The Effect of Credit Default Swaps on Risk Shifting

Chanatip Kitwiwattanachai*

University of Connecticut

Jiyoon Lee†

University of Illinois at Urbana-Champaign

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*University of Connecticut, School of Business, 2100 Hillside Road, Storrs, CT 06269, phone: 860-486-1275, email: ckitwiwattanachai@business.uconn.edu

†University of Illinois at Urbana-Champaign, College of Business, email: lee825@illinois.edu

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Abstract

We study the effect of credit default swaps (CDS) on a firm's risk shifting. Because CDS provides insurance against default, bondholders (banks) become indifferent whether a firm defaults and likely reduce monitoring efforts. Moreover, CDS strengthens bondholders' bargaining power, potentially leading to higher default rates. Therefore, managers of financially distressed firms have more incentives to, and find it easier to take on excessive risk. Controlling for the possibility of reverse causality that CDS trading may arise in anticipation of risk shifting, and a selection bias, we find empirical evidence that CDS trading causes financially distressed firms to engage in more risk shifting.

Introduction

A credit default swap (CDS) is a contract that provides insurance against the risk of default by a corporation or other obligor, termed the reference entity. Upon the occurrence of a credit event the CDS buyer has the right either to sell bonds issued by the reference entity to the CDS seller in exchange for the bonds' face value or receive from the CDS seller a cash payment equal to the difference between the face and market value of the bonds. Credit events include the reference entity's failure to meet its payment obligations on a financial instrument, the reference entity's bankruptcy, and sometimes restructuring of the bonds issued by the reference entity. The counterparty, the CDS seller, agrees to buy the bonds for their face value or make the cash payment upon the occurrence of the credit event, thus bearing the risk of default.

The market for CDS existed since late 1990s but has become popular and enjoyed exponential growth in early 2000s, up until the financial crisis in 2008. At the early stages, banks were the dominant players in the market, using CDS to hedge credit risk associated with lending activities. Later on speculators took part in the market as hedge funds and asset managers saw trading opportunities. CDS is also credited for allowing banks to free up their regulatory capital, reducing the cost of capital, and eventually fueling the growth of the economy.

With the new financial product comes the lack of understanding. CDS and other credit derivatives were one of the main culprits for the financial crisis in 2008. Questions are raised on the claimed benefits of CDS. Research fails to confirm that CDS trading actually leads to lower cost of debt (Ashcraft and Santos (2009)). Banks that hedge credit risk through CDS are likely to reduce monitoring effort, allowing managers to take excessive risk, shifting the risk to creditors who no longer have financial skin in the game. Debtors who have obtained insurance against default but otherwise retain control rights in bankruptcy (empty creditors) become a tougher negotiator which can lead to higher default rates (Bolton and Oehmke (2011), Subrahmanyam et al. (2012))

Risk shifting occurs when shareholders invest in risky negative-NPV projects as they benefit from the upside while bondholders suffer from the downside. Equity can be viewed as a call option on the firm's value (Merton (1974)), and call option's value increases with volatility. Equityholders thus have an incentive to take excessive risk, especially for distressed firms where the risk shifting behavior has been empirically confirmed (Eisdorfer (2008)). Risk shifting is more likely to occur if debtholders do not monitor the manager's behavior, allowing the manager to take actions to their disadvantage.

This paper investigates the risk shifting behavior when CDS is traded on the firm. Bondholders (banks) can hedge default risk by buying CDS and are likely to put less effort on monitoring. Moreover, since CDS tend to increase the default probability, firms become more distressed leading to more incentive for risk shifting.

We provide a simple theoretical background using the Merton model (Merton (1974)) and show that with higher default probability, equityholders prefer higher volatility. We then follow the empirical methodology in Eisdorfer (2008) and find significant effect of CDS on risk shifting behavior. Specifically, after CDS trading, firms will invest more in volatile times than previously. Distressed firms also exhibit more risk shifting behavior after CDS trading, consistent with the previous literature.

Since CDS initiation can be endogenous, one must control for the selection bias.

We use propensity score matching to alleviate such concern and find that the results are largely the same. We also perform falsification test and confirm that the results are robust to other random specifications. Furthermore, we address the possibility of reverse causality in which case CDS trading is triggered by bondholders' concern about risk shifting. We drop observations for firms that go into distress within 2 years after CDS initiation, possibly due to bondholders' foresight into the upcoming trouble. The regression results remain the same, confirming the direction of causality from CDS to risk shifting.

We also find evidence that firms invest less after CDS trading, contrary to the belief that CDS would reduce the cost of debt and allow firms to invest more. The findings are also robust to selection bias and cast more doubt on the benefits of CDS to the economy.

This paper is, to the best of our knowledge, the first to empirically investigate risk shifting associated with CDS trading. Ashcraft and Santos (2009) show that CDS trading does not reduce the cost of capital. Bolton and Oehmke (2011) provide theoretical framework for empty creditors with control rights but no financial involvement. Campello and Matta (2012) show that CDS may lead to risk shifting and increase the probability of default. Consistent with their theory, we find empirical evidence of risk shifting after CDS trading.

Subrahmanyam et al. (2012) show empirically that CDS trading leads to subsequent higher default rates. Risk shifting problem was introduced by Jensen and Meckling (1976) and subsequently confirmed empirically by Eisdorfer (2008). This paper also belongs to a strand of literature investigating the effect of derivatives on the underlying asset, in this case the impact of CDS on the firm's investment behavior.

The paper proceeds as follows. Secion 1 provides theoretical background for risk shifting after CDS trading. Section 2 shows empirical evidence of risk shifting after CDS trading. Section 3 provides robustness check. Section 4 concludes.

1 Theoretical Background

This section provides a simple theoretical background for risk shifting caused by CDS initiation, which motivates the empirical analysis. An equilibrium approach with similar conclusion can be found in Campello and Matta (2012).

Shareholders prefer higher volatility because, due to limited liability, they enjoy the rewards when the outcome is good while bondholders suffer the penalties if the outcome is bad. The Merton model (Merton (1974)) summarizes this asymmetry in payoff by viewing equity as a call option on the firm's value with the strike price as the default barrier, usually assumed to be the face value of debt. Thus, equity value, as a call option, will depend on the volatility of the underlying asset and the strike price[1].

$$E = C(\sigma, K) \tag{1}$$

where σ is the volatility and K is the default barrier. Since the call option value increases in volatility ($\frac{\partial C}{\partial \sigma} > 0$), equityholders have incentive to increase volatility to increase the equity value (ex ante). Thus, this framework also captures risk shifting.

Consider an introduction of CDS to be traded on the firm. Assume that the bond-

[1]Option value also depends on other factors such as the underlying asset value, time to maturity and interest rates, but these factors are of no concern for this paper

holders have bought a CDS to protect themselves against default risk. The first consequence is that bondholders (or banks) will reduce their monitoring effort due to the insurance provided by the CDS. Managers may find it easier to shift risk to the bondholders who no longer have financial skin in the game.

Even more troubling is that these empty creditors are likely tougher during debt renegotiations once the borrowers are in financial distress, raising the probability of default of the underlying firm (Bolton and Oehmke (2011), Subrahmanyam et al. (2012)). In the context of the Merton model, with CDS, the default barrier (K) has moved up, i.e,

$$K_{CDS} > K \tag{2}$$

where K_{CDS} is the default barrier when CDS exists.

Firms become more distressed when CDS is traded because the default barrier has been raised. As a result, shareholders find more incentive to increase volatility to increase the equity value. Using the Black-Scholes formula for option pricing,

$$\begin{aligned} \frac{\partial(\frac{\partial C}{\partial K})}{\partial \sigma} &= \frac{\partial^2 C}{\partial \sigma \partial K} \\ &= \frac{\partial(\frac{\partial C}{\partial \sigma})}{\partial K} \\ &= \frac{\partial \text{Vega}}{\partial K} \\ &= e^{-rT}\phi(d_2)\sqrt{T} > 0 \end{aligned} \tag{3}$$

where $Vega$ is the measure of call option's sensitivity to volatility, $\phi(.)$ is the standard normal probability density function, T is the time to maturity (usually assumed to be the time to debt maturity), and $d_2 = \frac{ln(V/K)+(r-\sigma^2/2)T}{\sigma\sqrt{T}}$. The first line is the change in equity value after CDS is introduced, and the subsequent change in equity value with respect to increase in volatility. The last line shows positive value, indicating that by increasing volatility, the equity value will increase, thus providing incentive for shareholders to shift the risk after CDS is traded[2].

Intuitively firms are more prone to risk shifting when in distress as shown by Eisdorfer (2008). When CDS is traded, firms become more distressed, and thus are more prone to risk shifting.

2 Empirical Analysis

With lower monitoring and higher distress, we expect more risk shifting for firms after CDS is introduced. In this section we follow Eisdorfer (2008) to empirically investigate risk shifting behavior after CDS initiation. Firms in financial distress are more likely to invest during volatile periods, increasing volatility of the firm and shift the risk from equityholders to debtholders. The relation between investment and volatility will be positive for firms with risk shifting behavior.

2.1 Data

There are three main sources of data: the CDS data, the market data regarding market volatility, and the accounting data regarding investments. For CDS data, we need the date when CDS starts trading for each firm. The CDS data are from Bloomberg. There are 765 firms whose CDS starts trading between January 2001 and December 2012,

[2] One can also think of this framework as diff-in-diff, where the first difference is before and after CDS, and the second difference is lower and higher volatility. One can expect a positive effect in such diff-in-diff exercise.

our sample period. The start trading date is the first date that the CDS quotes exist on Bloomberg[3]. Figure 1 shows the distribution of the start trading date by year.

The market data are from CRSP. We use the S&P500 index returns from 1927 to 2012 as the market returns to calculate the expected volatility using the GARCH(1,1) model. Figure 2 shows the resulting expected volatility from the GARCH(1,1,) model.

The accounting data are from Compustat. The annual data are available from 1963 to 2012. The firm will be included in the dataset if it has the variables for asset value, investment intensity, and Z-score. The final sample contains 105,747 firm-year observations with 12,710 different firms.

Table 1 shows summary statistics of variables used in empirical analysis. Investment intensity is the ratio of capital expenditures to PP&E at the beginning of the year. Z-score is based on Altman's (1968) model. The market-to book ratio is equity market value divided by equity book value. Leverage is the book value of total liabilities divided by total assets. Cash flow is the firm's operating cash flow divided by PP&E at the beginning of the year. The results are based on 105,747 firm-year observations over the period 1963 to 2012. The summary statistics are comparable to Eisdorfer (2008) except for leverage which is substantially higher but is still within a reasonable range[4].

[3]While there is no guarantee that this date is in fact the first date that anyone anywhere first starts trading CDS for the firm, the CDS trading must be sufficiently popular and accessible to bondholders to have an impact on the firm's investment. We assume that if the CDS is popular and quoted by many dealers, then the data will enter into the Bloomberg system which we then observe.

[4]Different from Eisdorfer (2008), we do not calculate firm size by solving the Merton model but simply use the sum of market value of eqiuty and book value of total liabilities.

2.2 Empirical Results

Following the regression framework in Eisdorfer (2008), we examine the effect of expected volatility on investment after CDS starts trading on the firm. We introduce a dummy variable *CDS* which is equal to 1 if the CDS exists for the firm, and 0 otherwise. The question is whether *CDS* significantly influences the relation between investment and expected volatility.

Table 2 shows the results for the effect of CDS on the relation between expected volatility and investment. Column (1) shows a baseline regression with all control variables. On average, expected volatility has negative impact on investment, indicating that on average firms are not in financial distress (Eisdorfer (2008)). The average Z-score is 4.27 ¿ 1.81 which is the cut-off for financial distress. All other coefficients for control variables are significant and have the same sign as in Eisdorfer (2008).

Column (2) shows the impact of CDS on the relation between expected volatility and investment. The interaction term between expected volatility and *CDS* is significantly positive, indicating that CDS firms increase investments during volatile periods, thus exhibiting risk shifting behavior.

Interestingly the sign for *CDS* is negative, indicating that firms decrease investment after CDS is introduced. Since *CDS* is a dummy variable, the interpretation is that fter CDS is traded, firms reduce investment by about 10%. This result is surprising because CDS is thought to enable firms to lower the cost of debt and thus invest more. While Ashcraft and Santos (2009) find no significant impact on the cost of debt after CDS trading, our result is even more contradictory to the belief by showing the impact in the opposite direction.

2.3 Distressed Firms

To further investigate the impact of CDS on risk shifting, we divide firms into 2 groups, healthy and distressed, similar to Eisdorfer (2008). Distressed firms have Z-score less than 1.81, and healthy otherwise. The dummy variable *Distress* is equal to 1 if the firm is in distress, and 0 otherwise.

Table 3 shows the regression results for distressed and healthy firms, separated by the *Distress* dummy variable. The results show that distressed firms are even more prone to risk-shifting after CDS trading because the interaction term between expected volatility, *CDS* and *Distress* is positive and statistically significant at the 10% level. The interaction term between expected volatility and *Distress*, however, is not statistically significant, contrary to Eisdorfer (2008). This may be because the classification of financial distress into two categories, healthy and distressed, is too rigid, or because the cut-off level at 1.81 is no longer applicable to the recent business environment. We show next that using the continuous Z-score gives more consistent results with the literature.

Table 4 shows the regression analysis for the interaction term between expected volatility and financial distress (Z-score). Instead of using a cut-off to define distress, Z-score is used directly as a proxy for financial distress. The results are consistent with Table 3 with the interaction term between expected volatility, *CDS* and Z-score statistically significant at the 1% level. Note that lower Z-score means higher financial distress, so the signs of the coefficients are opposite from Table 3. Moreover, the interaction term between expected volatility and Z-score is statistically significant, consistent with Eisdorfer (2008).

3 Robustness Check

This section provides robustness check for the main empirical results. We perform falsification test, exclude reverse causality scenarios, and address selection bias by propensity score matching.

3.1 Falsification test

The dummy variable *CDS* has a property that it is a step function. Before CDS trading, *CDS* is 0, but once CDS starts trading, *CDS* will switch to and remain at 1. It is thus possible that *CDS* is in fact a proxy for other macroeconomic conditions that happen to switch on around early 2000s, when the CDS market starts growing substantially. This section provides falsification test to alleviate such concern.

We introduce another dummy variable *After2001*, which is equal to 1 if the time period is from January 2001 onward, and 0 otherwise. We then run the same regression using *After2001* and see if this falsified proxy can reproduce the results obtained before.

Table 5 shows the results of falsification test. Column 1 shows regression results with *CDS* replaced by *After2001.* The interaction term between expected volatility and *After2001* is not statistically significant. Interestingly, the dummy *After2001* itself is negative and highly significant. However, we do not attempt to further explain the significance of this parameter here. It suffices to say that the falsification test does not reproduce the previous results on CDS and risk shifting.

In Table 5 column 2 we put back the interaction term between expected volatility and *CDS*. The coefficient for this term is positive and significant, similar to previous results in Table 2, but the magnitude somewhat declines. The same applies for the coefficient for the dummy *CDS* in the regression. This indicates that the dummy *CDS* may partially capture the time trend, but after controlling for such trend, the impact of CDS on risk shifting is still significant.

The recession dummy becomes positive and significant, but the magnitude is much lower than in Table 2. This indicates that *After2001* also partially captures the impact of the recessions in 2001 and 2008-2009.

3.2 Reverse Causality

A regression cannot prove causality, i.e., whether CDS initiation causes risk shifting or risk shifting causes CDS initiation. Our main explanation for the regression results is the first but not the second. In this section we alleviate the concern about reverse causality by dropping firms whose CDS trading is possibly triggered by risk shifting. If the main regression results still hold, it means that the causality is in the direction that we claim.

Bondholders may be concerned about manager's risk shifting in the next few years and want to protect themselves by purchasing CDS. We then observe firms with CDS going into distress, exhibiting risk shifting behavior, and conclude that CDS causes risk shifting but the fact is the other way around. While this scenario is possible, it is against our main explanation and thus we want to rule out this possibility. Bondholders may oversee the threat of risk shifting over the next few years, but it is unlikely that they can see the threat far into the future. To exclude this possibility, we drop firms with CDS, which go into distress within 2 years after CDS initiation. We can drop all observations for such firms, or drop only the observations within 2-year window. We try both options and run the same regressions as in Table 2 and Table 3.

Table 6 reports the results excluding reverse causality scenarios. Column 1 shows similar regression as in Table 2, excluding firms with reverse causality. Column 2 shows similar regression as in Table 2, excluding observations with reverse causality. Column 3 shows similar regression as in Table 3, excluding firms with reverse causality. Column 4 shows similar regression as in Table 3, excluding observations with reverse causality.

For all columns, the interaction term between expected volatility and *CDS* is positive and significant. The magnitude is similar to Table 2. Thus, the effect of CDS on the relation between investment and expected volatility is robust to reverse causality.

For column 3, the interaction term between expected volatility, *CDS* and *Distress* is no longer significant because we exclude all observations for firms in distress within 2 years of CDS initiation. *Distress* status tends to change slowly; firms in distress this year also tends to be in distress next year. Excluding CDS firms in distress within 2 years tends to exclude all CDS firms that will be in distress at all. With small observations for CDS firms that will be in distress, the regression analysis loses statistical power, rendering the results insignificant.

For column 4, the interaction term between expected volatility, *CDS* and *Distress* is still positive and significant with magnitude comparable to Table 3. We regain statistical significance because only distressed observations within 2 years are excluded, not all observations for the firm. Enough CDS firms in distress are left to derive statistical significance in the regression.

Since we found that the continuous Z-score may be better for the regression analysis than the dummy classification into healthy and distressed, we also perform reverse causality test using Z-score. The results are reported in Table 7. Column 1 shows similar regression as in Table 4, excluding firms with reverse causality. Column 2 shows similar regression as in Table 4, excluding observations with reverse causality. The results are the same.

Overall, the interaction term between expected volatility and *CDS* remains positive and significant after excluding potential reverse causality cases. Moreover, the interaction term between expected volatility, *CDS* and distress (using dummy or Z-score) also remains positive and significant. The results confirm our main explanation that CDS causes risk shifting.

3.3 Selection Bias: Propensity Score Matching

One potential concern for the empirical results is the selection bias. Firms selected for CDS trading may have special characteristics that correlate with how they invest in volatile periods. In particular, only distressed firms may be selected for CDS trading. Thus, what we observe as an increase in investments during volatile periods may be the results of CDS selection for distressed firms, but not the effect of CDS on the relation between investment and expected volatility. We apply propensity score matching in this section to alleviate such concern.

Propensity score matching selects firms with similar probability of CDS trading for the analysis. Thus, the regression analysis is no longer driven by the selection bias, because all firms have similar probability to be selected. For each CDS firm, we find three matching non-CDS firms with the nearest propensity score for CDS trading.[5] We

[5]One or two matching non-CDS firms also give similar results.

then run the same regression analysis on this matched dataset.

Propensity score is calculated from the covariates suggested by Subrahmanyam et al. (2012). The logistic regression results are reported in Table 8. The results are largely consistent with Subrahmanyam et al. (2012). Note that firms selected for CDS trading are not necessarily more risky or distressed. From Table 8, *Investment Grade* and *Rated* are positive, indicating that higher rated (safer) firms are more likely to have CDS. Moreover, traditional measures of financial distress, such as *WCAP/Total Asset* and *RE/Total Asset*, also enter positively in the regression, indicating more healthy firms are more likely to have CDS. At the same time, *Leverage* has a positive sign and *ROA* has a negative sign, indicating more risky and distressed firms are more likely to have CDS. Overall, the results are mixed and do not point particularly to distressed firms to be selected for CDS trading. This first informal evidence alleviates concerns that our results are driven solely by the selection bias of distressed firms.

With the CDS firms and the matched firms, we run the same regression as in Table 2, 3, and 4. The results are reported in Table 9.

The first column of Table 9 shows the base regression. *CDS* and the interaction term between expected volatility and *CDS* are significant with the same sign as in Table 2, but the magnitudes are smaller. Similar observation applies for the second and third columns. Thus, the selection bias may partially affect the magnitude of *CDS* and the interaction term between expected volatility and *CDS*, but they are still highly significant after controlling for such bias.

Interestingly, the coefficients for the interaction term between expected volatility, *CDS* and distress (using dummy or Z-score) remain highly significant with almost the same magnitude as in Table 3 and 4. These coefficients are not affected by the selection bias. Note also that the coefficient for *CDS* reduces to about -4%, still indicating that firms invest less after CDS trading.

Overall, the propensity score matching confirms that our results are robust and not driven by the selection bias.

4 Conclusion

We provide theoretical background and find significant empirical evidence of risk shifting when CDS is traded on the firm. Possible explanations include reduced monitoring effort from the bondholders (banks) when they are insured from default risk. Higher default probability from tougher creditors also put firms in distress, making them more prone to risk shifting.

The regression analysis shows positive relation between investment and expected volatility when CDS is traded on the firm. The positive relation is stronger for firms in financial distress. The empirical results are robust to falsification test, reverse causality test, and propensity score matching (selection bias). We also find evidence that firms invest less after CDS trading, contrary to the belief that CDS would reduce the cost of debt and allow firms to invest more.

The paper shows unintended consequence of credit derivatives on the firm's risk-taking and investment behavior. The problem may stem from the divergence between financial and control rights through insurance purchase. Future research may include identifying the mechanism to prevent these unintended consequences, possibly through risk retention of empty creditors, and proving (or disproving) if CDS is in fact beneficial to the economy.

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Table 1: Summary Statistics.
Investment intensity is the ratio of capital expenditures to PP&E at the beginning of the year. Z-score is based on Altman's (1968) model. The market-to book ratio is equity market value divided by equity book value. Leverage is the book value of total liabilities divided by total assets. Cash flow is the firm's operating cash flow divided by PP&E at the beginning of the year. The results are based on 105,747 firm-year observations over the period 1963 to 2012.

	Mean	Std	P25	P50	P75
Investment intensity	0.20	0.28	0.07	0.12	0.22
Z-score	4.27	4.76	1.99	3.27	5.03
Market-to-Book	2.33	2.87	0.90	1.49	2.60
Leverage	0.57	0.30	0.38	0.56	0.72
Cash flow	0.15	0.83	0.02	0.12	0.29

Table 2: Regression of investment on expected volatility and the interaction between expected volatility and *CDS*. The t-statistics are in the parenthesis with standard errors clustered by firms (***significant at 1% level, ** significant at 5% level, * significant at 10% level).

Explanatory Variables	(1)	(2)
Intercept	0.259***	0.259***
	(40.47)	(40.04)
Exp. Volatility	−0.223**	−0.267***
	(-2.27)	(-2.71)
CDS		−0.106***
		(-13.74)
Exp. Volatility * CDS		1.528***
		(13.76)
Log(size)	−0.004***	−0.003***
	(-6.83)	(-5.61)
Market-to-book	0.015***	0.015***
	(29.17)	(29.18)
Leverage	−0.155***	−0.154***
	(-28.99)	(-28.90)
Lagged cash flow	0.005***	0.005**
	(2.46)	(2.38)
Recession dummy	−0.017***	−0.015***
	(-6.36)	(-5.75)
Default spread	−3.054***	−3.084***
	(-14.52)	(-14.64)
Interest rate	0.960***	0.937***
	(22.10)	(21.38)
N	105747	105747
R^2	0.066	0.066

Table 3: Regression analysis for healthy and distressed firms. The t-statistics are in the parenthesis with standard errors clustered by firms (***significant at 1% level, ** significant at 5% level, * significant at 10% level).

Explanatory Variables	(1)
Intercept	0.255***
	(38.44)
Exp. Volatility	−0.230**
	(-2.23)
Distress	0.029***
	(4.19)
CDS	−0.105***
	(-13.28)
Exp. Volatility * Distress	-0.142
	(-1.05)
Exp. Volatility * CDS	1.422***
	(9.97)
Exp. Volatility * CDS *Distress	0.238*
	(1.64)
Log(size)	−0.003***
	(-5.22)
Market-to-book	0.015***
	(29.36)
Leverage	−0.169***
	(-28.66)
Lagged cash flow	0.006***
	(2.70)
Recession dummy	−0.014***
	(-5.35)
Default spread	−3.144***
	(-14.75)
Interest rate	0.954***
	(21.65)
N	105747
R^2	0.067

Table 4: Regression analysis for the interaction term between expected volatility and financial distress (Z-score). The t-statistics are in the parenthesis with standard errors clustered by firms (***significant at 1% level, ** significant at 5% level, * significant at 10% level).

Explanatory Variables	(1)
Intercept	0.108***
	(14.99)
Exp. Volatility	0.292**
	(2.21)
Z-score	0.018***
	(13.88)
CDS	−0.064***
	(-9.90)
Exp. Volatility * Z-score	−0.110***
	(-3.73)
Exp. Volatility * CDS	1.045***
	(8.66)
Exp. Volatility * CDS *Z-score	−0.139***
	(-4.18)
Log(size)	−0.003***
	(-6.07)
Market-to-book	0.006***
	(14.34)
Leverage	−0.012***
	(-2.84)
Lagged cash flow	-0.001
	(-0.45)
Recession dummy	−0.015***
	(-6.11)
Default spread	−1.811***
	(-9.26)
Interest rate	0.695***
	(17.02)
N	92887
R^2	0.126

Table 5: Regression analysis for falsification test. The t-statistics are in the parenthesis with standard errors clustered by firms (***significant at 1% level, ** significant at 5% level, * significant at 10% level).

Explanatory Variables	(1)	(2)
Intercept	0.312***	0.310***
	(39.77)	(39.24)
Exp. Volatility	−0.395***	−0.396***
	(-2.91)	(-2.92)
After2001	−0.064***	−0.060***
	(-8.55)	(-8.02)
CDS		−0.068***
		(-8.49)
Exp. Volatility * After2001	0.129	0.071
	(0.79)	(0.43)
Exp. Volatility * CDS		0.809***
		(7.04)
Log(size)	−0.003***	−0.002***
	(-4.53)	(-3.58)
Market-to-book	0.015***	0.014***
	(29.09)	(29.09)
Leverage	−0.157***	−0.157***
	(-29.13)	(-29.04)
Lagged cash flow	0.005**	0.005**
	(2.36)	(2.28)
Recession dummy	0.005*	0.005**
	(1.74)	(2.01)
Default spread	−2.367***	−2.334***
	(-10.84)	(-10.70)
Interest rate	0.145***	0.130**
	(2.73)	(2.43)
N	105747	105747
R^2	0.071	0.071

Table 6: Regression analysis excluding reverse causality scenarios. The t-statistics are in the parenthesis with standard errors clustered by firms (***significant at 1% level, ** significant at 5% level, * significant at 10% level).

Explanatory Variables	(1)	(2)	(3)	(4)
Intercept	0.255***	0.259***	0.250***	0.255***
	(38.59)	(40.04)	(36.99)	(38.43)
Exp. Volatility	−0.271***	−0.262***	−0.232**	−0.227**
	(-2.68)	(-2.65)	(-2.22)	(-2.20)
Distress			0.031***	0.028***
			(4.30)	(4.09)
CDS	−0.120***	−0.114***	−0.112***	−0.110***
	(-13.78)	(-13.93)	(-12.87)	(-13.09)
Exp. Volatility * Distress			-0.145	-0.132
			(-1.04)	(-0.97)
Exp. Volatility * CDS	1.528***	1.652***	1.529***	1.527***
	(11.43)	(13.84)	(11.03)	(10.16)
Exp. Volatility * CDS *Distress			-0.075	0.309*
			(-0.39)	(1.80)
Log(size)	−0.003***	−0.003***	−0.002***	−0.003***
	(-4.30)	(-5.61)	(-3.72)	(-5.22)
Market-to-book	0.015***	0.015***	0.015***	0.015***
	(28.89)	(29.19)	(29.00)	(29.36)
Leverage	−0.154***	−0.154***	−0.170***	−0.169***
	(-28.58)	(-28.88)	(-28.49)	(-28.64)
Lagged cash flow	0.005**	0.005**	0.005**	0.006***
	(2.21)	(2.38)	(2.54)	(2.70)
Recession dummy	−0.016***	−0.015***	−0.015***	−0.014***
	(-5.97)	(-5.78)	(-5.60)	(-5.37)
Default spread	−3.108***	−3.113***	−3.180***	−3.173***
	(-14.32)	(-14.69)	(-14.46)	(-14.81)
Interest rate	0.971***	0.935***	0.992***	0.953***
	(21.64)	(21.32)	(21.96)	(21.60)
N	102628	105476	102628	105476
R^2	0.064	0.066	0.066	0.067

Table 7: Regression analysis for the interaction term between expected volatility and financial distress (Z-score), excluding reverse causality scenarios. The t-statistics are in the parenthesis with standard errors clustered by firms (***significant at 1% level, ** significant at 5% level, * significant at 10% level).

Explanatory Variables	(1)	(2)
Intercept	0.105***	0.108***
	(14.42)	(14.99)
Exp. Volatility	0.292**	0.297**
	(2.17)	(2.25)
Z-score	0.018***	0.018***
	(13.78)	(13.88)
CDS	−0.074***	−0.069***
	(-9.56)	(-10.43)
Exp. Volatility * Z-score	−0.110***	−0.110***
	(-3.71)	(-3.74)
Exp. Volatility * CDS	1.096***	1.157***
	(5.97)	(8.68)
Exp. Volatility * CDS *Z-score	−0.116***	−0.143***
	(-2.67)	(-4.19)
Log(size)	−0.003***	−0.003***
	(-4.99)	(-6.07)
Market-to-book	0.006***	0.006***
	(14.06)	(14.35)
Leverage	−0.012***	−0.012***
	(-2.67)	(-2.83)
Lagged cash flow	-0.001	-0.001
	(-0.62)	(-0.45)
Recession dummy	−0.016***	−0.015***
	(-6.27)	(-6.13)
Default spread	−1.821***	−1.831***
	(-9.07)	(-9.32)
Interest rate	0.718***	0.694***
	(17.20)	(16.98)
N	90409	92670
R^2	0.123	0.125

Table 8: Probability of CDS trading. The table reports the estimates of the probability of CDS trading using a probit model. The sample period is from 2001 to 2012 at a yearly frequency. The standard errors are in parentheses (***significant at 1% level, ** significant at 5% level, * significant at 10% level).

Explanatory Variables	(1)
Intercept	-8.402^{***}
	(0.203)
Log(Assets)	0.576^{***}
	(0.017)
Leverage	1.326^{***}
	(0.110)
ROA	-0.838^{***}
	(0.200)
$r_{it-1} - r_{mt-1}$	0.0005
	(0.0003)
Equity Volatility	0.021
	(0.086)
PPENT/Total Asset	0.557^{***}
	(0.111)
Sales/Total Asset	0.079^{***}
	(0.027)
EBIT/Total Asset	0.080
	(0.319)
WCAP/Total Asset	0.416^{**}
	(0.166)
RE/Total Asset	0.183^{***}
	(0.065)
Cash/Total Asset	0.217
	(0.267)
CAPX/Total Asset	-2.754^{***}
	(0.490)
Investment Grade	0.539^{***}
	(0.045)
Rated	0.987^{***}
	(0.068)
Fixed Effect	Year, Industry
N	34427
Pseudo R^2	0.223

Table 9: Regression analysis with propensity score matching.

The table shows regression analysis of investment on expected volatility, and the interaction term between expected volatility and distress (using dummy and Z-score). The sample is constructed such that for each CDS firm, there are three matching non-CDS firms with the nearest propensity score for CDS trading calculated from Table 8. The t-statistics are in the parenthesis with standard errors clustered by firms (***significant at 1% level, ** significant at 5% level, * significant at 10% level).

Explanatory Variables	(1)	(2)	(3)
Intercept	0.318***	0.325***	0.207***
	(16.99)	(17.13)	(9.30)
Exp. Volatility	−0.412***	−0.499***	−0.259
	(-2.60)	(-3.10)	(-0.96)
Distress		−0.006	
		(-0.52)	
Z-score			0.012***
			(4.11)
CDS	−0.044***	−0.041***	−0.028***
	(-5.82)	(-5.36)	(-3.94)
Exp. Volatility * Distress		0.315	
		(1.54)	
Exp. Volatility * Z-score			-0.040
			(-0.58)
Exp. Volatility * CDS	0.613***	0.473***	0.698***
	(4.91)	(3.39)	(4.90)
Exp. Volatility * CDS *Distress		0.280**	
		(2.14)	
Exp. Volatility * CDS *Z-score			−0.142***
			(-3.81)
Log(size)	−0.014***	−0.014***	−0.013***
	(-8.46)	(-8.51)	(-7.66)
Market-to-book	0.010***	0.011***	0.005***
	(9.06)	(9.12)	(4.43)
Leverage	−0.147***	−0.156***	−0.033***
	(-10.08)	(-9.41)	(-2.61)
Lagged cash flow	0.039***	0.040***	0.036***
	(4.45)	(4.59)	(4.13)
Recession dummy	0.003	0.004 -0.005	
	(0.80)	(0.96)	(-1.20)
Default spread	−0.809***	−0.874***	−0.386
	(-2.70)	(-2.90)	(-1.37)
Interest rate	0.443***	0.444***	0.421***
	(6.02)	(6.03)	(5.89)
N	18649	18649	17852
R^2	0.108	0.109	0.143

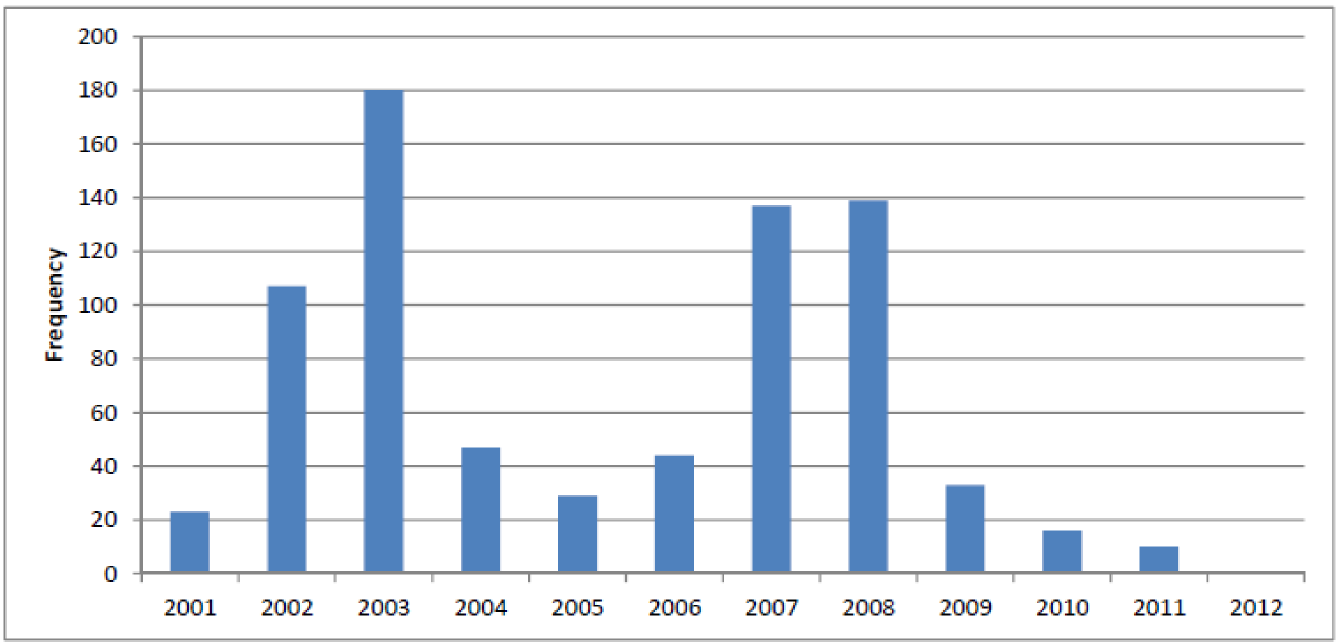

Figure 1: CDS start date distribution by year. The start trading date is the first date that CDS quotes exist on Bloomberg. Frequency corresponds to the number of firms with CDS start date falling within the year.

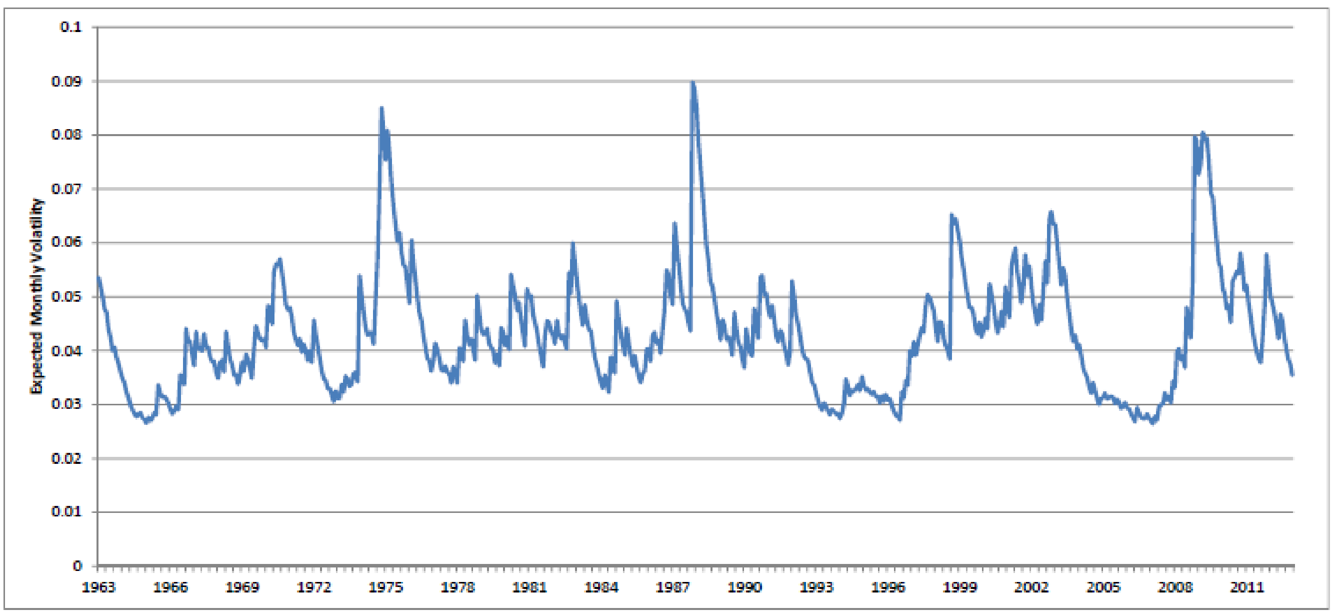

Figure 2: Expected volatility from GARCH(1,1) model. The expected volatility is calculated from the S&P 500 index monthly returns from 1927 to 2012.