CDS spreads and spread change determinants: A firm-specific and market-factors study

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Abstract

We examine the determinants of CDS spreads and spread changes on a broad database of 692 US firms during the period from early 2002 to late 2009. We find that firm-specific variables consistent with structural models substantially explain spread changes. Yet contrary to previous studies we discover that these variables have limited explanatory power after controlling for common market variables, especially when ratings are observable. We show that market variables still have explanatory power after controlling for firm-specific variables. Further, we show that ratings explain cross-section variation in CDS spreads even after controlling for structural model variables.

Keywords: Credit Default Swap; CDS; Credit spread; Corporate bond; Structural model

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Introduction

We analyze the determinants of and changes in CDS spread on a broad database of US firms, from early 2002 to late 2009. The study evaluates the ability of firm-specific data inspired by structural models to improve on the ability of market-risk factors and credit ratings to explain CDS spreads and spread changes.

Early studies of credit spread change determinants examined yield-to-maturity differences between corporate and treasury bonds.[1] The evolution of the Credit Default Swaps (CDS) market since the early 1990s has introduced new and more straightforward opportunities in the study of credit spreads.[2] By definition, CDS spreads are already spreads and therefore do not need to be extracted from corporate bonds prices. Early studies using CDS spreads were limited by relatively small samples caused by a small CDS market and young CDS market at the time these studies took place. For example, Blanco, Brennan and Marsh (2005) used CDS spreads and bond credit spread data from 33 U.S. and European investment-grade firms in the period from January 2001 through June 2002, and Ericsson et al. (2009) used CDS spread quotes from 94 companies during the period 1999-2002.

The growth of the CDS market also increased its use in other research areas. Several studies, such as Blanco et al. (2005) and Zhu (2006), have explored the relationship between credit spreads of bonds (yield difference between corporate bonds and treasuries) and CDS spreads. Other studies explored the relation between CDS spreads and credit ratings (Hull, Predescu and White 2004, Norden and Weber 2004, Galil and Soffer, 2011). These studies used the market model as a proxy for expected change in CDS spreads. Adjusted change in CDS spread during a specific time interval was calculated as CDS spread change minus the spread change in a CDS index. This simplistic adjustment method was used merely because of a lack of validated models that explain CDS spread changes.

Recent studies such as Ericsson et al (2009) found that variables inspired by the Merton (1974) structural model explain a significant amount of the variation of CDS spread changes. This result is in contrast to earlier research by Collin-Dufresne et al. (2001), which concluded that the explanatory power of structural variables is rather limited when using bonds data. We conjecture that these mixed results are partly due to the existing correlation between the structural-model variables and the market risk factors. Since stock returns are themselves related to market-risk factors, any relation found between spread changes and stock returns may in fact be a reflection of the direct relation between spreads and risk

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[1] Collin-Dufresne, Goldstein and Martin (2001), Campbell and Taksler (2003), Guazzarotti (2004), Avramov, Jostova and Philipov (2007), Cremers, Driessen, Maenhout and Weinbaum (2008) is probably an incomplete list of such studies.

[2] See Aunon-Nerin, Cossin, Hricko and Huang (2002), Greatrex (2009), Ericsson, Jacobs and Oviedo (2009) and Annaert, Ceuster, Roy and Vespro (2010).

factors.[3] Therefore, we propose exploring the ability of structural-model variables to explain spread changes only after controlling for the market risk factors.

The current study extends current literature in several aspects. First, we examine the explanatory power of common factors in the literature, such as Fama-French (hereafter, F&F) factors, the Pastor and Stambaugh (2003, hereafter, P&S) stock liquidity factor, and five Chen, Roll and Ross (1986) (hereafter, CRR) factors that have not been investigated in this context before.[4] Using these factors enables us to compare several approaches for explaining CDS spread changes: the structural approach, the empirical approach and the Aribtrage Pricing Theory (APT) approach. Second, we examine whether firm-specific variables inspired by structural models such as Merton (1974) are significant in explaining CDS spread changes after controlling for risk factors such as F&F factors and other common macro-variables, and vice versa. For this purpose we examine several alternative sets of variables that explain CDS spread changes using a broad database of 692 US firms with data on stock prices and CDS spreads over the period from February 2002 until November 2009. We find that firm-specific variables substantially explain CDS spread changes. However, contrary to Avramov et al. (2007) and Ericsson et al. (2009), we discover that market variables still have explanatory power after controlling for firm-specific variables.

Next, we present four sets of variables, each of which is applicable upon availability of data using the empirical approach. One set of variables is suggested for the case that a firm's stock returns are observable. Another set is suggested for the case that a firm's stock return and credit rating are observable. A third set is suggested for the case that neither the firm's stock return nor its credit rating are observable, and the fourth set is for the case that only the credit rating is observable. We find that the difference between the ability of the four models to explain spread changes is small and that individual stock information is critical only when credit ratings are not observable.

We then use a cross-section analysis to search for the determinants of CDS spreads before and during the Global Financial Crisis (GFC). Fundamental variables such as historical stock return, historical stock volatility and leverage explain CDS spreads after controlling for ratings. However, we also discover that ratings explain cross-section variation in CDS spreads

[3] It should be noted that Ericsson et al. (2009) did not use stock returns in their set of structural-model variables. However, we show later that changes in leverage based on the market value of equity capture a major portion of the variation in stock.

[4] Pastor and Stambaugh (2003) found in a cross-section analysis that expected stock returns are positively related to the sensitivities of returns to fluctuations in aggregate liquidity. Lin Wang and Wu (2011) investigated the pricing of liquidity risk using corporate bonds and found that the average return on bonds with high sensitivities to aggregate liquidity exceeds that of bonds with low sensitivities by 4%. We use the Pastor and Stambaugh (2003) stock liquidity factor combined with F&F factors for explaining the CDS spread change.

after controlling for fundamental variables. This finding suggests that using a linear combination of these fundamental variables is not efficient from the informational perspective. Finally, we show that during the GFC fundamental variables maintained their explanatory power, while the explanatory power of ratings decreased to almost zero.

The remainder of the paper is organized in the following way: Section 1 describes the sample data and the methodology. Section 2 presents the explanatory variables and their theoretical relation to CDS spread changes. In Section 3 we provide a time-series analysis. Cross-section analysis is provided in Section 4. Section 5 concludes.

1. Data and methodology

In this section we describe the methodology and data we use for explaining CDS spread changes.

1.1 Methodology

We use a framework similar to that used in Collin-Dufresne et al. (2001), Avramov et al. (2007) and Ericsson et al. (2009) to explain the determinants of credit spreads. First, we use a time-series analysis to investigate the ability of various factors to explain CDS spread changes: firm-specific variables (stock return, Δ Volatility and Δ Leverage), common factors (Δ Spot rate, Δ Term-structure slope, ΔVIX), F&F factors (HML, SML and MKT), stock liquidity factor (innovations in aggregate liquidity from Pastor and Stambaugh, 2003) and five Chen, Roll and Ross (1986) macro-variables - CRR factors (MP, UI, DEI, ΔUTS, ΔUPR). We compare models using firm-specific variables with models using common factors. Finally, we use all variables (firm-specific, common factors, F&F factors and CRR factors) and offer four sets of variables, each of which is useful, depending on availability of data, to explain CDS spread changes.

For measuring the ability of the four sets of variables to explain CDS spread changes we use time-series analysis. We run individual regressions for each CDS and then average the estimated coefficients across all CDS. The t-statistics are computed from the cross-section of the individual regression coefficients, as in Collin-Dufresne et al. (2001), Avramov et al. (2007) and Ericsson et al. (2009).

In addition, we conduct a cross-section analysis to examine the ability of ratings and firm-specific variables (stock return, stock volatility and leverage) to explain CDS spreads (level-analysis). We address this issue using two methods: First we run cross-section regressions on four different time periods (prior to the GFC - June 2005; the beginning of the GFC- June 2007; the peak of the GFC – September 2008; and a year after the peak of the

GFC - September 2009). Doing so allows us to explore the ability of ratings and common-factors to explain CDS spreads. Second, we use the methodology of Fama and MacBeth (1973) to explain CDS prices over time. We run a cross-section regression for each month and then report the average estimate coefficients separating the results into three time periods (February 2002 to November 2009, February 2002 to June 2007, and July 2007 to November 2009).

1.2 Data

The initial sample includes US dollar nominated 5-year CDS data for 1412 entities, obtained from Markit for the period from February 2002 to November 2009. We were able to obtain equity return for 880 firms from the Center for Research in Security Prices (CRSP). In line with Collin-Dufresne et al. (2001) and Avramov et al. (2007), we omit firms with less than 25 monthly quotes of CDS prices and equity return. This leaves us with 692 firms traded on the US stock market. For each firm we calculate the CDS spread change as follows:

$$(1)\ \Delta CDS_{i,t} = CDS_{i,t} - CDS_{i,t-1}\ .$$

where $CDS_{i,t}$ is the CDS spread of firm i in month t.

In our time-series analysis we focus on the changes in CDS spreads rather than on the levels of CDS spreads. This method is justified because changes are stationary while levels tend not to be stationary.[5]

2. **Description of theoretical variables and their relation to CDS spread changes.**

In this section we describe the variables and their theoretical relation to CDS spread changes. We divide the variables into four groups (firm-specific variables, common factors, F&F and P&S factors, and CRR factors) and present the descriptive statistics for independent and dependent variables during the period of February 2002 to November 2009.

2.1 Firm-specific variables

Stock return: The Merton model suggests a negative connection between a firm's equity and its probability of defaulting. We use monthly stock returns obtained from CRSP as an indication of changes in a firm's equity. Higher stock returns increase a firm's value, which theoretically should decrease CDS spreads. Hence, a negative relation is expected between stock returns and CDS spreads.

[5] We use the Dickey-Fuller test (1 lag, 5% significance level) on changes and find that approximately 95% of the change series are stationary (661 of CDS change series, 689 of the stock return series, and 690 of the stock volatility change series are stationary).

Volatility (stock volatility): The Merton model views debt as a combination of a short Put-option on a firm's assets and a risk free loan. Therefore we expect that higher stock volatility (reflecting higher asset volatility) will lead to a greater probability of default and a higher CDS spread. The firm-specific volatility is estimated separately for each firm, as the annualized variance of the individual stock returns for the previous 250 trading days obtained from CRSP. Our approach resembles that of Campbell and Taksler (2003) and of Ericsson et al. (2009).[6]

Leverage: We calculate leverage as follow:

$$(2)\ \ Leverage = \frac{Book\_Debt}{Book\_Debt + Equity\_Value}.$$

The book value of debt ($Book\_Debt$) is compiled from long-term debt and debt in current liabilities. The market value of equity ($Equity\_Value$) is the number of outstanding shares times the price per share. Since the data obtained from COMPUSTAT is on a quarterly basis, we use a linear interpolation (as in Collines-Dufrense et al. 2001 and Ericsson et al., 2009) for estimating monthly leverage to fill the gaps. In Merton's approach, higher leverage indicates a shorter distance to the default barrier and hence a higher probability of default. Therefore, we expect a positive connection between leverage changes and CDS spread changes.

2.2 Common factors

Spot: To be consistent with the 5-year maturity of the CDS contracts, we measure the spot rate using the daily 5-year Treasury Constant Maturity Rate obtained from the Saint Louis Federal Reserve (FRED). Longstaff and Schwartz (1995) argued that a higher reinvestment rate (higher spot rate) increases future value. Collins-Dufresne et al. (2001) noted that a higher spot rate reduces the probability of default. Both arguments support a negative connection between spot rate and credit spreads. Longstaff and Schwartz (1995) empirically confirmed the negative relationship.

Term-structure slope: We use the differences between the 10-year Treasury Constant Maturity Rate and the 2-year Treasury Constant Maturity Rate obtained from FRED as term-structure slope. The expected relation between term-structure slope and credit spreads is unclear. On the one hand, Fama and French (1989) claimed that an increase in the yield-curve slope anticipates improved economic growth, thus improving the recovery rates. Therefore, a negative relationship is expected between term-structure slope and credit spread.

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[6] In their base case regressions, Campbell and Taksler (2003) construct historical volatility based on 180 days of return.

On the other hand, the same process of slope steepening may reduce the number of projects with a positive net present value available to firms. This effect leads to an increase in the probability of default and therefore to a positive relation between term-structure slope and credit spread.

Market condition: The overall business climate affects the probability of default and the expected recovery rate (Altman and Kishor, 1996). An improvement in market condition reduces the probability of default and increases the expected recovery rate, which leads to lower credit spreads. For measuring market condition we use the change in the Median Rated Index (ΔMRI) calculated as the median spread change of all the firms in the same rating group. We use four groups: 1) AAA/AAs; 2) As; 3) BBBs; 4) BB+ or lower (speculative grades). We expect a positive relationship between market condition and spread change.

Market volatility (VIX): For measuring market volatility we follow Collin-Dufrense et al. (2001) and use the VIX index, which represents option-implied volatility based on S&P 500 index options obtained from the Chicago Board Options Exchange (CBOE). As with firm-specific volatility, we expect a positive relation between market volatility and CDS spreads.

2.3 Fama and French (F&F) factors and Pastor and Stambaugh (P&S) liquidity factor

We use three F&F factors: HML, SMB and MKT.[7] HML is the return on the portfolio of high-book-to-market stocks minus the return on the portfolio of low-book-to-market stocks. SMB is the return on the small capitalization portfolio minus the return on the big capitalization portfolio. MKT is the excess return on the market and is calculated as Rm-Rf. The market return (Rm) is the value weighted return of all NYSE, AMEX and NASDAQ stocks (from CRSP), and the risk-free return (Rf) is the one month Treasury bill rate.

The connection between F&F factors and the CDS spread was claimed to be negative in the literature. Higher factors indicate better economic conditions (higher assets value) and therefore lower credit spreads.

We also use innovations in the aggregate liquidity factor (hereafter, IAL) of Pastor and Stambaugh (2003).[8] The relation between this factor and changes in CDS spreads is not clear. On the one hand, based on structural models stock price liquidity premium is not relevant for bond pricing. The price and the statistical features of stock prices are used in pricing corporate bonds simply because they enable extracting the value and statistical

[7]Data obtained from Professor Kenneth French's website.
[8] Data obtained from Professor Lubos Pastor's website.

features of a firm’s assets that constitute the underlying asset for the two derivatives - equity and debt. However, stock illiquidity does not necessarily signal features of firm’s assets. Therefore, based on this logic we should not find any relation between CDS spread changes and the IAL factor. On the other hand, innovations in the liquidity factor of stock markets may be correlated with innovations in the liquidity factor of the corporate bonds market. If so, we expect a negative relation between CDS spread changes and P&S factor.

2.4 Chen, Roll and Ross (1986) factors

We use the same factors as in Liu and Zhang (2008) and Cooper and Pristley (2011). The five factors are as follow:

MP: MP is the growth rate of industrial production, calculated as $MP_t = Log(IP_t) - Log(IP_{t-1})$ where IP_t is the index of Industry Production in month t obtained from the FRED database. Chen, Roll, and Ross (1986) showed that MP is a priced risk factor. Johnson (2002) and Sagi and Seasholes (2007) argued that apparent momentum profits can reflect temporary increases in growth-related risk for winner-minus-loser portfolios. Liu and Zhang (2008) found that winners have temporarily higher MP loadings than do losers for short periods. Therefore, we expect a negative connection between MP and CDS spreads.

UI and DEI: The unexpected inflation (UI) and the change in expected inflation (DEI) are calculated as in Cooper and Priestley (2011). The unexpected inflation implies unexpected economic growth, and therefore a negative relation is expected between UI and CDS spread changes. The connection between DEI and the spread is unclear. On the one hand, high inflation suggests growing economics that reduce the spreads. On the other hand, compensation may exist between nominal and real interest rates, which can lead to an increase in the spreads.

UTS: UTS is the yield spread between the twenty-year (long-term) and the one-year Treasury bonds obtained from FRED. We conjecture that the relation between UTS and CDS spreads is similar to the relation between the term-structure slope and the CDS spread (negative).

UPR: UPR is the default premium calculated as the yield spread between Moody's Baa and Aaa corporate bonds from FRED. It is reasonable to assume that a higher default premium, which indicates a riskier market, would lead to higher CDS spreads. UPR is another measure of market condition.

Table 1 summarizes the variables and the direction of their impact on CDS spread changes.

2.5 Descriptive statistics

Table 2 depicts the descriptive statistics of independent and dependent variables during the period from February 2002 to November 2009. Panel A describes the variables divided into five groups: spread variables, firm-specific variables, common factors, F&F and P&S factors, and CRR factors. The CDS spread mean is 189 basis points (BP), with a standard deviation of 242 BP. The monthly mean of spread changes is 11 BP, and the stock monthly change mean is 0.85%. The stock return ranges from -98% to 334%. This range is due to the unique situation during and after the GFC. For example, our dataset includes Washington Mutual Inc., which was the largest US savings and loan association until its collapse in 2008. Within a short period of time, its stock price decreased from approximately \$50 to less than \$0.04. Among the other companies in our sample that collapsed during the sample period are American International Group (AIG), Hartford Financial Services Group Inc. (HIG), Nova Chemicals Corp and others. The sample contains 12 companies (out of 692) that lost more than 70% of their stock value during a single month.

Panel B shows the descriptive statistics for the data, divided into investment-graded firms (479) and speculative-graded firms (128). The other 85 firms were not rated and are not included in these results. The means of CDS and ΔCDS are 142.48 and 9.91 BP, respectively, in the investment-graded group and are lower than in the speculative-graded group (430 BP and 21 BP, respectively). The standard deviation in the investment-graded group is lower than in the speculative-graded group (209 and 116 BP for CDS and ΔCDS vs. 432 and 214 in the speculative-graded group). These results are consistent with the higher probabilities to default among the speculative-graded group.

3. Results – time-series analysis

In this section we explore the ability of different factors to explain the changes in the CDS spreads. First, we explore the ability of firm-specific variables (stock return, Δ Volatility and Δ Leverage), common factors (ΔSlope, ΔSpot and ΔVIX), F&F and P&S factors (F&F: MKT, SMB and HML; P&S: IAL) and CRR factors (MP, UI, DEI, ΔUTS, ΔUPR) using both univariate and multivariate regressions. Then we suggest four sets of variables, each of which useful conditional upon availability of data to explain the CDS spread changes.

3.1 Correlations and univariate regression analysis

We first explore the ability of firm-specific variables, common factors, F&F and P&S factors and CRR factors to explain the changes in the CDS spreads by examining the correlation coefficients and univariate regressions. This provides information on how satisfactorily single factors are associated with CDS spread changes.

Correlation coefficients between the variables are presented in Panel A of Table 3. We find that the monthly CDS spread changes are mostly correlated with MKT, ΔUTS, ΔUPR and stock return factors (-0.33, 0.28, 0.28 and -0.27, respectively). All correlation coefficients between the independent variables and changes in CDS spreads have the expected sign.[9] We find that stock return is highly correlated with Δ Leverage (-0.75).[10] ΔVIX is also highly correlated with F&F MKT factor (-0.74). These high correlations confirm the existence of multicollinearity when both are used in multivariate regressions. We do not find a high correlation between ΔVIX and ΔVolatility (0.16), but the relation (sign) is positive as expected. The variables UI (unexpected inflation) and DEI (change in the expected inflation), are highly correlated (0.95). The variables that measure the term-structure slope (ΔUTS and ΔSlope) are highly correlated (0.67), and the variables that measure market condition (ΔMRI and Δ UPR) are also positively correlated as expected.[11]

We estimate the ability of the univariate regression to explain the CDS spread changes (Adj. R^2) and the direction of the relation. The results of the following regression are described in Panel B of Table 3:

$$(3) \quad \Delta CDS_{i,t} = \alpha_0 + \beta_1 \cdot SingleFactor_{i,t} + \varepsilon$$

Most of the investigated variables have some ability to explain changes in credit spreads (except for ΔSlope, Δ UTS, IAL and MP factors, which have low Adj. R^2 of 2.19%, 2.18%, 1.26% and 0.60%, respectively). All coefficients have the expected sign, and most of them are statistically significant (except for ΔSlope and HML factors). We find that the stock liquidity factor is significant and has a small impact on CDS spread changes. Four factors play a larger role in explaining changes in CDS spreads when using univariate regression: MKT, ΔUPR, Stock Return, and ΔLeverage (Adj. R^2 of 13.94%, 12.67%, 11.69% and 10.24%, respectively). These results comply with Avramov et al. (2007) and Ericsson et al. (2009).[12]

We find that all CRR variables are significant at the 5% level and have the expected sign. The Δ UPR factor alone explains 12.67% of spread changes and is the most important

[9] The theoretical sign between the term-structure slope and the changes in CDS spread is unclear (discussed earlier). We find a small positive correlation between them (0.09).
[10] This high correlation may be explained by the fact that market value is used in calculating Δ Leverage. A similar strong and negative correlation (-0.83) was also documented by Greatrex (2009).
[11] The MRI (Median Rated Index) is a compound of four different indices (AAA/AAs, As, BBBs and lower than BBB-). The correlations of this index with ΔUPR are 0.20, 0.45, 0.32 and 0.13, respectively. These results are not shown in this table.
[12] Avramov et al. (2007) showed that firm-specific stock return can alone explain 15.45% of the credit spreads (using bond data), and Ericsson et al. (2009) showed that leverage (Adj. R^2 of 13.5% on average), equity volatility (10.5% on average) and 10-year US Treasury Bond yields (6.6% on average) are significant factors in explaining the CDS spread change.

factor among the five. Each one of the other four factors alone explains less than 5.3% of the CDS spread change.

3.2 Multivariate regression analysis

We examine the ability of nine sets of variables to explain changes in CDS spreads. In panel C of Table 3 we present the results of the following multivariate regressions:

(4) M1: $\Delta CDS_{i,t} = \alpha_0 + \beta_1 \cdot Stock\,\mathrm{Re}turn_{i,t} + \beta_2 \cdot \Delta Volatility_{i,t} + \beta_3 \cdot \Delta Leverage_{i,t} + \varepsilon_{i,t}$

(5) M2: $\Delta CDS_{i,t} = \alpha_0 + \beta_1 \cdot HML_t + \beta_2 \cdot SMB_t + \beta_3 \cdot MKT_t + \varepsilon_{i,t}$

(6) M3: $\Delta CDS_{i,t} = \alpha_0 + \beta_1 \cdot HML_t + \beta_2 \cdot SMB_t + \beta_3 \cdot MKT_t + \beta_4 \cdot IAL_t + \varepsilon_{i,t}$

(7) M4: $\Delta CDS_{i,t} = \alpha_0 + \beta_1 \cdot MP_t + \beta_2 \cdot UI_t + \beta_3 \cdot DEI_t + \beta_4 \cdot \Delta UTS_t + \beta_5 \cdot \Delta UPR_t + \varepsilon_{i,t}$

(8) M5: $\Delta CDS_{i,t} = \alpha_0 + \beta_1 \cdot Stock\,\mathrm{Re}turn_{i,t} + \beta_2 \cdot \Delta Leverage_{i,t} + \beta_3 \cdot MKT_t + \varepsilon_{i,t}$

(9) M6: $$\Delta CDS_{i,t} = \alpha_0 + \beta_1 \cdot Stock\,\mathrm{Re}turn_{i,t} + \beta_2 \cdot \Delta Volatility_{i,t} + \beta_3 \cdot \Delta Spot_t + \beta_4 \cdot \Delta Slope_t + \beta_5 \cdot \Delta VIX_t + \varepsilon_{i,t}$$

(10) M7: $$\Delta CDS_{i,t} = \alpha_0 + \beta_1 \cdot Stock\,\mathrm{Re}turn_{i,t} + \beta_2 \cdot \Delta Volatility_{i,t} + \beta_3 \cdot \Delta Spot_t + \beta_4 \cdot \Delta Slope_t + \beta_5 \cdot \Delta VIX_t + \beta_6 \cdot HML_t + \beta_7 \cdot SMB_t + \beta_7 \cdot MKT_t + \varepsilon_{i,t}$$

(11) M8:
$$\Delta CDS_{i,t} = \alpha_0 + \beta_1 \cdot Stock\,\mathrm{Re}turn_{i,t} + \beta_2 \cdot \Delta Volatility_{i,t} + \beta_3 \cdot \Delta Leverage_{i,t} + \beta_4 \cdot \Delta Spot_t + \beta_5 \cdot \Delta Slope_t + \beta_6 \cdot \Delta VIX_t + \beta_7 \cdot HML_t + \beta_7 \cdot SMB_t + \beta_8 \cdot MKT_t + \varepsilon_{i,t}$$

(12) M9: $$\Delta CDS_{i,t} = \alpha_0 + \beta_1 \cdot Stock\,\mathrm{Re}turn_{i,t} + \beta_2 \cdot \Delta Volatility_{i,t} + \beta_3 \cdot \Delta Spot_t + \beta_4 \cdot HML_t + \beta_5 \cdot MKT_t + \varepsilon_{i,t}$$

M1 checks the ability of structural-model-induced firm-specific variables to explain changes in CDS spreads. We find that ΔLeverage is not significant. This result may reflect the high correlation between ΔLeverage and stock return (-0.75). In addition, we find that this model can explain 17.4% of CDS spread changes, compared to 23% by Ericsson et al. (2009).[13] This difference in explanatory power may be attributed to the sample differences.

Next we explore the ability of F&F factors to explain changes in the CDS spreads (M2). To the best of our knowledge this is the first study to examine these factors using CDS data. Avramov et al. (2007) used bonds data to show that the F&F factors explain

[13] The model of Ericsson et al. (2009) did not contain stock returns but did contain risk-free rate. We show in this paper that ΔLeverage is responsible for much of the variation in stock returns and that the contribution of risk-free interest rate to the explanatory power of the model is minor. Hence M1 in this paper is comparable to the Ericsson et al. (2009) model.

approximately 26% of the variation in credit spread changes. They also found that all three factors are statistically significant and have the expected coefficient sign according to theory. Using CDS data, we find that F&F factors together can explain 16.2% of the changes in CDS spreads (panel C in Table 3). The factors' coefficients have the expected sign, but none of them is statistically significant. Using univariate regression (panel B in Table 3) we find that the MKT and SMB factors are significant at the 5% level. Next (for M3) we add the Pastor and Stambaugh (2003) innovations in the aggregate liquidity factor to the F&F factors. We find that the stock liquidity factor (IAL) is not statistically significant.

We continue by examining five CRR factors (M4). We find that this regression can explain 15% of the CDS spread changes. Earlier, we found that ΔUPR alone explains 12.7% of the spread changes. This means that ΔUPR is the most important factor of the five. The contribution of the other four factors to the explanation power of the model is very limited (2.5%). Overall, the CRR model slightly underperforms all previous empirical models, which were able to explain approximately 16%-17% of the time-series variation in CDS spreads.

We examine the ability of MKT, stock return and ΔLeverage factors to explain the changes in CDS spreads using M5 regression. We find that these factors can explain 18.7% of the CDS spread changes, though the coefficient of ΔLeverage is not statistically significant. Therefore, hereafter we do not use both variables in the same regression.[14]

Regression M6 includes stock return, ΔVolatility and three market variables: ΔSpot, ΔSlope (changes in term-structure slope) and ΔVIX. These variables explain 24% of the CDS spread changes. However, ΔVIX and ΔSlope factors are not statistically significant and are highly correlated (0.41, panel A, Table 3). ΔSlope is also found not to be statistically significant in univariate analysis. The high correlation between ΔVIX and ΔVolatility may be responsible for the lack of significance of ΔVIX. Dropping ΔVolatility factor from the regression makes the ΔVIX significant but lowers the Adj. R^2 (20.38%) more than in the case of dropping the ΔVIX (22.07%). Excluding the ΔSlope from the regression does not considerably change the results and reduces the Adj. R^2 by only 0.6% to 23.4%. These results support the hypothesis that the ΔSlope factor is not significant in explaining CDS spread changes.

[14] When both ΔLeverage and the stock return are used in the same regression, ΔLeverage loses its significance. Using them separately makes both of the factors significant at 5%. Removing the stock return from the regression reduces the Adj. R^2 to 16.78% (instead of 18.68%), and removing the ΔLeverage factor reduces it to17.91%. We replace between-stock return and ΔLeverage in regressions M5, M6 and M8 and find that stock return's ability to explain the CDS change is higher by more than 1% than ΔLeverage's ability. The results using ΔLeverage are not reported.

Next we add the F&F factors to the regression (M7) to examine their ability to explain changes in CDS spreads. Doing so increases the Adj. R^2 by almost 4%, to 27.82%. When using F&F factors alone (M2) we find that none of them is statistically significant at 5%, but when combining them with firm-specific factors (stock return, ΔVolatility) and common factors (ΔSlope, ΔSpot and ΔVIX) we find that HML and MKT are statistically significant at the 1% level. This means that the F&F factors can add to the explanation of spread changes.[15] Adding the ΔLeverage vector does not change the results and increases the Adj. R^2 by only 0.2%. Also, this variable is found not to be statistically significant (M8). After removing all variables that are not significant (M9), we find that the model explains 25.05% of credit spread changes.

After controlling for firm-specific variables, we find that market variables are still significant in explaining CDS spreads and can add more than 10% to the explanatory power of spread changes (27.8% vs. of 17.4%). Furthermore, the F&F factors alone have almost the same explanatory power as the firm-specific variables. These results differ from those of Avramov et al. (2007), who found that F&F factor information is already captured by the structural model using bond data, and from those of Ericsson et al. (2009), who argued that their three structural factors explain a significant amount of the variation in CDS data. We may attribute the difference between our results and those of Avramov et al. (2007) and Ericsson et al. (2009) to the more accurate calculation of the CDS spreads (through CDS rather than through bond prices), to a longer and wider dataset (compared to Ericsson et al., 2009) and perhaps to the unique features of the sample period.

3.3 Four sets of variables explaining CDS spread changes

In this section we describe the results of time-series analysis using 607 rated firms with firm-specific variables, common factors, F&F and CRR factors.[16,17] We suggest four

[15] Avramov et al. (2007) found that F&F factors alone had a negative and statistically significant impact on credit-spread changes, explaining almost 26% of spread changes. In their study, adding the F&F factors to the common factors and the firm-specific variables increased the explanatory power by approximately 1%, but both MKT and HML lost significance in the presence of the other variables and the SMB factor flipped sign. The authors claimed that the information provided by F&F factors is already captured by the structural model factors and subsumes the explanatory power of F&F factors.

[16] Our rating-based CDS indices (ΔMRI) may be used only on rated firms. We also explore two additional CDS indices: Average Spread Change Index (ASCI) and Reduced Average Spread Change Index (RASCI). The ASCI is the monthly average spread change of all 692 firms in the sample. The RASCI is the same, except for the number of firms. For each case we calculate RASCI from the participating firms. For example, our sample contains 128 speculative-grade firms, so when analyzing only the speculative-graded firms we use the index compiled from speculative-graded firms alone. We also use ASCI instead of ΔMRI in measuring the effect of market condition, and the qualitative results remain the same. The results with ASCI are omitted for space considerations and are available upon request.

[17] We do not use stock liquidity factor because in the previous section this factor was found not to be significant when combined with other factors.

basic sets, each of which is useful conditional upon availability of data. Model A is useful when a firm's stock returns are observable, model B is useful when a firm's stock returns and credit rating are observable, model C is useful when both the stock returns and the credit ratings are not observable, and model D is useful when credit rating only is observable. The ability to propose these alternative models relies on the structural model rationale. Since according to these models the value of equity and the volatility of equity returns are inputs in pricing corporate bonds, they can be replaced with factors that explain these variables (e.g. market return and VIX).

Table 4 displays the results of five sets of variables. In the first set we use all factors that can explain CDS spread changes. These variables explain almost 36% of spread changes. Models A-D explain 24.13% to 28.61% of the CDS spread changes. All variables in these models (A-D) are statistically significant and their coefficients have the expected signs.

In model A we use the stock return, ΔSpot, ΔVolatility, HML, MKT, UI and DEI variables. The variables stock return, ΔSpot, ΔVolatility are considered solid determinants in explaining credit spread changes (e.g., Collin-Dufresne et al., 2001; Campbell and Taksler, 2003; Avramov et al., 2007; and Ericsson et al., 2009). We have already shown that by adding the F&F factors we are able to increase the explanatory power of the model by almost 4% (Table 3, Panel C, M6 vs. M7), but the SMB factor loses its significance.[18] For that reason we add only two of the F&F factors: HML and MKT. The term-structure slope factors (Δ Slope and ΔUTS) have limited ability in explaining the credit spread changes. Therefore we do not use these factors when stock return is observable. We use the CRR factors - UI and DEI - because their information is not captured by the other factors in our model. This model explains almost 27% of the CDS spread changes.

In model B we use only four variables - stock return, Δ Volatility, HML and Δ MRI - which manage to explain 28.61% of the CDS spread changes. Adding more variables to the model (as in model A) increases the explanatory power of the model but reduces the significance of the explanatory factors. In models C and D we use the same six variables: ΔSpot, ΔSlope, ΔVIX, MP, ΔUTS and ΔUPR. Adding the macro variables ΔUTS, ΔUPR and ΔSlope and the ΔVIX variables compensates for the lack of stock data. So, although we do not have information on stock prices, these models are able to explain 24.13% (C) and 27.60% (D) of the CDS spread changes. The difference between models C and D is the use of the Δ MRI variable in model D.

[18] This might happen because this factor is positively correlated with stock return, HML and MKT.

These results show that even in the absence of stock prices the ability to explain the CDS spread changes is relatively steady. The drop in explanatory power due to the absence of stock prices is compensated by the use of market factors (ΔVIX, MP, ΔUTS and ΔUPR). Therefore, overall structural variables do not significantly improve the explanation of CDS spread changes.

3.4 Consistency across rating classes and throughout the business cycle

Using univariate regressions we compare the ability of single variables to explain CDS spread changes for speculative-graded firms (BB+ or lower), investment-graded firms (BBB- or higher) and rated firms (speculative-graded or investment-graded firms). The results are described in Table 5. We find that the explanatory power of single variables is slightly higher in the investment-graded group, though the coefficients are smaller.

We find that MKT, stock return, ΔMRI and ΔUPR are the most important factors in explaining CDS spread changes for speculative-graded firms (Adj. R^2 of 12.66%, 11.11%, 9.32% and 9.10% respectively). These factors are significant and have the expected sign. ΔMRI, MKT, ΔUPR, stock return and ΔVolatility are the most important factors when using the investment-graded firms (19.31%, 14.31%, 13.74%, 12.46% and 9.87% respectively). These factors are significant (except for the MKT factor) and have the expected sign. We find that most variables are significant, except for SMB, UI in speculative-graded firms and ΔSlope, HML, MKT and MP in investment-graded firms.

Next we examine the strength of these four models under different conditions. We choose to divide our sample into three time periods and three rating groups (3X3 options). The time periods are: (1) February 2002 to November 2009 (94 months); (2) prior to the GFC (February 2002 to July 2007, 65 months); (3) during the GFC (July 2007 to November 2009, 29 months). We also divide the firms into: (1) all-rated firms; (2) speculative-graded firms; (3) investment-graded firms.[19] Table 6 shows the Adj. R^2 of the models.

We find that in most cases the differences between the ability of the four models to explain the CDS spread changes is small and the variables have the correct sign, though some

[19] We also examine models using 692 unrated and rated firms using the ASCI (Average Spread Change Index) instead of ΔMRI. The results are similar and are omitted due to space considerations. We also compare three different indices to calculate the market condition - ASCI, RASCI and ΔMRI - during three different time periods (before/after GFC and both periods) and three categories (rated firms, investment-graded firms, and speculative-graded firms). We find that all three methods have approximately the same ability to explain the changes in CDS spread. The variable coefficients for the most part maintain their signs and statistical significance. Due to space considerations, we only present the ΔMRI results in this paper ; the results using other indices are available upon request.

of them are not significant.[20] We also find that the four models better explain the investment-graded firms (Adj R^2 between 7.70%-50.80%) than the speculative-graded firms (Adj R^2 ranging from 7.59% to 33.99%) for all three periods. This result contrasts the results of Avramov et al. (2007) and Ericsson et al. (2009) showing the higher explanatory power of structural variables among speculative-graded firms (compared to investment-graded firms).[21]

Consistent with Annaert et al. (2010) we find that the Adj R^2 of the models is higher during the GFC (ranging from 20.59% to 50.80%) than before the GFC (from 7.59% to 20.66%). We also discover that stock information is critical only when credit ratings are not observable. The difference between model A (stock return are observable, credit rating are not) and model C (neither the stock return nor the credit rating are observable) can reach up to 11%. The differences between model B (firm's stock return and credit rating are observable) and model D (only credit rating is observable) is less than 3.8% in all cases.

4 Results - cross-section analysis

We explore the cross-section ability of annual stock return, annual stock volatility, leverage and credit ratings by Standard & Poor's (S&P) to explain CDS spreads using the following regressions:

(13)
$$CDS_{i,t} = \alpha_0 + \beta_0 \cdot Stock\,Return_{i,t} + \beta_1 \cdot Volatility_{i,t} + \beta_2 \cdot Leverage_{i,t} + \varepsilon_{i,t}$$

(14) $$CDS_{i,t} = \alpha_0 + \beta_0 \cdot D_{0,i} + \beta_1 \cdot D_{1,i} + \beta_2 \cdot D_{2,i} + \beta_3 \cdot D_{3,i} + \varepsilon_{i,t}$$

(15) $$\begin{aligned} CDS_{i,t} &= \alpha_0 + \beta_0 \cdot Stock\,Return_{i,t} + \beta_1 \cdot Volatility_{i,t} + \beta_2 \cdot Leverage_{i,t} + \\ &\beta_3 \cdot D_{0,i} + \beta_4 \cdot D_{1,i} + \beta_5 \cdot D_{2,i} + \beta_6 \cdot D_{3,i} + \varepsilon_{i,t} \end{aligned}$$

Equation (13) shows the ability of structural variables consistent with Merton (1974) model (stock return, volatility and leverage) to explain CDS spreads. It should be noted that the risk-free interest rate, which is also used in the Merton (1974) model, has to be omitted in

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[20] These results are not reported due to space considerations but are available upon request.

[21] Avramov et al. (2007) and Ericsson et al. (2009) found that variables are better at explaining speculative-graded firms than investment-graded firms and that the adjusted R^2 monotonically increases with credit risk. Avramov et al. (2007) used bonds data (different dependent variable) from 1990-2003 (different period) and did not use bond ratings to form the groups because many bonds were not rated by any agency. They divided the groups on the basis of the bonds' credit spread levels. Ericsson et al. (2009) used limited data of 4,813 bid and 5,436 offer quotes of CDS spread over 94 companies during the limited period of 1999-2002 (different period). They found that Adj. R^2 for the lower ratings are always a bit higher than those for the higher ratings. More recently, Annaert et al. (2010) used CDS spread change data for 31 listed euro area banks and did not find a monotonic link between the model's explanatory ability and credit risk.

a cross-section analysis. Equation (14) shows the ability of credit ratings to explain CDS spreads.[22] Equation (15) shows CDS as a function of all variables.

The intercept in equations (14) and (15) represents firms with high ratings (AAA-AAs), and the independents variables $D_{0,t}$, $D_{1,t}$, $D_{2,t}$, $D_{3,t}$ are binary dummy variables indicating credit ratings at time i. $D_{0,t}$ gets 1 if the rating is As, and 0 otherwise. Similarly, $D_{1,t}$ equals 1 if rating is BBBs, $D_{2,t}$ gets 1 for speculative-graded firms only and $D_{3,t}$ gets 1 for unrated firms only.

In Table 7 we present the results of the cross-section analysis using the above three regressions (equations 13-15) during four period times: June 2005, July 2007, September 2008 and September 2009. June 2005 is selected as being significantly prior to the GFC. We select July 2007 because it was the beginning of the GFC period, which began with the fall of two hedge funds associated with Bear Stearns. September 2008 is selected as the peak of the GFC, when Merrill Lynch was purchased by Bank of America, Lehman Brothers filed for bankruptcy and AIG was bailed out. September 2009 is one year after the peak of the GFC.

The results show that the model using structural and credit rating variables maintained its ability to explain CDS spreads during our four sample periods (Adj R^2 of 53.01%, 56.60%, 48.97% and 46.95%). When dividing the variables into structural-model variables and credit rating variables we find that the ability of structural-model variables to explain CDS spreads remains relatively steady over time (44.30%, 34.20%, 45.37% and 39.28%). while the ability of credit rating is substantially lower for the period of GFC (Adj. R^2 of 15.85% and 15.81%) than in the period prior to GFC (Adj. R^2: 29.04% and 45.83%). We find that the ratings had less ability to predict CDS spreads during the crisis, but the structural factors continued to predict the spreads relatively well.

The coefficient estimates for stock return and volatility have the hypothesized sign and are statistically significant in most estimations. The high correlation coefficient between stock return and leverage causes the last variable to become not statistically significant and to flip signs. In the credit-rating model, we find that all dummy variable coefficients are positive and increase monotonically. However, only the coefficients for unrated firms and speculative-graded firms are statistically significant (different from AAA-AAs graded firms). When using the structural variables and credit rating together, we find that the dummy variable for As-graded firms is negative but not statistically significant.

[22] We also analyze the results in equations (14, 15) using 10 rating dummy variables, one for each rating group (AAA down to BBB-) and two additional dummy variables for speculative and unrated firms). These results are not reported and are available upon request.

F-tests for equation (15) reveal that structural variables are informative after controlling for rating information (Panel B in Table 7). This finding is not surprising and complies with event studies such as Norden and Weber (2004) and Galil and Soffer (2011) that documented the delay in rating changes after new information has already arrived at the CDS market. More interestingly the tests also show that in all time periods, rating information had explanatory power after controlling for the information embedded in the structural variables. This finding may indicate that ratings embed information not reflected in the structural variables and that a linear combination of structural variables is not a sufficient statistics in explaining CDS spreads. [23]

Next we use the Fama MacBeth procedure nine times: three models - (1) structural variables, (2) credit-rating variables and (3) both structural and credit variables - for three different time periods: (1) the entire sample period, February 2002 to November 2009; (2) before the GFC, February 2002 to June 2007; (3) during and after GFC, July 2007 to November 2009).[24] Table 8 presents the results. Panel A describes the results during the entire sample period (February 2002 to November 2009). We find that the structural variables and credit-rating variables explain on average 38.81% and 30.51% of the CDS spreads, respectively. When the ratings are combined with the structural variables, their explanatory ability increases to 50.85% on average. All factor coefficients have the hypothesized sign (except for As rating) and are significant at the 5% level (except for leverage). Panel B describes the results during the pre-GFC period (February 2002 to June 2007). We find that the ratings model and the structural variables model have almost the same explanatory power (35.17% and 38.85%, respectively). The combination adds 15% to the explanatory power of the model (53.03%). Panel C describes the results for the GFC period (July 2007 to November 2009). We find that the ability of ratings to explain CDS spreads drops from 35.17% to 19.31% during and after the GFC, but the structural model retains its ability (38.73% pre-GFC).

Figure 1 shows the ability (Adj R^2) of the three models to explain the CDS prices for each month in our sample period. We find that during the GFC the ability of the ratings to explain the CDS spreads practically disappeared (almost 0% in March 2009), while the ability of the structural variables dropped more moderately and for a shorter period of time (the

[23] We also conduct F-tests for examining the explanatory power of ratings with notches (e.g. 'A+', 'A', 'A-'instead of 'As' only) together with the structural model factors. All tests reveal that in all four periods, the structural model variables are informative after controlling for rating information and vice versa. These results are omitted due to space considerations and are available upon request.

[24] We use an implementation of the Fama and MacBeth (1973) two-step procedure: first, for each month we run a cross-section regression and find the coefficient estimated by the regression. Second, we average the coefficient estimated in the first step. The R^2 reported is the average R^2 provided by the first step.

lowest explanatory power was 13% in May 2009 but was around 30% throughout most of the GFC period).

5. Conclusions

This paper investigates the determinants of credit spread changes using a broad dataset of 692 US firms during the period from February 2002 to November 2009. We expand the current literature by exploring F&F factors and CRR factors using CDS data. Using a broader dataset than in Ericsson et al. (2009), we find that firm-specific variables inspired by structural models (stock return, change in stock volatility and change in leverage) explain approximately 17% of the CDS spread changes. The CRR model explains 15% and the F&F model 16%. Nevertheless, a model combining different types of variables is able to explain almost 28% of the variation in CDS spread changes. Unlike Avramov et al. (2007), we find that, after controlling for firm-specific variables, F&F factors can add to the models' explanatory power in explaining CDS spread changes. We also find that Pastor and Stambaugh's (2003) liquidity factor has no additional explanatory power and is already captured by the F&F market factor or by individual stock returns. Overall, our results suggest that structural-model variables have limited explanatory ability after ratings and common market variables are controlled for.

We find that our model better explains the GFC period (July 2007 to November 2009) than the period prior to the GFC (February 2002 to July 2007). In addition, the models are better able to explain investment-graded firms than speculative-graded firms. This result is in contrast to Avramov et al. (2007), who found that the structural model better explains credit spreads of lower-rated bonds. This difference in results may be due to the difference in sample periods (1990-2003 vs. 2002-2009) or due to the source of spread data (bonds vs. CDS).

We also explore the cross-sectional ability of structural model variables and S&P credit ratings to explain CDS spreads. We find that the ratings and the structural model variables both have explanatory power after controlling for each other. The finding that ratings substantially improve the explanation of CDS spreads indicates that a linear combination of the structural model variables is not statistically sufficient in explaining CDS spreads. However, it also appears that the ability of rating to predict CDS spreads during 2009 was severely damaged by the crisis and decreased almost to zero, while the ability of structural-model variables only mildly deteriorated and for a shorter period of time.

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Table 1: Definition of variables explaining CDS spread changes

This table describes the variables used in the time series regressions explaining CDS spread changes and their predicted sign. CRSP database is Center for Research in Security Prices. FRED is Federal Reserve Economic Data. CBOE is Chicago Board Options Exchange. The F&F factors, HML, SML and MKT, are taken from the Kenneth French site. MRI is Median Rated Index. IAL is Innovations in Aggregate Liquidity from Pastor and Stambaugh (2003).

Variable	**Description**	**Data Source**	**Predicted sign**
	Firm-specific variables		
Stock return	Monthly stock return	CRSP	-
ΔVolatility	250 days variance of individual stock return	CRSP	+
ΔLeverage	Book value of debt divided by the sum of book value of debt and the market value of equity	COMPUSTAT	+
	Common factors		
ΔSpot	5-year treasury rate	FRED	-
ΔSlope	Difference between 10-year Treasury Constant Maturity Rate and 2-year Treasury Constant Maturity Rate	FRED	?
ΔVIX	CBOE volatility index	CBOE	+
Market condition (ΔMRI)	Median spread change of all the firms in the same rating group (AAA/AAs, As, BBBs and lower ratings)	Inside calculation	+
	Fama & French and Pastor & Stambaugh (2003) factors		
HML	High book-to-market portfolio minus low book-to-market portfolio return	Kenneth French website	-
SML	Small capitalization portfolio minus big capitalization portfolio return	Kenneth French website	-
MKT	Market excess return	Kenneth French website	-
IAL	Innovation in aggregate liquidity factor (stock market)	Lumbos Pastor website	?
	Five Chen, Roll and Ross (1986) factors		
MP	Growth rate of industrial production	FRED	-
UI	Unexpected inflation	Labor Bureau of Statistic	-
DEI	Change in expected inflation	Labor Bureau of Statistic	?
ΔUTS	Term premium	FRED	?
ΔUPR	The default premium	FRED	+

Table 2 : Descriptive statistics of the data set

This table presents the descriptive statistics of the dataset for the period from February 2002 to November 2009. Panel A describes the variables divided into five groups: spread variables, firm-specific variables, common factors, F&F and P&S factors, and CRR factors. The spread and firm-specific variables are calculated using data from 692 rated and unrated firms. Panel B describes the firm-specific variables using 607 rated firms divided into investment-graded firms (AAA to BBB- ratings) and speculative-graded firms (BB+ or lower). ΔVolatility is the change in volatility of the annualized daily stock returns. Leverage is the book value of debt divided by the sum of book value of debt plus the market value of equity. Spot is the 5-year treasury rate, and term-structure slope (marked as Slope) is the difference between the 10-year and the 2-year treasury constant maturity rate. Change in Median Rated Index (ΔMRI) is calculated from the mean spread change of all the firms in the same rating groups of: 1) AAA-AA's, 2) A's, 3) BBB's and 4) BB+ or lower). IAL is innovations in aggregate liquidity factor by Pastor and Stambaugh (2003). The CRR macro factors are: MP – the growth rate industrial production; UI – unexpected inflation; DEI –change in the expected inflation; UTS – the term premium. UPR is the default premium.

Panel A

Statistic	Mean	Median	Min	Max	St. Dev.
		Spread variables			
CDS (bp)	188.99	64.30	2.67	29,244	241.78
ΔCDS (bp)	11.07	-0.05	-8,818	22,779	122.98
		Firm-specific variables			
Stock Ret (%)	0.85	0.83	-97.98	334.49	10.09
ΔVolatility (%)	1.63	0.16	-1520	4587	22.79
ΔLeverage	0.06	-0.06	-51.85	99.66	2.46
		Common factors			
ΔSpot	-0.03	-0.04	-0.87	0.92	0.32
ΔSlope	0.01	-0.03	-0.52	0.60	0.20
ΔVIX	0.04	-0.39	-16.09	20.50	4.67
		Fama-French and Pastor-Stambaugh factors			
MKT (%)	0.12	0.84	-17.15	10.17	4.60
SMB (%)	0.37	0.16	-5.32	10.64	2.66
HML (%)	0.35	0.18	-8.75	19.72	3.81
IAL *100	-0.67	-0.04	-22.13	12.63	6.68
		Five Chen, Roll and Ross factors			
MP (%)*100	1.84	7.80	-403.59	137.29	79.93
UI (%)*100	1.93	5.37	-172.80	97.07	39.83
DEI (%)*100	0.24	0.73	-40.46	20.31	9.65
ΔUTS *100	0.57	-3.00	-51.00	80.00	24.25
ΔUPR *100	-0.28	-1.00	-63.00	94.00	16.56

Panel B

Statistic	Investment graded firms				Speculate-graded firms			
	Mean	**Min**	**Max**	**Stdev**	**Mean**	**Min**	**Max**	**Stdev**
CDS (bp)	142.48	2.67	23,131	209.05	430.20	15.97	27,914	432.45
Δ CDS (bp)	9.91	-8,818	9577	116.20	21.06	-8,335	22,778	214.26
Stock Ret (%)	0.71	-97.97	263	9.94	1.12	-87.02	334.49	15.33
Δ Volatility(%)	1.80	-763	4,587	21.16	2.10	-950	936	28.72
Δ MRI (bp)	-0.36	-64.83	67.38	16.86	1.01	-1391	1171	347.18
Num of firms	479				128			

Table 3 : Spread changes explanatory power of firm-specific variables, common factors, F&F and P&S factors and CRR factors

This table shows the connection between CDS spread change and the determinant factors. The data contain 692 firms during the period from Feb 2002 to Nov 2009. Panel A describes the correlation between the variables. IAL is innovations in aggregate liquidity factor. The CRR factors are MP – the growth rate industrial production; UI – unexpected inflation; DEI –change in the expected inflation; ΔUTS – the term premium; and ΔUPR - the default premium. Panel B reports the average coefficient from univariate regressions and the corresponding t statistics (in brackets). Panel C describes the results of the multivariable regressions. Coefficients marked ***, **, and * are significant at the 1%, 5%, and 10% significance levels, respectively.

Panel A - Correlation Coefficients

Variable	Δ CDS	Stock Return	Δ Volatility	Δ Leverage	Δ Slope	Δ Spot	Δ VIX	MKT	HML	SMB	IAL	MP	UI	DEI	ΔUTS	ΔUPR
Spread variable																
ΔCDS	1.00	-0.27	0.21	0.12	0.09	-0.24	0.23	-0.33	-0.23	-0.19	-0.01	-0.25	-0.12	-0.17	0.28	0.28
Firm-specific variables																
Stock return	-0.27	1.00	-0.14	-0.75	-0.13	0.16	-0.36	0.48	0.31	0.24	0.11	0.07	-0.17	-0.14	-0.09	0.10
ΔVolatility	0.21	-0.14	1.00	0.17	0.11	-0.15	0.16	-0.26	-0.06	-0.10	-0.11	-0.21	-0.18	-0.23	0.12	0.34
ΔLeverage	0.12	-0.75	0.17	1.00	0.14	-0.14	0.32	-0.43	-0.29	-0.20	-0.12	-0.04	-0.04	-0.07	0.08	0.15
Common factors																
ΔSlope	0.09	-0.13	0.11	0.14	1.00	0.05	0.41	-0.27	0.01	-0.07	-0.31	-0.08	0.20	0.10	0.67	0.06
ΔSpot	-0.24	0.16	-0.15	-0.14	0.05	1.00	-0.24	0.38	0.12	0.27	0.18	0.03	0.26	0.31	0.26	-0.28
ΔVIX	0.23	-0.36	0.16	0.32	0.41	-0.24	1.00	-0.74	-0.27	-0.23	-0.18	0.01	-0.00	-0.07	0.12	0.23
F&F and P&S factors																
MKT	-0.33	0.48	-0.26	-0.43	-0.27	0.38	-0.74	1.00	0.51	0.37	0.25	0.10	0.05	0.12	-0.14	-0.31
HML	-0.23	0.31	-0.06	-0.29	0.01	0.12	-0.27	0.51	1.00	0.33	0.09	-0.01	0.03	0.01	-0.10	-0.14
SMB	-0.19	0.24	-0.10	-0.20	-0.07	0.27	-0.23	0.37	0.33	1.00	0.02	-0.07	0.12	0.13	-0.11	-0.14
IAL	-0.01	0.11	-0.11	-0.12	-0.31	0.18	-0.18	0.25	0.09	0.02	1.00	0.31	-0.12	-0.02	-0.11	-0.12
CRR factors																
MP	-0.25	0.07	-0.21	-0.04	-0.08	0.03	0.01	0.10	-0.01	-0.07	0.31	1.00	-0.04	0.04	-0.04	-0.09
UI	-0.12	-0.17	-0.18	-0.04	0.20	0.26	-0.00	0.05	0.03	0.12	-0.12	-0.04	1.00	0.95	0.03	-0.54
DEI	-0.17	-0.14	-0.23	-0.07	0.10	0.31	-0.07	0.12	0.01	0.13	-0.02	0.04	0.95	1.00	-0.06	-0.58
ΔUTS	0.28	-0.09	0.12	0.08	0.67	0.26	0.12	-0.14	-0.10	-0.11	-0.11	-0.09	0.03	-0.06	1.00	0.05
ΔUPR	0.28	0.10	0.34	0.15	0.06	-0.28	0.23	-0.31	-0.14	-0.14	-0.12	-0.30	-0.54	-0.58	0.05	1.00

Panel B - Univariate regressions (692 firms)

Factor	Coefficient	Adj R^2	R^2	Average months
A. Firm-specific variables				
Stock return	-1.76*** (-9.25)	11.69	13.31	66.55
Δ Volatility	63.88*** (8.21)	7.36	8.87	69.50
Δ Leverage	6.69*** (10.82)	10.24	11.95	67.00
B. Common factors				
Δ Slope	21.72 (1.52)	2.19	3.70	71.79
Δ Spot	-62.42*** (-3.77)	6.90	8.34	71.79
Δ VIX	2.91*** (5.07)	7.75	9.17	71.79
C. F&F and P&S factors				
MKT	-4.19** (-1.98)	13.94	15.28	71.79
HML	-2.85 (-1.20)	7.25	8.69	71.79
SMB	-4.25*** (-3.67)	4.89	6.37	71.79
IAL	-101.46*** (-3.83)	1.26	1.76	71.79
D. CRR factors				
MP	-18.72** (-2.11)	0.60	2.13	71.79
UI	-21.88*** (-5.11)	4.81	6.28	71.79
DEI	-108.88*** (-6.55)	5.22	6.68	71.79
ΔUTS	41.02** (2.17)	2.18	3.69	71.79
ΔUPR	129.7*** (5.26)	12.67	14.02	71.79

Panel C - Multivariate regressions (692 firms)

	M1- Firm-Specific variables	M2- Fama-French Factors	M3 -F&F and P&S factors	M4 –CRR factors	M5- Mixed	M6 – Mixed	M7- Mixed	M8- Mixed	M9- Mixed
intercept	3.46*	12.24**	12.19**	8.76***	3.88***	0.70	1.47**	3.56**	1.17*
	(1.92)	(2.42)	(2.49)	(2.56)	(3.11)	(1.16)	(2.16)	(2.04)	(1.68)
Stock return	-1.72***				-1.39***	-1.48***	-1.15***	-1.36***	-1.23***
	(-5.17)				(-4.17)	(-7.17)	(-6.39)	(-4.15)	(-6.90)
ΔVolatility	54.21***					46.70***	41.53***	38.57***	43.41***
	(8.56)					(7.41)	(7.22)	(6.90)	(7.36)
ΔLeverage	-1.61				-1.23			-1.49	
	(-1.31)				(-1.01)			(-1.37)	
ΔSpot						-14.63***	-9.31***	-2.25	-10.91***
						(-4.13)	(-2.60)	(-0.32)	(-2.80)
ΔSlop						0.04	3.28	3.40	
						(0.01)	(0.61)	(0.50)	
ΔVIX						0.48	-0.72	-0.91*	
						(1.35)	(-1.60)	(-1.77)	
HML		-1.10	-1.17				-1.23***	-1.27***	-1.43***
		(-0.85)	(-0.95)				(-4.50)	(-3.44)	(-4.63)
SMB		-1.26	-1.52				-0.36	-0.45	
		(-0.66)	(-0.68)				(-1.06)	(-0.70)	
MKT		-3.40	-3.10		-2.83***		-2.09***	-2.62***	-1.40***
		(-1.61)	(-1.26)		(-4.95)		(-3.16)	(-2.94)	(-3.01)
IAL			-41.20						
			(-0.65)						
MP				-18.39**					
				(-2.00)					
UI				-27.61**					
				(-2.50)					
DEI				123.51*					
				(1.79)					
ΔUTS				32.55***					
				(3.44)					
ΔUPR				128.36***					
				(3.68)					
R^2 (%)	22.53	20.10	21.17	21.60	23.73	31.07	38.64	40.97	32.05
Adj R^2 (%)	17.41	16.17	17.32	15.05	18.68	24.00	27.82	28.00	25.05

Table 4 : Suggested models for spread changes

This table describes the ability of four models (A-D) to explain CDS spread changes using data from 607 firms during the period from Feb 2002 – Nov 2009. Model A is useful when a firm's stock returns are observable. Model B is useful when a firm's stock returns and credit rating are observable. Model C is useful when neither the firm's stock returns nor its credit rating are observable. Model D is useful when credit rating only is observable. Coefficients marked ***, **, and * are significant at the 1%, 5%, and 10% significance levels, respectively.

	M1- all info	Model A: Stock return is observable	Model B: stock return and ratings are both observable	Model C: neither stock return nor ratings are observable	Model D: only credit rating is observable
Stock return	-1.24*** (-6.07)	-1.26*** (-6.50)	-1.18*** (-7.47)		
ΔVolatility	37.15*** (5.87)	43.13*** (7.00)	45.89*** (7.96)		
ΔSpot	-4.80 (-1.17)	-8.59** (-2.22)		-43.22** (-2.53)	-29.49* (-1.82)
Slope				-67.82*** (-2.82)	-62.37*** (-2.72)
ΔVIX				2.39*** (3.12)	2.14*** (2.75)
HML	-0.51** (-2.05)	-1.43*** (-4.54)	-0.91*** (-2.66)		
SMB	0.27 (0.54)				
MKT	-0.81 (-1.34)	-1.71*** (-3.26)			
MP	1.37 (1.27)			-17.66* (-1.78)	-17.21* (-1.74)
UI	-12.68*** (-2.65)	-17.66*** (-4.53)			
DEI	37.28** (2.09)	54.96*** (3.80)			
ΔUTS	4.27 (0.69)			66.55*** (5.17)	58.26*** (5.20)
ΔUPR	-18.28 (-0.88)			79.30*** (3.73)	83.89*** (3.73)
ΔMRI	0.77*** (3.26)		0.73*** (4.47)		0.80*** (4.01)
R^2	50.65	36.51	32.9	31.35	35.72
Adj R^2	35.80	26.82	28.61	24.13	27.60

Table 5: Single variable regressions by rating classes

This table shows the ability of a single variable to explain CDS spread changes of speculative-graded firms (BB+ or lower), investment-graded firms (BBB- or higher) and rated firms (either speculative or investment-graded firms) using univariate regression. Coefficients marked ***, **, and * are significant at the 1%, 5%, and 10% significance levels, respectively.

	Speculative-graded firms			Investment-graded firms			All rated firms		
	Coff	R^2	Adj R^2	Coff	R^2	Adj R^2	Coff	R^2	Adj R^2
Firm-specific variables									
Stock return	-3.15*** (-4.36)	13.32	11.11	-1.41*** (-8.40)	13.92	12.46	-1.78*** (-8.73)	13.79	12.18
Δ Volatility	1.22*** (4.72)	10.23	8.26	0.60*** (9.23)	11.25	9.87	0.73*** (8.26)	11.02	9.53
Common factors									
Δ Spot	-68.56*** (-2.80)	7.16	5.28	-64.59*** (-2.81)	8.57	7.22	-65.43*** (-3.47)	8.27	6.81
Δ Slope	72.80** (2.36)	4.11	2.16	4.83 (0.26)	3.39	1.97	19.16 (1.18)	3.54	2.01
Δ VIX	5.81*** (5.04)	9.56	7.71	2.24*** (2.97)	9.11	7.76	2.99*** (4.63)	9.21	7.75
Δ MRI	0.33*** (4.13)	10.85	9.32	1.42*** (6.96)	20.49	19.31	1.19*** (7.30)	18.39	17.07
Fama-French factors									
HML	-9.52*** (-3.35)	6.79	4.89	-0.90 (-0.27)	9.03	7.67	-2.72 (-1.01)	8.56	7.09
SMB	-5.45 (-1.04)	6.95	5.06	-4.10*** (-4.39)	6.39	5.00	-4.38*** (-3.30)	6.51	5.02
MKT	-12.07*** (-6.02)	14.42	12.66	-1.94 (-0.64)	15.57	14.31	-4.07* (-1.69)	15.33	13.96
CRR factors									
MP	-17.66*** (-2.71)	2.18	0.20	-18.84 (-1.49)	2.22	0.78	-18.59* (-1.85)	2.21	0.65
UI	-18.94 (-1.33)	5.24	3.32	-22.83*** (-5.50)	6.72	5.34	-22.01*** (-4.95)	6.41	4.92
DEI	-104.6* (-1.84)	5.59	3.68	-106.83*** (-6.33)	7.56	6.19	-106.36*** (-5.94)	7.14	5.66
Δ UTS	106.59*** (4.14)	3.74	1.78	25.54*** (4.13)	3.63	2.20	42.63*** (5.75)	3.65	2.12
Δ UPR	145.80*** (2.57)	10.91	9.10	128.59*** (4.03)	15.00	13.74	132.22*** (4.75)	14.14	12.77
NUM OBS		128			479			607	

Table 6: The Adjusted R^2 for various models and periods

This table shows the Adj. R^2 of all the models used in this paper. We divide the sample into nine categories: three time categories - the sample period (February 2002- November 2009), before the global financial crisis (February 2002- July 2007) and during the global financial crisis (July 2007 – November 2009) - and three ratings categories - rated firms, speculative-graded firms and investment-graded firms. The five models in this table are the same as those in Table 4.

	M1- all info	Model A: Stock return is observable	Model B: both stock returns and ratings are observable	Model C: neither stock returns nor ratings are observable	Model D: only credit rating is observable
Entire sample period					
Rated firms	35.80	26.82	28.61	24.13	27.60
Investment-graded	38.38	27.82	30.92	25.62	32.78
Speculative-graded	28.96	23.10	19.71	18.57	22.99
Before GFC					
Rated firms	20.33	11.12	17.05	7.76	14.31
Investment-graded	20.66	11.78	18.47	7.70	15.94
Speculative-graded	12.93	8.57	11.76	7.59	7.98
During GFC					
Rated firms	47.26	36.55	39.16	28.91	40.04
Investment-graded	50.80	38.07	41.25	32.14	43.94
Speculative-graded	33.99	31.72	27.92	20.59	29.55

Table 7: Cross-Section regression for CDS spreads before/during and after the GFC

This table shows the results of cross-section regression of three models over four periods for explaining CDS spread levels. Model M1 uses structural variables (annualized stock return, annualized volatility of daily stock return and leverage). Model M2 uses Moody's rating to explain CDS spreads. D0 is a dummy variable for As-rated firms, D1 for BBBs-rated firms, D2 for speculative-graded firms and D3 for unrated firms. The intercept is AAA-AAs rated firms. The last model (M3) uses both structural variables and credit ratings to explain the CDS spreads. Panel A shows the regressions results and panel B the results of F tests for significance of variables in the M3 model. Coefficients marked ***, **, and * are significant at the 1%, 5%, and 10% significance levels, respectively.

Panel A - Regression results

	Intercept	Stock return	Volatility	Leverage	D0	D1	D2	D3	R^2	Adj	OBS
06/2005 M1	-145.66*** (-10.64)	-0.88*** (-4.97)	164.06*** (21.06)	-2.56 (-0.76)					44.57	44.30	613
06/2005 M2	19.98 (0.64)				11.34 (0.33)	42.88 (1.30)	296.90*** (8.69)	89.75** (2.49)	29.48	29.04	647
06/2005 M3	-101.52*** (-4.98)	-0.98*** (-5.99)	123.47*** (14.88)	-1.23 (-0.40)	7.43 (0.31)	21.12 (0.90)	157.57*** (6.15)	22.35 (0.85)	53.55	53.01	613
07/2007 M1	-122.45*** (-7.36)	-0.12 (-0.70)	151.04*** (15.13)	22.25*** (8.46)					34.52	34.20	621
07/2007 M2	35.85 (1.55)				0.53 (0.02)	33.42 (1.35)	327.08*** (12.77)	102.39*** (3.84)	46.15	45.83	687
07/2007 M3	-59.24** (-2.54)	-0.64*** (-4.40)	80.01*** (8.67)	13.75*** (6.24)	-10.18 (-0.44)	9.73 (0.43)	243.42*** (9.75)	74.62*** (2.90)	57.09	56.60	621
09/2008 M1	-281.75*** (-9.12)	-2.52*** (-4.52)	173.00*** (16.51)	4.77 (1.18)					45.66	45.37	563
09/2008 M2	109.75 (1.05)				47.20 (0.41)	64.12 (0.58)	662.09*** (5.81)	199.26* (1.69)	16.36	15.85	662
09/2008 M3	-261.33*** (-4.05)	-2.54*** (-4.71)	152.12*** (14.30)	-4.80 (-0.01)	-23.79 (-0.36)	0.81 (0.01)	215.02*** (3.12)	39.27 (0.54)	49.61	48.97	563
09/2009 M1	-233.92*** (-7.88)	-0.21 (-0.43)	94.98*** (16.75)	-62.94 (-0.13)					39.69	39.28	449
09/2009 M2	53.00 (0.58)				20.49 (0.20)	70.03 (0.72)	506.65*** (5.07)	272.27*** (2.65)	16.43	15.81	542
09/2009 M3	-178.69*** (-2.84)	-0.65 (-1.41)	73.08*** (12.17)	3.63 (0.80)	-38.98 (-0.59)	-9.88 (-0.16)	261.56*** (3.77)	42.29 (0.58)	47.78	46.95	449

Panel B - F tests for the combined rating and structural variables model (M3)

Date	F-test: Stock Return= Volatility=leverage=0		F-test: D0=D1=D2=D3=0	
	F	**Prob**	**F**	**Prob**
06/2005	91.78	0.0000	29.23	0.0000
07/2007	51.59	0.0000	80.61	0.0000
09/2008	115.44	0.0000	10.87	0.0000
09/2009	54.12	0.0000	17.10	0.0000

Table 8: Fama MacBeth regression results:

This table presents Fama MacBeth regression for three models in three time periods. The Fama MacBeth procedure follows two steps: (1) running a cross-section regression for each month in the sample period and (2) averaging the results from the first step. The R^2 is the average of R^2 from the first step. D0, D1, D2 and D3 are dummy variables. D0 gets 1 for As-rated firms, D1 gets 1 for BBBs-rated firms, D2 gets 1 for speculative-rated firms and D3 gets 1 for unrated firms. Coefficients marked ***, **, and * are significant at the 1%, 5%, and 10% significance levels, respectively.

	Intercept	Stock return	Volatility	Leverage	D0	D1	D2	D3	Ave. R^2	OBS
Panel A : Feb 2002 – Nov 2009										
M1	-232.98***	-1.30***	156.49***	1.81**					38.81	43,305
	(-9.59)	(-6.24)	(22.96)	(2.09)						
M2	42.53***				20.32***	78.38***	503.90***	138.25***	30.51	48,609
	(11.21)				(6.82)	(9.39)	(10.4)	(9.56)		
M3	-184.58***	-1.40***	114.33***	2.29	-16.95***	24.70***	275.06***	45.40***	50.85	43,305
	(-8.67)	(-6.99)	(17.80)	(1.07)	(-3.14)	(3.14)	(12.98)	(4.90)		
Panel B: Feb 2002 – June 2007										
M1	-150.33***	-0.64***	138.96***	-1.33					38.85	29,238
	(-11.17)	(-5.45)	(18.68)	(-0.72)						
M2	23.26***				19.51***	74.67***	411.72***	90.47***	35.17	31,582
	(14.13)				(8.45)	(7.54)	(8.93)	(18.47)		
M3	-111.52***	-0.79***	95.13***	-0.90	1.78	42.35***	271.75***	34.32***	53.03	29,238
	(-9.23)	(-6.11)	(15.08)	(-0.51)	(1.20)	(4.76)	(9.77)	(7.85)		
Panel C: July 2007 – Nov 2009										
M1	-431.94***	-2.88***	198.71***	9.37*					38.73	14,067
	(-6.99)	(-5.27)	(17.51)	(1.75)						
M2	88.90***				22.25***	87.31***	725.82***	253.27***	19.31	17,027
	(14.32)				(2.58)	(5.57)	(6.36)	(6.27)		
M3	-360.48***	-2.86***	160.56***	9.97*	-62.02***	-17.79	283.03***	72.07**	45.58	14,067
	(-6.75)	(-5.58)	(13.59)	(1.74)	(-4.14)	(-1.36)	(10.23)	(2.44)		

Figure 1 : Evolution of the explanatory power of various types of variables

This figure shows the Adjusted R^2 of three models: model using only rating information, model using only structural variables, and a model that combines them all. The sample covers the period from February 2002 until November 2009 (94 months).