on the borrowers' investment policy, conditioned on the lender hedging its client risk

This table reports results on the relation between CDS inception and borrower's investment policy, conditional on the likelihood of lender hedging its client risk. We identify lenders to CDS firms and non-CDS firms in our sample using the Dealscan database, and we collect the risk weights on banks' assets from the Federal Reserve Y-9C reports. We infer that lenders that increased risk capital ratio in the year in which the client's CDSs started trading are more likely to have hedged their risk with respect to the specific borrower through CDS contracts. We split the sample into two categories: firm-year observations with lenders that increase capital ratio and those that decrease capital ratio. All variables are defined in Appendix A. *t*-statistics in parentheses are based on robust standard errors clustered by industry and year. *, **, and *** denote significance at the 0.10, 0.05, and 0.01 level, respectively, two-tailed in control variables and one-tailed when discussing the results of hypothesis tests with predicted signs of coefficient estimates.

	Dependent variable							
	R&D		*SG&A*		*M&A*		*OPINCVOL*	
Variable	*Risk capital ratio* decreases	*Risk capital ratio* increases	*Risk capital ratio* decreases	*Risk capital ratio* increases	*Risk capital ratio* decreases	*Risk capital ratio* increases	*Risk capital ratio* decreases	*Risk capital ratio* increases
CDS_TRADE	0.0006	−0.0064	−0.0411	−0.0183	−0.3757	−0.4368	0.0011	−0.0026
(*CDS_FIRM* × *POST_CDS*)	(0.18)	(−2.41)**	(−5.22)***	(−2.23)**	(−2.58)**	(−4.01)***	(0.80)	(−1.86)*
VEGA	0.0000	0.0032	0.0349	0.0583	0.9659	−0.1513	−0.0009	−0.0009
	(0.00)	(1.25)	(2.50)**	(2.38)**	(3.88)***	(−1.19)	(−1.30)	(−0.57)
CDS_TRADE × *VEGA*	0.0033	0.0174	0.0239	0.0720	−0.1295	0.4607	−0.0032	0.0033
	(1.51)	(2.45)**	(1.57)	(1.80)*	(−0.48)	(2.34)**	(−0.74)	(2.30)**
Difference in	0.0141		0.0481		0.5902		0.0065	
CDS_TRADE × *VEGA*	(2.08)**		(1.79)*		(2.08)**		(1.87)*	
Firm-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	4,123	3,868	4,123	3,868	4,087	3,798	3,773	3,488
Adj. *R*-squared	0.776	0.739	0.412	0.582	0.362	0.283	0.358	0.358

Table 9
Robustness check: Changes in firm's operating policy after the initiation of credit default swap (CDS) trading [three-stage least squares approach (3SLS)]

This table reports results on the relation among CDS inception, management compensation, and corporate investment policy using a three-stage least squares approach (Zellner and Theil, 1962). The onset of CDS trading, vega, and corporate investment policy could be jointly determined. So, all three are determined simultaneously with the other two endogenous variables as regressors, in addition to the control variables. We also use two exogenous variables: *Industry Peers' Bond Trading Volume* and *Investment / Speculative Grade Frontier*. All variables are defined in Appendix A. Sample consists of 5,111 non-CDS firm-years and 6,627 CDS firm-years (2,668 firm-years for pre–CDS initiation and 3,959 firm-years for post–CDS initiation). Panel A reports results of the three-stage model with dependent variable *R&D* and *SG&A*; and Panel B, *M&A* and *OPINCVOL*. *t*-statistics in parentheses are based on robust standard errors clustered by industry and year. *, **, and *** denote significance at the 0.10, 0.05, and 0.01 level, respectively, two-tailed in control variables and one-tailed when discussing the results of hypothesis tests with predicted signs of coefficient estimates.

Panel A: 3SLS for R&D and SG&A

	3SLS when *RiskyInvestment* = *R&D*			3SLS when *RiskyInvestment* = *SG&A*		
		Dependent variable			Dependent variable	
Variable	*CDS_TRADE*	*VEGA*	*R&D*	*CDS_TRADE*	*VEGA*	*SG&A*
CDS_TRADE (*CDS_FIRM×POST_CDS*)		0.0367	−0.0019		0.0516	−0.0430
		(2.80)***	(−3.33)***		(3.96)***	(−9.28)***
CDS_FIRM		−0.0662	0.0025	−0.0027		0.0746
		(−6.35)***	(5.50)***	(−0.31)		(20.05)***
VEGA	−0.0326		0.0010		−0.0484	−0.0167
	(−3.84)***		(2.06)**		(−4.68)***	(−4.55)***
CDS_TRADE × *VEGA*			0.0053			0.0887
			(3.98)***			(8.31)***
RiskyInvestment	0.1049	0.9939		−0.4083	0.7114	
	(0.51)	(4.70)***		(−16.13)***	(27.89)***	
Industry Peers' Bond Trading Volume	−0.1028			−0.0768		
	(−9.22)***			(−6.66)***		
Investment / Speculative Grade Frontier	0.1878			0.3501		
	(4.64)***			(8.32)***		
Firm-level controls	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	11,738	11,738	11,738	11,738	11,738	11,738
R-squared	0.376	0.264	0.747	0.377	0.265	0.416

Table 9 continued

Panel B: 3SLS for M&A and OPINCVOL

	3SLS when *RiskyInvestment* = *M&A*			3SLS when *RiskyInvestment* = *OPINCVOL*		
	Dependent variable			Dependent variable		
Variable	*CDS_TRADE*	*VEGA*	*M&A*	*CDS_TRADE*	*VEGA*	*OPINCVOL*
CDS_TRADE (*CDS_FIRM*×*POST_CDS*)		0.0886	−1.0587		0.0450	0.0017
		(6.74)***	(−34.48)***		(6.41)***	(2.25)**
CDS_FIRM		−0.0385	−0.3309		−0.0333	−0.0015
		(−3.66)***	(−13.58)***		(−5.98)***	(−2.69)***
VEGA	0.0426		0.3022	0.0092		−0.0093
	(5.22)***		(11.90)***	(0.60)		(−8.61)***
CDS_TRADE × *VEGA*			0.4483			0.0015
			(6.30)***			(1.56)*
RiskyInvestment	−0.1964	0.0641		0.3584	−0.8006	
	(−61.03)***	(16.91)***		(2.15)**	(−8.69)***	
Industry Peers' Bond Trading Volume	−0.0879			−0.0968		
	(−8.11)***			(−8.62)***		
Investment / Speculative Grade Frontier	0.1731			0.2541		
	(4.39)***			(6.30)***		
Firm-level controls	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	11,738	11,738	11,738	11,738	11,738	11,738
R-squared	0.398	0.265	0.163	0.376	0.400	0.234