# Credit Default Swaps, Options and Systematic Risk

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**Abstract**

We study the impact of systematic risk on the pricing of two economically similar derivatives contracts - the credit default swap and equity put options. We document, for the roughly 130 firms in the CDX index, that the greater proportion of a firm's volatility that is systematic, the more expensive it is to purchase insurance via both (i) put options and (ii) credit default swaps. We provide evidence that these two derivatives are influenced by systematic risk through the same channel.

# 1 Introduction

Traditional derivatives pricing models are silent on the impact of systematic risk on the values of individual contracts. Neither the Black & Scholes (1973) equity option model nor the Merton (1974) credit risk model let systematic risk influence prices except via that of the underlying. Recently, it has been documented that the amount of systematic risk of a given stock impacts the price of options written on it. It is thus tempting to think that systematic risk may be important in other derivative markets. We consider whether this is the case in the market for default protection and ask whether our findings are consistent with what has been documented for stock options.

We study the link between systematic risk and derivatives prices in a dataset of CDS and options for firms in the CDX index from 2004 to 2007. On the option side we reconfirm the results of Duan & Wei (2007) - the proportion of systematic risk in a firm's total volatility increases the ratio of implied to historical volatilities, interpreted as a risk premium. We thus find that their findings are robust to a significantly larger cross section and different time period.[1]

For the CDS contracts, the issue is more subtle. We first document that CDS spreads are robustly negatively related to the systematic risk proportion for individual firms, consistent with recent work by Li (2008). We then show that this intriguing result can be explained by variation in the components of the CDS spread. The price of default protection contains a component that simply compensates for expected losses and in addition a risk premium component. These components are not perfectly correlated.[2] When we repeat our empirical tests on the risk premium component, we find a robust and positive relationship, confirming our initial intuition - default protection is more expensive, all else equal, for firms with more systematic risk.

Finding that the proportion of systematic risk in the volatility can explain risk premia in both stock option and credit derivative markets is compelling, but to better understand

[1] Duan & Wei (2007) consider the impact of systematic volatility risk on individual equity option prices for 30 stocks between 1991 and 1995. They rely on a measure for systematic risk based on the proportion of total equity volatility which is systematic. They ask whether this metric can explain the difference between option-implied and historical equity volatilities as well as the the steepness of the implied volatility skew. Both relationships turn out positive, albeit weaker for the slope. They interpret this as evidence for systematic risk being priced in options markets. We carry out our test both on their dataset and the broader and more recent data for the firms in the CDX index for default protection. We confirm their results for the level of implied volatilities in both data sets although we do not find a significant relationship for the slope of the volatility skew.

[2] Recently, Berndt Douglas Duffie Ferguson and Schrantz (2008) have studied the risk premium component after filtering out expected losses by relying on EDF data from Moody's KMV. Ericsson and Elkamhi (2008) study expected losses and risk premia in a panel of corporate bond data. We will rely on their methodology for separating the components.

how risk premia in both markets are formed we study whether the risk premium measures can be directly linked. We find that this is in fact the case - regressing the ratio of implied- to historical volatilities on the risk premium proportion of CDS spreads yields a robust and significant relationship. This provides a rationale for the documented marginal information content of implied volatilities over their historical counterparts. [1]

## 2 Empirics

In order to investigate the relationship between stock option and default protection prices and systematic risk, we rely on the measure of systematic risk proposed by Duan and Wei (2008), that is

$$b_{j,k} = \frac{\beta_{j,k}^2 \sigma_{M,k}^2}{\sigma_{j,k}^2}, \tag{1}$$

where $\beta_{j,k}$ is firm $j$'s sensitivity to the market factor as measured for month $k$, and where $\sigma_{j,k}$ is the total volatility of the firm and $\sigma_{M,k}$ that of the market on the given month.

In order to obtain these three measures, we follow the approach of Duan and Wei (2008), inspired from that of Bakshi, Kapadia, and Madan (2003). Thus, for each firm $j$ on each day $t$, we perform the following regression

$$R_{j,s} = \alpha_{j,t} + \beta_{j,t} R_{M,s} + \varepsilon_s, \quad s \in \{t-251, t\} \tag{2}$$

where $R_{j,s} = \log\left(S_{j,s}/S_{j,s-1}\right)$ is firm's $j$'s log-return from time $s-1$ to time $s$, and where $R_{M,s}$ is computed similarly using S&P 500 index's closing prices. The daily measure of volatility for firm $j$, $\sigma_{j,t}$, is the standard deviation of $R_{j,s}$ returns entering the regression in Equation (2) on day $t$, and similarly for the market volatility at $t$. Then, on a monthly basis, the daily estimators, e.g. $\beta_{j,t}$, are averaged in order to obtain monthly measures, e.g. $\beta_{j,k} = N_{t\in k}^{-1} \sum_{t\in k} \beta_{j,t}$, for each month $k$.

Note that the systematic risk measure of Equation (1) is computed using *monthly averages* of each of the three inputs, as in Duan and Wei (2008). In the subsections to come, any monthly data we consider is also averaged from daily quantities.

### 2.1 Data

The data we consider was obtained from four databases, namely CRSP, COMPUSTAT, OptionMetrics and Markit. Overall, we consider 129 firms that have been included in the Dow Jones CDX index at one time or another between 2003 and 2004. Data from CRSP was used in order to compute returns necessary for Equations (1) and (2).

[1] see Cao Yu Zhong (2009).

Mainly in order to obtain leverage measures, we downloaded quarterly data from COMPUSTAT, first linearly interpolated the series of interest to obtain daily measures within the quarters, and then averaged monthly as described above.

For OptionMetrics data, option prices are assumed to be the midpoints between bid and ask prices and implied volatility measures are taken directly from OptionMetrics. Filters from Bakshi, Kapadia and Madan (2003) are applied.

Finally, daily CDS quotes from Markit are averaged on a monthly basis in order to obtain monthly measures of the spread. For each firm $j$, we will denote by $s^m_{j,k}$ the so-obtained measure using month $k$ quotes on CDS contracts of maturity $m$.

## 2.2 Reproducing Duan and Wei's Results

As our data includes 129 firms on a period ranging from 2003 to 2007 while that of Duan and Wei (2008) consist of 30 firms from 1991 to 1995, a natural first step in our analysis is to verify that their results hold in our dataset.

For that purpose, we again follow their procedure in order to derive monthly measures of level and slope for the implied volatility curve. That is, for each firm $j$, the following regression is ran at each month $k$

$$IV_{\tilde{j},t} - \sigma_{j,t} = a^0_{j,k} + a^1_{j,k}(y_{\tilde{j},t} - \bar{y}_{j,k}) + \varepsilon_{\tilde{j},k} \tag{3}$$

using all options $\tilde{j}$ on firm $j$'s stock, traded on days $t$ of month $k$. Note that $y_{\tilde{j},t} = K_{\tilde{j},t}/S_{j,t}$ is the *moneyness* of the option, and that $\bar{y}_{j,k}$ is the average of the moneyness of all options traded on firm $j$'s stock during month $k$. Thus, $a^0_{j,k}$ captures the mean of the volatility premium for firm $j$ during month $k$, and $a^1_{j,k}$ captures the slope of the implied volatility curve once adjusted for historical volatility. This is exactly Duan and Wei's Equation (2), in more extensive notations.

In light of the third panel of Figure **??**, we compute analogous level and slope measures using implied volatility proportions, that is

$$\frac{IV_{\tilde{j},t} - \sigma_{j,t}}{IV_{\tilde{j},t}} = \tilde{a}^0_{j,k} + \tilde{a}^1_{j,k}(y_{\tilde{j},t} - \bar{y}_{j,k}) + \varepsilon_{\tilde{j},k} \,. \tag{4}$$

We will refer to $\tilde{a}^0_{j,k}$ and $\tilde{a}^1_{j,k}$ and IV proportion levels and slopes. Regressions in Equations (3) and (4) are performed on four moneyness and three maturity buckets. Along the moneyness dimension, we part (i) out-of-the-money puts, with moneyness in the $[0.90, 0.95)$ range; (ii) at-the-money puts, with moneyness in the $[0.95, 1.00)$ range; (iii) at-the-money calls, with moneyness in the $[1.00, 1.05)$ range; and (iv) out-of-the-money calls, with moneyness in the $[1.05, 1.10]$ range. As for the maturity dimension, we part (a) short-term options, with 20 to 70 days to maturity; (b) medium-term options, with 71 to

120 days to maturity; and (c) long-term options, with 121 to 180 days to maturity. This partition is the same as that of Duan and Wei.

We thus have monthly cross-sections of implied volatility level and slope measures $a^0_{j,k}$ and $a^1_{j,k}$, and of implied volatility proportion measures $\tilde{a}^0_{j,k}$ and $\tilde{a}^1_{j,k}$. We replicate Duan and Wei's exercise of regressing, in a Fama-MacBeth fashion, cross-sections of level and slope measures on firms' systemic risk proportions. Thus, for each month $k$, we perform the following regression

$$a^0_{j,k} = \eta_{0,k} + \eta_{1,k} b_{j,k} + \varepsilon_{j,k} \tag{5}$$

and similarly for the $a^1_{j,k}$ slope measure. Table 1 reports the the average of the monthly $\eta_{1,k}$ estimates so obtained. The t-statistics are computed using Newey-West standard errors with lag 3 in order to account for the likely autocorrelation and heteroskedasticity in the series of coefficients. We also report the proportion (between zero and one) of coefficients that were positive and the average of the monthly R-squared statistics.

In short, the averaged estimates are all positive, as expected, and statistically significant for the two first moneyness buckets, when using the Duan and Wei's measure of the premium level, and significant almost everywhere when using the IV proportion levels. The average proportion of positive estimates is around two thirds. Admittedly, these results are not as impressive as those of Duan and Wei, but this was to be expected. First, Duan and Wei's analysis was conducted on the 30 largest stocks of the S&P 100 as of May 1998, and using option data from the Berkeley database. We here consider 129 firms, and option data from OptionMetrics.

We do not report here the results regarding the slope effect. These results were already weaker than their level counterpart in Duan and Wei (2008); in our dataset, the slope effect is hardly observed.

### 2.3 Credit Default Swaps

We now turn to the analysis of CDS spreads. Indeed, as discussed in Section **??**, we argue that a firm's systematic risk level impacts its spreads just as it does impact the firm's implied volatility. As a first, naive exercise, we regress monthly the cross-section of spreads on the cross-section of volatility premium levels obtained from Equation (3). The results of these Fama-MacBeth regressions are reported in Table 2.

The relationship is positive, which, to some extent, was to be expected. Indeed, both spreads and implied volatilities are driven by firm volatilities, and their positive relationship has already been studied in number of papers Yet, the actual question of interest here is whether or not the decomposition of a firm's volatility, in terms of systematic and idiosyncratic risk, has an effect on the observed spread level for the firm.

**Table 1:** *Fama-MacBeth Regressions of Implied Volatility Levels on Systematic Risk Proportions*

| | | Duan and Wei IV Level | | | | IV Proportion Level | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | **Avg. Coeff** | **t-stat** | **Coeff > 0** | **$R^2$** | **Avg. Coeff** | **t-stat** | **Coeff > 0** | **$R^2$** |
| **Moneyness** | **All maturities** | 0.035 | 2.098 | 0.685 | 0.035 | 0.244 | 4.523 | 0.833 | 0.057 |
| **(K/S)** | **Short-term** | 0.038 | 2.024 | 0.704 | 0.038 | 0.255 | 4.491 | 0.833 | 0.061 |
| **0.90-0.95** | **Medium-term** | 0.024 | 1.170 | 0.600 | 0.073 | 0.235 | 3.277 | 0.756 | 0.084 |
| | **Long-term** | 0.058 | 3.273 | 0.702 | 0.083 | 0.320 | 4.595 | 0.851 | 0.106 |
| **Moneyness** | **All maturities** | 0.041 | 3.004 | 0.741 | 0.030 | 0.245 | 4.112 | 0.833 | 0.041 |
| **(K/S)** | **Short-term** | 0.039 | 2.457 | 0.704 | 0.031 | 0.243 | 3.782 | 0.796 | 0.039 |
| **0.95-1.00** | **Medium-term** | 0.053 | 3.059 | 0.674 | 0.059 | 0.267 | 3.386 | 0.739 | 0.066 |
| | **Long-term** | 0.045 | 2.944 | 0.617 | 0.075 | 0.278 | 3.405 | 0.766 | 0.098 |
| **Moneyness** | **All maturities** | 0.019 | 1.660 | 0.667 | 0.023 | 0.128 | 2.447 | 0.685 | 0.026 |
| **(K/S)** | **Short-term** | 0.019 | 1.437 | 0.667 | 0.024 | 0.127 | 2.220 | 0.667 | 0.028 |
| **1.00-1.05** | **Medium-term** | 0.009 | 0.548 | 0.500 | 0.054 | 0.083 | 1.547 | 0.577 | 0.059 |
| | **Long-term** | 0.022 | 1.910 | 0.685 | 0.051 | 0.164 | 2.117 | 0.704 | 0.057 |
| **Moneyness** | **All maturities** | 0.023 | 1.952 | 0.611 | 0.025 | 0.142 | 2.471 | 0.648 | 0.031 |
| **(K/S)** | **Short-term** | 0.021 | 1.501 | 0.630 | 0.027 | 0.134 | 2.280 | 0.667 | 0.033 |
| **1.05-1.10** | **Medium-term** | 0.037 | 1.905 | 0.600 | 0.066 | 0.245 | 1.725 | 0.600 | 0.065 |
| | **Long-term** | 0.023 | 2.375 | 0.574 | 0.049 | 0.123 | 3.106 | 0.574 | 0.056 |

*We have panels of implied volatility level measures $a^0_{j,k}$, and of implied volatility proportion measures $\tilde{a}^0_{j,k}$. We perform monthly regressions of these variables on firms' systemic risk proportions in a Fama-MacBeth fashion, that is*

$$a^0_{j,k} = \eta_{0,k} + \eta_{1,k} b_{j,k} + \varepsilon_{j,k}$$
$$\text{and} \quad \tilde{a}^0_{j,k} = \eta_{0,k} + \eta_{1,k} b_{j,k} + \varepsilon_{j,k} \,,$$

*and report here the average of the $\eta_{1,k}$ coefficients (Avg. Coeff). The t-statistics are computed using Newey-West standard errors with lag 3 in order to account for the likely autocorrelation and heteroskedasticity in the series of coefficients. We also report the proportion (between zero and one) of coefficients that were positive and the average of the monthly R-squared statistics. Note that equity volatility is already controlled for in Duan and Wei's (2008) first-pass regressions (Equations (3) and (4)).*

**Table 2:** *Regressing Monthly CDS Spreads on Duan and Wei's $a^0$ and $a^1$ Measures*

| | Duan Wei IV Level ( $a^0_{j,k}$ ) — Short-Term, OTM Puts | | | |
|---|---|---|---|---|
| *Spread* ( $s^{5y}_{j,k}$ ) | **Avg. Coeff** | **t-stat** | **Coeff > 0** | $\mathbf{R^2}$ |
| **All Firms** | 3.848 | **2.531** | 0.725 | 0.125 |
| **Investment Grade** | 0.378 | 1.544 | 0.600 | 0.032 |
| **Speculative Grade** | 13.299 | **7.863** | 1.000 | 0.579 |

*We have panels of monthly five-year spread measures $s^{5y}_{j,k}$ and of implied volatility level measures $a^0_{j,k}$. We perform monthly regressions of the spreads on the implied volatility level in a Fama-MacBeth fashion,*

$$s^{5y}_{j,k} = \eta_{0,k} + \eta_{1,k} a^0_{j,k} + \varepsilon_{j,k} \,, \tag{7}$$

*and report here the average of the $\eta_{1,k}$ coefficient monthly estimates (Avg. Coeff). The t-statistics are computed using Newey-West standard errors with lag 3 in order to account for the likely autocorrelation and heteroskedasticity in the series of coefficients. We also report the proportion (between zero and one) of coefficients that were positive and the average of the monthly R-squared statistics.*

As mentioned before, Credit Default Swap Spreads and the Composition of the Total Risk (2008) established that, surprisingly, measures of CDS spreads were negatively correlated with a firm's systematic risk proportion. In line with the methodology followed in the previous section, we performed monthly Fama-MacBeth regressions of the spread levels on systematic risk proportions

$$s^{5y}_{j,k} = \eta_{0,k} + \eta_{1,k} b_{j,k} + \varepsilon_{j,k} \,. \tag{6}$$

Results in the upper part of Table 3 confirms Li's (2008) results on a different dataset.[1] These results thus seem robust, but they are clearly at odds with the intuition we get from the comparative statics of Section **??**. To explain her findings, Li suggests an explanation based on transaction costs. She argues that contracts on a firm with a lower systematic risk proportion are subject to higher transaction or hedging costs for the seller; the more closely a firm's value moves with the market, she says, the easier it is for the seller to find cheap hedging instruments. Thus, higher hedging costs would justify higher CDS prices.

As Li duly highlights "this explanation implies that the systematic risk has the same pricing impact on credit spreads as the idiosyncratic risk and, thus, the risk composition should not matter if there are no transaction costs." While the hedging argument is plausible in itself, this corollary statement is hard to accept in light of the statics derived in Section **??**, using a relatively simple model with no transaction costs.

We thus suggest an alternative explanation that appeals to the decomposition of a spread in its expected loss and its risk premium components. In recent work, Coval, Jurek, and Stafford (2009) call back to the fundamental notion of state prices in order to

[1] Li's dataset was CDS spreads provided by GFI for the period of January 2000 to December 2004.

explain the inherent difference between two bonds with similar expected losses, but that would default in different states of the economy. Naturally, for a given expected loss, a bond that is more likely to default in bad states of the economy should require a relatively larger risk premium than an otherwise equal bond more likely to default in good states of the economy.

Then, rephrasing that insight and assuming that the value of the market portfolio proxies for the state of the economy, firms with higher systematic risk proportions should require a higher risk premium and thus higher spreads. However, there is an endogeneity issue here; firms with larger systematic risk proportions are also likely to be well established firms with lower expected losses, and thus lower spreads. We argue that Li's results, summarily confirmed here, might be due to the fact that the effect of a lower expected loss offsets that of a higher risk premium.

To test our hypothesis, we thus have to decompose the observed spreads into their expected loss and risk premium components. For each firm, we estimate the spread predicted under physical measure by the Leland and Toft (1996) model and consider it as a measure of expected loss. Consequently, we define the *systemic proportion* of the spread as follows

$$\tilde{s}^{m}_{j,k} = \frac{s^{m}_{j,k} - s^{m,LT}_{j,k}}{s^{m}_{j,k}} \,. \tag{8}$$

Note that we do not use the risk premium directly, but the proportion of the spread explained by that premium.

Using this new measure, we repeat the regressions of Equation (6); results are reported in the lower part of Table 3. As we expected, the impact of systematic risk is now significantly positive... [Discuss results and implications further]

### 2.4 Systematic Risk Proportion as a Link between CDS and Options Markets

In this section, we will investigate the extant to which the systematic risk proportion indeed links the CDS and options markets. *This section is a work in progress and its exposition is still approximative.*

Assume that the following model

$$\tilde{s}^{5y}_{j,k} = \zeta_{0,k} + \sum_{i=1}^{N} \zeta_{i,k} F_i(x_k) + u_{j,k} \tag{9}$$

is the optimal linear in that it accounts for all systematic factors $F_i$ given state of the economy $x_k$ in month $k$. Then, when performing the trivial regression

$$\tilde{s}^{5y}_{j,k} = \eta^{*}_{0,k} + \varepsilon^{*}_{j,k} \,, \tag{10}$$

**Table 3:** *Fama-MacBeth Regressions of CDS Spreads and of Systemic Proportions on Systematic Risk Proportions*

| | Proportion Only ( $b_{j,k}$ ) | | | | Proportion and Equity Volatility | | | | Proportion and Firm Volatility | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Spread*** **( $s^{5y}_{j,k}$ )** | **Avg. Coeff** | **t-stat** | **Coeff > 0** | **$R^2$** | **Avg. Coeff** | **t-stat** | **Coeff > 0** | **$R^2$** | **Avg. Coeff** | **t-stat** | **Coeff > 0** | **$R^2$** |
| **All Firms** | -2.080 | **-4.906** | 0.000 | 0.071 | -1.143 | **-4.881** | 0.074 | 0.289 | -2.275 | **-4.810** | 0.000 | 0.088 |
| **Investment Grade** | -0.540 | **-9.239** | 0.019 | 0.066 | -0.453 | **-9.044** | 0.037 | 0.175 | -0.492 | **-8.231** | 0.037 | 0.085 |
| **Speculative Grade** | -3.122 | **-2.251** | 0.259 | 0.074 | 0.773 | 0.908 | 0.500 | 0.425 | -3.455 | **-2.772** | 0.259 | 0.254 |
| ***Systemic Proportion*** **( $\tilde{s}^{5y}_{j,k}$ )** | | | | | | | | | | | | |
| **All Firms** | 0.381 | **2.828** | 0.762 | 0.037 | 0.438 | **2.654** | 0.643 | 0.054 | 0.331 | **2.090** | 0.619 | 0.080 |
| **Investment Grade** | 0.351 | **2.368** | 0.625 | 0.033 | 0.418 | **2.549** | 0.675 | 0.077 | 0.320 | 1.756 | 0.600 | 0.049 |
| **Speculative Grade** | 0.005 | 0.030 | 0.600 | 0.025 | -0.190 | -0.801 | 0.575 | 0.072 | 0.002 | 0.008 | 0.650 | 0.137 |

*We have panels of monthly five-year spread measures $s^{5y}_{j,k}$, and of corresponding systemic proportions $\tilde{s}^{5y}_{j,k}$. We perform monthly regressions of these variables on firms' systemic risk proportions in a Fama-MacBeth fashion, that is*

$$s^{5y}_{j,k} = \eta_{0,k} + \eta_{1,k} b_{j,k} + \varepsilon_{j,k}$$
$$\text{and} \quad \tilde{s}^{5y}_{j,k} = \eta_{0,k} + \eta_{1,k} b_{j,k} + \varepsilon_{j,k} \, ,$$

*and report here the average of the $\eta_{1,k}$ coefficients (Avg. Coeff). The t-statistics are computed using Newey-West standard errors with lag 3 in order to account for the likely autocorrelation and heteroskedasticity in the series of coefficients. We also report the proportion (between zero and one) of coefficients that were positive and the average of the monthly R-squared statistics. Given the sensitivity of spreads to equity/firm volatility, we control for equity volatility (standard deviation of last 252 trading days' log returns), and for firm volatility (equity volatility unlevered using market leverage).*

$\eta^*_{0,k}$ will simply capture the cross-sectional mean of observed spreads on month $k$, and $\varepsilon^*_{j,k}$ will embed all the structure provided by the above factors on month $k$.

Then, note that Equation (6), when applied to $\tilde{s}^{5y}_{j,k}$, is equivalent to

$$\tilde{s}^{5y}_{j,k} - \varepsilon_{j,k} = \eta_{0,k} + \eta_{1,k} b_{j,k} \tag{11}$$

and thus that

$$\tilde{s}^{5y}_{j,k} - \varepsilon_{j,k} - \eta^*_{0,k} = \eta_{0,k} + \eta_{1,k} b_{j,k} - \eta^*_{0,k} \tag{12}$$

$$= \varepsilon^*_{j,k} - \varepsilon_{j,k}\,. \tag{13}$$

Let $\Delta^{\tilde{s}}_{j,k} = \varepsilon^*_{j,k} - \varepsilon_{j,k}$. Set $\Delta^{a^0}_{j,k}$ and $\Delta^{\tilde{a}^0}_{j,k}$ analogously. Then, these $\Delta$'s capture the contribution of the systematic risk proportion factor in each market, if indeed this proportion is a factor.

The exercise we suggest here is simply to regress $\Delta^{\tilde{s}}_{j,k}$ on $\Delta^{\tilde{a}^0}_{j,k}$ to judge of the correlation between systematic risk's impact on the spreads and its impact on the implied volatility level. Results are in Table 4.

## 3 Conclusion

We document empirically that firm level equity options and credit derivatives are influenced by the amount of systematic risk a firm is exposed to. Default insurance against high systematic risk names and stock options on the same are more expensive all else equal. Our contribution is to highlight that the channel by which these contracts are influenced by firm level systematic risk is the same. We are thus able to generalize earlier findings on stock options for a new and broader dataset as well as extend these implications to the market for credit derivatives.

**Table 4:** *Systematic Risk Proportion as a Link between CDS and Options Markets.*

| | Duan and Wei IV Level | | | | IV Proportion | | | |
|---|---|---|---|---|---|---|---|---|
| | **(Avg.) Coeff** | **t-stat** | **Coeff > 0** | **(Avg.) R2** | **(Avg.) Coeff** | **t-stat** | **Coeff > 0** | **(Avg.) R2** |
| **Cross-Sectional Regressions** | 0.006 | 0.334 | 0.288 | 0.009 | 3.440 | 1.310 | 0.550 | 1.000 |
| **Time-Series Regressions** | -0.007 | -0.183 | 0.445 | 0.139 | 0.298 | **4.777** | 0.494 | 0.146 |
| **Panel Regressions** | | | | | | | | |
| **All Firms** | 0.017 | 0.719 | | 0.001 | 0.624 | **11.446** | | 0.157 |
| **Investment Grades** | 0.011 | 0.414 | | 0.000 | 0.562 | **9.822** | | 0.136 |
| **Speculative Grades** | 0.038 | 0.936 | | 0.005 | 0.734 | **5.504** | | 0.151 |

*We perform the monthly cross-sectional regressions*

$$\Delta^{\tilde{s}}_{j,k} = \eta_{0,k} + \eta_{1,k}\Delta^{a^0}_{j,k} + \varepsilon_{j,k}$$
$$\Delta^{\tilde{s}}_{j,k} = \eta_{0,k} + \eta_{1,k}\Delta^{\tilde{a}^0}_{j,k} + \varepsilon_{j,k}\,,$$

*firmwise time-series regressions*

$$\Delta^{\tilde{s}}_{j,k} = \eta_{0,j} + \eta_{1,j}\Delta^{a^0}_{j,k} + \varepsilon_{j,k}$$
$$\Delta^{\tilde{s}}_{j,k} = \eta_{0,j} + \eta_{1,j}\Delta^{\tilde{a}^0}_{j,k} + \varepsilon_{j,k}\,,$$

*and panel regressions on the full sample and on the investment and speculative grades subsamples. The (average) of the $\eta_1$'s coefficients are reported with t-statistics that are computed using Newey-West standard errors with lag 3. We also report, when relevant, the proportion (between zero and one) of coefficients that were positive and the average of the monthly R-squared statistics.*

**Table 5:** *Fama-MacBeth Regressions of Five-Years CDS Spreads on Systematic Risk*

| | #Obs | | | | |
|---|---|---|---|---|---|
| ***Spreads*** | | | | | |
| *From AAA to A-* | 2446 | 0.4682 | 0.2975 | | |
| | | **(14.01)** | **(16.70)** | | |
| *BBB+, BBB, BBB-* | 3164 | 0.6240 | | 0.5347 | |
| | | **(25.59)** | | **(28.53)** | |
| *BB+ and lower* | 1125 | 1.5974 | | | 1.9683 |
| | | **(13.98)** | | | **(12.18)** |
| *Systematic Risk* | | -0.0022 | -0.0026 | -0.0019 | 0.0077 |
| | | **(-2.38)** | **(-8.29)** | **(-2.02)** | (0.91) |
| *Equity Volatility* | | 0.0343 | 0.0090 | 0.0120 | 0.0828 |
| | | **(7.94)** | **(5.68)** | **(5.52)** | **(7.06)** |
| $R^2$ | | 52.05% | 19.74% | 13.48% | 42.52% |
| | | | | | |
| ***Systemic Proportions*** | | | | | |
| *From AAA to A-* | 2446 | 66.5740 | 76.8720 | | |
| | | **(19.68)** | **(17.76)** | | |
| *BBB+, BBB, BBB-* | 3164 | 75.0010 | | 75.0960 | |
| | | **(25.37)** | | **(28.82)** | |
| *BB+ and lower* | 1125 | 59.1000 | | | 51.7570 |
| | | **(15.37)** | | | **(13.30)** |
| *Systematic Risk* | | 0.4553 | 0.9467 | 0.3384 | -0.1899 |
| | | **(3.13)** | **(6.67)** | (1.76) | (-0.80) |
| *Equity Volatility* | | 0.2463 | 1.8643 | 0.2712 | -0.7031 |
| | | (1.75) | **(6.73)** | (1.40) | **(-4.36)** |
| $R^2$ | | 10.21% | 11.86% | 9.51% | 7.16% |

*For each month in our sample, we regress the cross-section of spreads (upper panels) or of their systemic proportions (lower panel), on rating dummies and on the systematic risk proxy of Duan and Wei (2008), controlling for equity volatilities. Except for the dummies, regressands and regressors are in percentage terms and are centered by subtracting their panel mean. The t-statistics reported in parentheses below each average coefficient were obtained using Newey and West (1987) standard errors (with three lags) and are in bold font whenever their magnitude is greater than two. The #Obs column reports the number of month/firm observations in each rating bucket.*

**Table 6:** *Fama-MacBeth Regressions of Short-Term, OTM Puts Implied Volatilities on Systematic Risk*

| ***D&W's Vol Premium*** | #Obs | **Not Controling for Equity Volatility** | | | | **Controling for Equity Volatility** | | | |
|---|---|---|---|---|---|---|---|---|---|
| *From AAA to A-* | 1698 | 3.7277 | 4.0647 | | | 3.3574 | 4.0955 | | |
| | | (12.32) | (14.72) | | | (9.03) | (15.40) | | |
| *BBB+, BBB, BBB-* | 2300 | 4.4913 | | 4.3609 | | 5.0703 | | 4.8763 | |
| | | (12.49) | | (11.45) | | (16.82) | | (14.99) | |
| *BB+ and lower* | 769 | 6.2409 | | | 10.8400 | 7.1846 | | | 11.4010 |
| | | (7.29) | | | (11.08) | (9.84) | | | (8.48) |
| *Systematic Risk* | | 0.0671 | 0.0646 | 0.0780 | -0.0635 | 0.0342 | 0.0032 | 0.0845 | -0.1538 |
| | | (3.90) | (3.79) | (4.04) | (-0.36) | (3.00) | (0.28) | (4.10) | (-2.49) |
| *Equity Volatility* | | | | | | -0.2209 | -0.3061 | -0.2125 | 0.1020 |
| | | | | | | (-5.04) | (-10.98) | (-5.07) | (0.35) |
| *R2* | | 11.46% | 7.16% | 5.74% | 5.84% | 28.51% | 31.64% | 26.84% | 19.51% |
| | | | | | | | | | |
| ***IV Proportion*** | | | | | | | | | |
| *From AAA to A-* | 1698 | 14.3950 | 15.9910 | | | 12.1200 | 16.0370 | | |
| | | (14.49) | (16.71) | | | (11.00) | (19.31) | | |
| *BBB+, BBB, BBB-* | 2300 | 14.4560 | | 13.9370 | | 17.7400 | | 16.6940 | |
| | | (15.20) | | (13.31) | | (21.62) | | (18.80) | |
| *BB+ and lower* | 769 | 15.9870 | | | 23.9870 | 21.4400 | | | 23.5380 |
| | | (8.07) | | | (9.43) | (11.87) | | | (8.50) |
| *Systematic Risk* | | 0.3296 | 0.3551 | 0.2428 | 0.4749 | 0.1337 | 0.0267 | 0.2520 | -0.3666 |
| | | (5.87) | (5.89) | (3.07) | (0.90) | (3.74) | (0.83) | (4.14) | (-3.39) |
| *Equity Volatility* | | | | | | -1.2814 | -1.6570 | -1.1326 | -1.2449 |
| | | | | | | (-10.77) | (-17.96) | (-9.74) | (-2.00) |
| *R2* | | 10.25% | 10.91% | 6.69% | 8.94% | 43.74% | 55.17% | 43.89% | 25.32% |

*For each month in our sample, we regress the cross-section of short-term, OTM put IV premia (upper panel) or IV proportions (lower panel), on rating dummies and on the systematic risk proxy of Duan and Wei (2008), controlling or not for equity volatilities. Except for the dummies, regressands and regressors are in percentage terms and are centered by subtracting their panel mean. The t-statistics reported in parentheses below each average coefficient were obtained using Newey and West (1987) standard errors (with three lags) and are in bold font whenever their magnitude is greater than two. The #Obs column reports the number of month/firm observations in each rating bucket.*

**Table 7:** *Fama-MacBeth Regressions of Short-Term, OTM Puts Implied Volatilities on CDS Spreads*

| ***D&W's Vol Premium*** | #Obs | **Regressed on CDS's Spreads** | | | | **Regressed on CDS's Systemic Proportion** | | | |
|---|---|---|---|---|---|---|---|---|---|
| *From AAA to A-* | 1698 | 4.1169 | 4.3421 | | | 3.5783 | 4.1344 | | |
| | | **(9.34)** | **(16.10)** | | | **(10.29)** | **(15.17)** | | |
| *BBB+, BBB, BBB-* | 2300 | 5.4504 | | 5.3446 | | 5.0308 | | 4.8341 | |
| | | **(14.88)** | | **(23.24)** | | **(16.66)** | | **(16.02)** | |
| *BB+ and lower* | 769 | 4.6507 | | | 9.2315 | 7.1822 | | | 13.8590 |
| | | **(11.45)** | | | **(5.56)** | **(9.82)** | | | **(7.66)** |
| *Spreads/Systemic Prop.* | | 1.7888 | 4.5745 | 3.8980 | 4.7560 | 0.0040 | 0.0063 | 0.0268 | -0.1484 |
| | | **(4.00)** | (1.93) | **(3.61)** | **(9.66)** | (0.90) | **(2.78)** | **(3.58)** | **(-12.13)** |
| *Equity Volatility* | | -0.2745 | -0.3326 | -0.2391 | -0.2967 | -0.2302 | -0.3137 | -0.2246 | 0.2452 |
| | | **(-7.71)** | **(-9.32)** | **(-5.36)** | (-1.41) | **(-4.81)** | **(-9.94)** | **(-6.27)** | (0.77) |
| R2 | | 35.82% | 37.25% | 29.97% | 70.04% | 28.53% | 31.98% | 27.00% | 26.52% |
| | | | | | | | | | |
| ***IV Proportion*** | | | | | | | | | |
| *From AAA to A-* | 1698 | 13.8390 | 16.8330 | | | 12.9430 | 16.1570 | | |
| | | **(10.56)** | **(19.61)** | | | **(12.93)** | **(18.88)** | | |
| *BBB+, BBB, BBB-* | 2300 | 18.4080 | | 18.1180 | | 17.6600 | | 16.6720 | |
| | | **(17.86)** | | **(28.51)** | | **(21.89)** | | **(20.06)** | |
| *BB+ and lower* | 769 | 15.6970 | | | 19.5100 | 21.0950 | | | 28.7710 |
| | | **(11.69)** | | | **(5.46)** | **(11.10)** | | | **(8.47)** |
| *Spreads/Systemic Prop.* | | 3.3782 | 12.2180 | 10.2450 | 9.3498 | 0.0081 | 0.0197 | 0.0605 | -0.3126 |
| | | **(2.88)** | (1.84) | **(2.97)** | **(6.83)** | (0.69) | **(2.81)** | **(2.93)** | **(-73.13)** |
| *Equity Volatility* | | -1.4110 | -1.7412 | -1.2118 | -1.9579 | -1.3179 | -1.6935 | -1.1665 | -0.9314 |
| | | **(-12.96)** | **(-15.36)** | **(-9.18)** | **(-3.87)** | **(-10.16)** | **(-17.51)** | **(-10.86)** | (-1.40) |
| R2 | | 47.21% | 58.17% | 45.79% | 70.42% | 43.24% | 55.48% | 43.54% | 34.22% |

*For each month in our sample, we regress the cross-section of short-term, OTM put IV premia (upper panel) or IV proportions (lower panel), on rating dummies and on either CDS spreads or their systemic proportions, controlling for equity volatilities. Except for the dummies, regressands and regressors are in percentage terms and are centered by subtracting their panel mean. The t-statistics reported in parentheses below each average coefficient were obtained using Newey and West (1987) standard errors (with three lags) and are in bold font whenever their magnitude is greater than two. The #Obs column reports the number of month/firm observations in each rating bucket.*

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