An empirical analysis of the relationship between credit default swap spreads and short-selling activity

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Abstract

In this study, we examine the determinants of CDS spreads, using a new measure of the likelihood of firm default - short-selling. We find that the variables which explain the greatest variation in CDS spreads are those predicted by the structural form models. After controlling for the determinants of CDS spreads, we find that CDS spreads are positively related to short-selling. These results are economically significant and robust to various controls including the use of changes in CDS spreads, choice of short-selling measure, cross-sectional controls for fixed effects, subgroup analysis by rating categories, calculation of average regression coefficients using time-series regressions and the use of contemporaneous explanatory variables.

Keywords: CDS spreads, Credit default swaps, credit spreads, short-selling.

JEL classification: G10, G14

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1 Introduction

Prior to the current financial crisis, credit default swaps (CDS) were a fairly esoteric financial instrument. This all changed however, with the onset of the "credit crunch" where CDS were thrust into the public spotlight as the result of a series of spectacular business failures associated with their use (most notably that of the American Insurance Group, AIG, which posted a record loss of US$61.7bn in the fourth quarter of 2008). In its simplest form, a CDS is a privately negotiated contract that insures the holder against any losses in the event that the issuer of a bond defaults on their payment obligations. The holder makes a periodic payment in return for this service, called the spread.[1] The spread is conceptually similar to the premium charged by an insurance company and compensates the issuer for the risk they incur in providing the guarantee. The losses incurred during the current financial crisis however, tend to suggest that CDS were significantly underpriced relative to their true risk.

The burgeoning CDS market has not gone unnoticed by academia and a substantial body of work has developed on credit sensitive instruments. The majority of the literature, which focuses on corporate bonds and in particular credit spreads, emanates from two theoretical approaches to pricing corporate bonds and credit spreads. Reduced-form models, developed by Litterman and Iben (1991), Jarrow and Turnbull (1995) and Jarrow, Landow and Turnbull (1997), use market data to recover the parameters needed to value credit-sensitive claims. Empirical applications of

[1] In theory, since a portfolio consisting of a corporate bond and a CDS is risk free, the spread should be equal to the spread of the corporate bond over the risk free rate (see Hull, Predescu and White, 2004). Differences between the theoretical and market price are readily observed however, and this is most commonly thought to result from the presence of a liquidity premium (see Blanco et al., 2005, Pan and Singleton, 2008, and Tang and Yan, 2007).

reduced-form models include Duffee (1999) and Duffie, Pedersen, and Singleton (2003).

The second approach, structural models, developed by Black and Scholes (1973) and Merton (1974), connect the price of credit-sensitive instruments directly to the economic determinants of financial distress and loss given default. Structural models imply that the main determinants of the likelihood and severity of default are financial leverage, volatility, and the risk-free term structure. Collin-Dufresne, Goldstein, and Martin (2001) use the structural approach to identify the theoretical determinants of corporate bond credit spreads. These variables are then used as explanatory variables in regressions for changes in corporate credit spreads, rather than inputs to a particular structural model. Collin-Dufresne et al. (2001) find that the explanatory power of the theoretical variables is modest, and that a significant part of the residuals is driven by a common systematic factor that is not captured by the theoretical variables. Campbell and Taksler (2003) extend this analysis using regressions for levels of the corporate bond spread, rather than changes in corporate credit spreads. They show that firm specific equity volatility is an important determinant of the credit spreads, and that the economic effects of volatility are large. Cremers, Driessen, Maenhout, and Weinbaum (2004) confirm and extend this analysis by showing that option-based volatility contains increased explanatory power that is different from historical volatility.

Similar to these studies (Collin-Dufresne et al., 2001; Campbell and Taksler, 2003; and Cremers et al., 2004), recent studies (Benkert, 2004; Greatrex, 2009; Ericsson, Jacobs, and Oviedo, 2009; and Zhang, Zhou, and Zhu, 2009) estimate linear regressions on the relationship between CDS spreads and key variables suggested by economic theory. While the main focus remains credit risk, an important distinction is the use of CDS spreads rather than corporate bond spreads. Ericsson, Jacobs, and Oviedo (2009) advocate the use CDS spreads rather than bond spreads for a number of reasons. While economically comparable to bond spreads, CDS spreads do not require the specification of a benchmark risk-free yield curve as they are already quoted as spreads. This avoids undue noise which may arise from the use of a mis-specified model of the risk-free yield curve. The choice of the risk-free yield curve includes the choice of a reference risk-free asset, which can be problematic (see Houweling and Vorst, 2005), but also the choice of a framework to remove coupon effects.

CDS spreads may reflect changes in credit risk more accurately and quickly than corporate bond yield spreads. Blanco, Brennan, and Marsh (2003) show that a change in the credit quality of the underlying entity is more likely to be reflected in the CDS spread before the bond yield spread. This may be due to important non-default components in bond spreads that obscure the impact of changes in credit quality. Longstaff, Mithal, and Neis (2005) document the existence of an illiquidity component in bond yield spreads. Related to this, trading in CDS markets has increased, while many corporate bonds are rarely traded. Partly as a result, CDS data is collected at a daily frequency, while many studies that use corporate bonds typically use observations at a monthly frequency, which should allow for cleaner tests.

The aim of this study is to extend the literature that empirically investigates the determinants of CDS prices. The previous literature in this area uses a range of theoretical determinants of default risk to model CDS spreads. Benkert (2004), Greatrex (2009) and Ericsson, Jacobs, and Oviedo (2009) document that individual firm CDS prices are related to risk free interest rates, share prices, equity volatility, bond ratings and firm leverage. These studies suggest that theoretical determinants of default risk explain a significant amount of variation in CDS prices. Other studies incorporate new determinants to better explain the variation in CDS spreads. Zhang, Zhou, and Zhu (2009) use theoretical determinants along with volatility and jump risk of individual firms from high frequency equity prices to explain variation in CDS spreads. Cao, Yu, Zhong (2009) find that individual firms put option implied volatility is superior to historical volatility in explaining variation in CDS spreads. Tang and Yan (2007) find that measures of CDS liquidity are significant in explaining variation in CDS spreads.[2]

In this study, we extend this work by proposing a new measure of the likelihood of firm default - short selling. Diamond and Verrecchia (1987) suggest that, since short sellers do not have the use of sale proceeds, market participants' never short-sell for liquidity reasons, which *ceteris paribus* implies relatively few uninformed short sellers. Empirical studies confirm heavily shorted stocks under-perform, implying short sellers are informed (see *inter alia* Desai, Ramesh, Thiagarajan and Balachandran, 2002, Jones and Lamont, 2002, Boehme, Danielson and Sorescu, 2004, Diether Lee and Werner, 2008 and Boehmer, Jones and Zhang, 2008). Therefore short sellers are informed traders who take positions by selling a company's stock in the expectation that prices will fall in the near future following the revelation of bad news specific to that firm. As such, the level of short selling is a direct measure of the prospects for a company. High (low) short selling indicates a

[2] Other studies examining the CDS market include Duffie (1999) and Hull and White (2000) who examine the pricing of spreads. Other empirical studies which examine the CDS market include Houweling and Vorst (2005) who implement a set of simple reduced-form models on market swap quotes and corporate bond quotes. Their paper focuses on the pricing performance of the model and the choice of benchmark yield curve. Hull et al. (2004) analyse the impact of rating announcements on the pricing of swaps. Blanco et al. (2003) study the relative pricing of corporate bonds and default swaps. Longstaff et al. (2005) document the differences between default swap spreads and corporate bond yield spreads, using various risk-free benchmarks. Under the assumption that default swap spreads do not contain a liquidity component, the differences between the spreads highlight the relative importance of default risk and liquidity for corporate bonds.

more (less) pessimistic view of a company and an increased (decreased) likelihood of default. Therefore, CDS spreads should exhibit a positive and significant relationship to the level of short selling. Thus, by examining the relationship between CDS spreads and short-selling, we add to the existing literature which examines the determinants of CDS spreads and also add to the existing literature on the information content of short-selling.

We estimate the relationship between CDS spreads and the theoretical determinants of CDS spreads using OLS regressions. Results reveal that the variables which explain the greatest variation in CDS spreads are those predicted by the structural form models. After controlling for the determinants of CDS spreads (credit ratings, firm-specific variables and macro-financial variables), CDS spreads are positively related to short-selling. These results are economically significant and robust to various controls including the use of changes in CDS spreads, choice of short-selling measure, cross-sectional controls for fixed effects, subgroup analysis by rating categories, calculation of average regression coefficients using time-series regressions and the use of contemporaneous explanatory variables.

The remainder of this paper is organized as follows. Section 2 describes the data and determinants of CDS spreads. Section 3 describes the model specification and the results of the empirical analysis. Section 4 provides a summary of the main results and conclusions.

2 Data

2.1 CDS

As CDS for individual firms are traded over-the-counter, there is no central clearing house from which market activity is observed. Thus, early research typically uses limited samples of data, normally sourced from a sole market maker. For example, Aunon-Nerin et al. (2002) use CDS data from ‘a major London interdealer broker’, Benkert (2004) use data from German bank WestLB and Hull, Predescu and White (2004) use data from derivatives broker, GFI. The use of data that captures only a subset of the market poses a problem as there is always a certain element of uncertainty as to how representative are the research findings. The availability of reliable data has improved with the emergence of ‘Markit’, a commercial data vendor that specializes in the CDS market. Markit currently collect price data from 40 of the major CDS price makers to create a comprehensive dataset that covers more than 3,000 corporate bond issuers. While this data is typically used by corporate clients to mark-to-market open CDS positions as well as to identify profitable capital structure arbitrage opportunities, a select number of researchers have been granted access to Markit data for the purposes of academic research (see *inter alia* Tang and Yan, 2007, Greatrex, 2009, Cao, Yu, Zhong, 2009 and Zhang, Zhou and Zhu, 2009).

In this study, we use the Markit CDS database which contains the CDS composite spread, the seniority of the underlying debt obligation, the currency and maturity of the contract and the average recovery rates used by data contributors in pricing each CDS contract. For our analysis, we use US dollar-denominated five-year CDS contracts written on senior unsecured debt of US obligors. While the contract maturity can range from six months to 30 years, five-year maturity is by far the most common. The extant literature also examine contracts with a five-year maturity (see *inter alia* Cao, Yu, Zhong, 2009). Similarly, we eliminate the subordinated class of contracts as the majority of contracts are written over senior unsecured obligations. The extant literature also eliminates obligors in the financial, utility, and government sectors because of the difficulty in interpreting their capital structure variables.

While CDS spreads are available on a daily basis, we use weekly data to avoid the use of stale CDS spreads, to minimize the effects of noise in the data, and to better capture variation over time if certain CDS spreads do not vary on a daily basis while still allowing enough observations to analyze at the firm-level. In addition, using daily data is likely to understate the effect of firms' balance sheets on CDS pricing because balance sheet information is available only on a quarterly basis. For each entity, we calculate the weekly CDS spread and the weekly recovery rates linked to end-of-week CDS spreads.

After matching the CDS data with other information, such as short-selling, equity prices and balance sheet information (all discussed later), we arrive at a final sample of 368 firms. Our sample period (1 June, 2006 to 1 September, 2008) is determined by the availability of short-selling data. The start of our sample period is chosen due to the beginning of our short-selling database, while the end of our sample coincides with the beginning of the 2008 short-selling bans in the U.S. Given the main purpose of this study is to examine the relationship between short-selling and CDS spreads, we do not extend the study into the period during the short-selling bans as the majority of short-selling was prohibited.

2.2 Short-selling

As discussed in the introduction, short sellers are informed traders who take positions by selling a company's stock in the expectation that price will fall in the near future following the revelation of bad news specific to that firm. As such, the level of short selling is a direct measure of the prospects for a company. High (low) short selling indicates a more (less) pessimistic view of a company and an increased (decreased) likelihood of default. Therefore, CDS spreads should exhibit a positive and significant relationship to the level of short selling.

Given securities lending is a commonly used proxy for the level of short sales (see D'Avolio, 2002)[3]; we utilize a unique proprietary database, provided by Data Explorers, which captures information on the securities lending market. The data contain information from a significant number of the largest custodians in the industry and, by their own estimates, capture approximately 80% of the market for equity lending. From Data Explorers, we obtain information on the fraction of total lendable assets that are currently on loan (denoted as utilisation hereafter). Utilisation captures the amount of stock that is lent out for short-selling as a percentage of the total amount available for stock lending. This measure is preferred over the total amount of stock on loan because it captures the intensity of short-selling and controls for the amount of stock on issue and amount of stock available for lending.

2.3 Explanatory variables

To examine the effect of short-selling on CDS spreads, we include several explanatory variables to control for the fundamental determinants of credit risk. Following the extant literature we include standard structural factors, including firm-specific balance sheet information and macroeconomic variables, along with individual equity, rating and CDS contract information. These variables' hypothesized relationship and empirical specifications are outlined below.

Following Zhang, Zhou and Zhu, 2009, we include the following firm-specific variables: leverage ratio, return on equity, and dividend payout ratio, all obtained from Compustat. We use the last available quarterly observations in regressions, and the three firm-specific variables are defined as follows (in percentages):

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[3] The use of securities lending market data is a fairly new innovation in the literature and only a handful of papers have had access to this type of data, including D'Avolio (2002) and Diether, Lee and Werner (2008).

$$\text{Leverage ratio} = \frac{\text{Current debt} + \text{Long-term debt}}{\text{Total equity} + \text{Current debt} + \text{Long-term debt}},$$

$$\text{Return on equity} = \frac{\text{Pretax income}}{\text{Total equity}},$$

$$\text{Dividend payout ratio} = \frac{\text{Dividend payout per share}}{\text{Equity price}},$$

We expect a firm's leverage ratio, which is central to all the structural form models, to have a positive relationship with CDS spreads. The more levered the firm, the higher the probability of default. A firm's return on equity is expected to have a negative relationship with CDS spreads as the probability of default is lower when the firm's profitability improves. A firm's dividend payout ratio is expected to have a positive relationship with CDS spreads, as a higher dividend payout ratio indicates a decrease in asset value; therefore, default is more likely to occur. We also include recovery rate as an explanatory variable due to its effect on the present value of protection payments. For example, higher recovery rates reduce the present value of protection payments in the CDS contract.

We also use four macro financial variables: (1) the S&P 500 index average daily return (past six months), (2) the S&P 500 implied volatility—VIX—from the option market, (3) the spot rate (average three-month Treasury rate), and (4) the slope of the yield curve (the ten-year rate minus the three-month rate). The S&P 500 index proxies for the overall state of the economy and improving market conditions should improve individual CDS spreads. Given individual firm value is a function of its business risk which is, in turn, dependent on overall market conditions, we expect a positive relationship between the index level and individual spread levels.

Longstaff and Schwartz (1995) note that the static effect of a higher spot rate is to increase the risk neutral drift of the firm value process. Given a higher drift reduces the probability of default, we expect an increase in the spot rate (three-month Treasury rate) to reduce credit spreads. Collins-Dufresne et al. (2001) note that although the spot rate is the only interest-rate-sensitive factor that appears in the firm value process, the spot rate process itself may depend upon the slope of the Treasury curve. If an increase in the slope of the Treasury curve increases the expected future short rate, then by the same argument as above, it should also lead to a decrease in credit spreads. Further a steeper slope of the term structure is an indicator of improving economic activity in the future, but it can also forecast an economic environment with a rising inflation rate and a tightening of monetary policy. Thus we expect CDS spreads to be inversely related to the slope of the yield curve (the ten-year rate minus the three-month rate).

In Merton's (1974) structural framework, equity is a call option on the underlying firm while debt is similar to a put option. An increase in volatility should decrease the value of risky debt and increase CDS spreads. Intuitively, higher equity volatility often implies higher asset volatility; therefore, the firm value is more likely to hit below the default boundary. Using data from DataStream, two measures of firm-specific volatility are estimated. Historical volatility is estimated as the 250-day rolling variance of the individual stock returns. Intraday volatility is measured as ln (daily high / daily low). The S&P 500 implied volatility—VIX—from the option market is also examined as it captures the markets expectation of volatility.

Credit rating is shown to have explanatory power for credit spreads, even after controlling for the economic determinants of spreads (Fabozzi, Cheng, Chen, 2007). Credit rating is an opinion of the general credit worthiness of an obligor and its ability in the future to make timely payments on a specific fixed income security. Therefore the rating should directly reflect the probability of default and is expected to have a significant impact on CDS spreads. Ratings are reported using Standard and Poor's notation and reflect the average of the respective Standard and Poor's and Moody's ratings, or whichever rating was available if the company was not rated by both organizations. We expect an inverse relationship between the quality of the respective borrower and the CDS spreads. Dummy variables are included for all rating classes below AAA that are represented in the sample. The effect of the respective rating classes is measured relative to a rating of AAA. There are no CDS in the sample for firms rated worse than CCC.

3 Model specification and Empirical Results

The benchmark regression is an ordinary least-squared test that pools together all valid observations:

$$CDS_{i,t} = \alpha + \beta_s Utilisation_{i,,t-1} + \beta_v\, Volatility_{i,,t-1} + \beta_r\, Rating_{i,,t-1} + \beta_m\, Macro_{i,,t-1} + \beta_f\, Firm_{i,,t-1} + \beta_r\, Recovery_{i,,t-1} + \varepsilon_{i,t}$$

where $CDS_{i,t}$ is the spread for stock i at time t, the explanatory variables are the vectors detailed in the previous section and $\varepsilon_{i,t}$ is the error term. Zhang, Zhou, and Zhu (2009) note that most of the explanatory variables are jointly determined with CDS spreads which may artificially inflate the explanatory power of the model. To avoid this simultaneity problem we utilise lagged explanatory variables in our model. Standard errors are adjusted using a variance/covariance matrix that is robust to clustering with respect to the firm (Petersen, 2009). We adopt this approach to adjust for potential bias in OLS standard errors.

3.1 Summary statistics

Table 1 reports summary statistics for CDS spreads and the explanatory variables discussed in the previous section. The statistics are reported for the whole sample and divided into rating categories based on credit ratings. The CDS entities are concentrated in the BBB (44%), 'AAA to A' (33%) and 'BBB and below' (23%) categories. Consistent with previous findings, CDS spreads exhibit significant cross-sectional variation across the ratings categories. The highest grade entities (AAA to A) have an average spread of 33.72 basis points (bps) compared to the lowest grade (BB and below) 259.28 bps. Figure 1 shows that CDS spreads demonstrate significant time variation across the sample period (July 2006 to August 2008). There is an increase in CDS spreads that coincides with the onset of the GFC in June 2007, with CDS spreads more than doubling in the remainder of the sample period.

<Insert Table 1>

<Insert Figure 1>

Utilisation, our measure of short-selling and the main explanatory variable of interest, also demonstrates cross sectional variation. Across the ratings, entities with the highest ratings (AAA to A) have an average utilisation of 6% compared to the lowest ratings (BB and below) which have an average utilisation of 22.04%. Other explanatory variables behave as predicted by the literature. Leverage and volatility measures are lower for high rating firms compared to low rating firms, while return on equity and payout ratios are higher for high rating firms compared to low rating firms.

3.2 Univariate regression analysis

Before estimating multivariate regressions, the relationship between each explanatory variable and CDS spreads is estimated individually using OLS univariate regressions. The results, presented in Table 2, are consistent with previous literature and demonstrate the following patterns. The coefficients on all volatility measures (Historical, Intraday and VIX) are positive and significant at the one percent level. Leverage exhibits a positive and significant relationship with CDS spreads which is consistent with structural form models. The key coefficient of interest, utilisation, is positive and significant when regressed against CDS spreads. This is preliminary evidence that short-selling is positively related to CDS spreads. Table 2 shows that the variables which explain the greatest variation in CDS spreads are those predicted by the structural form models. Particularly leverage and historical volatility regressions have the highest R^2 of 26% and 32%, respectively.

<Insert Table 2>

3.3 Multivariate analysis

While the univariate analysis in Table 2 shows that CDS spreads are positively related to short-selling, these regressions do not control for the theoretical determinants of CDS spreads. In Table 3, the results of the multivariate OLS regressions are reported. The regressions are first conducted using only rating dummy variables; we then add firm specific variables (excluding utilisation) and macro-financial variables before finally adding utilisation in the final regression. Regression 1 shows that credit rating is an important determinant of CDS spreads. Consistent with previous studies (i.e. Zhang, Zhou, and Zhu, 2009), firms with low credit ratings exhibit higher CDS spreads compared to high rating firms. The R^2 (42.74%) shows that credit ratings alone can explain a large amount of variation in CDS spreads.

<Insert Table 3>

In regression 2 we add all explanatory variables (excluding utilisation) to the rating dummies. The direction of the results is consistent with the theoretical predictions and extant empirical evidence. Regression 2, in Table 3, shows that the coefficients on the spot rate (average three-month Treasury rate) and the slope of the yield curve (the ten-year rate minus the three-month rate) are negative and significant at the five percent level. This is consistent with previous evidence from corporate bond yield spreads (see *inter alia* Duffie, 1999) and CDS spreads (see *inter alia* Cao, Yu, Zhong, 2009).

The individual volatility measures (Historical and Intraday) are both positive and significant; while the market volatility measure (VIX) is not significant. This is consistent with the results of Cao, Yu, Zhong, 2009 who suggest that the information content of market-level volatilities is subsumed by firm-level volatilities. Evidence of this is highlighted in the univariate regressions in Table 2, where the coefficient of the market volatility measure (VIX) is positive and highly significant. However when examined in a multivariate framework, controlling for firm-level volatilities and other factors, its explanatory power diminishes. Similarly, the coefficient on the market index (S&P 500 index average daily return) is not significant in Regression 2 of Table 3. Again, in the univariate regressions in Table 2, the coefficient is negative and highly significant, and suggests that the information content of market index returns is subsumed by other explanatory variables. A similar result is documented for the recovery coefficient which is no longer significant in the multivariate regressions.

For the other firm specific variables: the coefficient of the leverage ratio is positive and significant at the one percent level; while the coefficient of the return on equity ratio is negative and significant at the one percent level; and the coefficient on the payout ratio is not significant. These regression coefficients, while not the focus of this study, are consistent with previous findings. Further, adding these variables increases the explanatory power of the regression (R^2 increases to 63%), suggesting that these variables have explanatory power over and above the rating information.

The third regression in Table 3 incorporates all variables, including our measure of short-selling (utilisation). The results are consistent with the univariate regression in Table 2. After controlling for the determinants of CDS spreads, the magnitude of the coefficient has fallen from 1.96 to 0.41. However the coefficient remains positive and significant at the one percent level, suggesting a positive relationship between CDS spreads and short-selling. In terms of economic significance, this implies that a one percent increase in utilisation will lead to a 0.41 percent increase in CDS spreads (given CDS spreads are measured in bps this is equal to 0.40 bps).

3.4 Changes in CDS spreads

The results so far examine CDS spread levels, rather than changes in CDS spreads. Previous studies (see *inter alia* Greatrex, 2009; Zhang, Zhou, and Zhu, 2009; and Ericsson, Jacobs, and Oviedo, 2009) examine both levels and changes in CDS spreads. Greatrex (2009) finds that spread levels tend to be non-stationary while, spread changes are stationary. Thus any findings using levels (as opposed to changes) are potentially subject to spurious regression inferences. We therefore run the following regression:

$$\Delta CDS_{i,t} = \alpha + \beta_s\, \Delta Utilisation_{i,,t} + \beta_v \Delta Volatility_{i,,t} + \beta_m \Delta Macro_{i,,t} + \beta_f\, \Delta Firm_{i,,t} + \varepsilon_{i,t}$$

This regression examines the relation of weekly changes in CDS spreads with contemporaneous changes in explanatory variables. The regression includes all explanatory variables except rating information and recovery rates as these variables rarely display any variation. Overall, the results in Table 4 show the explanatory power of the model is much lower when examining spread changes compared to spread levels. This is consistent with previous studies on both credit spread changes (see *inter alia* Collin-Dufresne, Goldstein, and Martin 2001) and CDS spread changes (see *inter alia* Zhang, Zhou, and Zhu, 2009; and Ericsson, Jacobs, and Oviedo, 2009). Importantly, the utilisation coefficient remains positive and statistically significant when regressed against CDS spread changes. This suggests short-selling is not only positively related to CDS spread levels, but also changes in CDS spreads.

<Insert Table 4>

3.5 Alternative measure of short-selling

While securities lending is a commonly used proxy for the level of short sales (see D'Avolio, 2002); it is possible that utilisation is not a true representation of the level of short-selling. To test for robustness we use short-interest as another measure of short-selling. Short-interest is commonly used as a proxy for short-selling (see *inter alia* Senchack and Starks, 1990; and Desai, Ramesh, Thiagarajan and Balachandran, 2002). From Compustat we obtain monthly short-interest data from 1 January, 2007 to 1 September, 2008 and re-conduct the analysis replacing utilisation with short-interest.

Table 5 reports the results of these regressions using short-interest and short-interest (%) scaled by the number of shares outstanding. Short-interest (%), similar to utilisation, captures the amount of short-selling pressure relative to the number of securities available. In Table 5, we firstly run univariate regressions on the short-interest measures and then conduct multivariate regressions. Regressions 1 and 2 show that short-interest is positively related to the level of CDS spreads and both are significant at the one percent level. While short-interest behaves in the same way to utilisation, short interest (%) explains a greater variation in CDS spreads (R^2, 39%) compared to short-interest (R^2, 10%) and utilisation (R^2, 7%). These results indicate that while short-interest (%) explains a greater variation in CDS spreads, all our measures of short-selling provide homogenous results in terms of direction and significance.

<Insert Table 5>

3.6 Additional Tests

The results in the previous sections suggest a positive relationship between short-selling and CDS spreads. In this section, we probe the robustness of our results by examining various regression specifications and techniques. Firstly, following previous studies (i.e. Benkert, 2004) we include fixed effects for time and firm. Second, following Zhang, Zhou, and Zhu (2009) we conduct regressions excluding ratings dummies and dividing the sample into the three rating groups used in Table 1: 'AAA to A'; 'BBB'; and 'BBB and below'. Third, following Collin-Dufresne, Goldstein, and Martin (2001) and Ericsson, Jacobs, and Oviedo (2009) we also calculate average regression coefficients using a series of time-series regressions, one for each entity. These regressions, similar to including firm fixed effects, control for variation among firms. Finally, following Ericsson, Jacobs, and Oviedo (2009) we regress CDS spread levels against contemporaneous explanatory variables.

The most notable changes between techniques include: incorporating fixed effects leads to increased explanatory power (R^2 increases to 84%); and using contemporaneous explanatory variables increases the magnitude and significance of the relationship between short-selling and CDS spreads. Overall, the coefficient direction and significance of the explanatory variables, and in particular short-selling, remain qualitatively unchanged. This demonstrates our results are robust to different specifications and regression techniques.[4]

[4] As mentioned, the different specifications lead to identical conclusions, and are thus omitted for brevity. These results are available upon request from the authors.

3.7 Discussion of Results

While we show that short-selling exhibits a positive relationship with CDS spreads, the question remains whether short-selling leads the CDS market or vice-versa. This question in part can be implied from previous studies which examine the relationship between CDS spreads and stock markets. These studies (see *inter alia* Norden and Weber, 2009 and Forte and Pena, 2009) document that stock market returns lead CDS spread changes, suggesting price discovery occurs in the stock market more often than in the CDS market. While we do not examine whether short-selling leads the CDS market directly, given short-selling occurs in the stock market, this implies that short-selling is likely to lead the CDS market. This is consistent with the notion that short-sellers are informed (see *inter alia* Boehmer, Jones and Zhang, 2008), given the majority of price discovery occurs in the stock market. Possible explanations for stocks returns leading CDS spreads could be the structural difference between the markets in which the assets are being traded. The structural differences could imply probable differences in the relative speed with which respective markets respond to the changes in credit conditions. For example, CDS markets for individual firms are OTC compared to stock markets which are traded through an electronic exchange.

4 Conclusion

In this study, we examine the determinants of firm-level CDS spreads, using a new measure of the likelihood of firm default - short-selling. By examining the relationship between CDS spreads and short-selling, we add to the existing literature which examines the determinants of CDS spreads and also add to the existing literature on the information content of short-selling. We firstly estimate the relationship between CDS spreads and the theoretical determinants of CDS spreads using OLS univariate regressions. The univariate results reveal that that the variables which explain the greatest variation in CDS spreads are those predicted by the structural form models. The key coefficient of interest, utilisation (our measure of short-selling), is positive and significant when regressed against CDS spreads. While the univariate analysis shows that CDS spreads are positively related to short-selling, these regressions do not control for the theoretical determinants of CDS spreads. After controlling for the determinants of CDS spreads (credit ratings, firm-specific variables and macro-financial variables) the coefficient on our measure of short-selling (utilisation) remains positive and significant. These results are economically significant and robust to various controls including the use of changes in CDS spreads, choice of short-selling measure, cross-sectional controls for fixed effects, subgroup analysis by rating categories, calculation of average regression coefficients using time-series regressions and the use of contemporaneous explanatory variables.

References

Aunon-Nerin, D., Cossin, D., Hricko, T. and Huang, Z. (2002) "Exploring for the determinants of credit risk in credit default swap transaction data: Is fixed-income markets' information sufficient to evaluate credit risk?" FAME Research Paper No. 65, International Center for Financial Asset Management and Engineering.

Benkert, C. (2004) "Explaining credit default swap premia", *Journal of Futures Markets*, 24, 71–92.

Black, F., Scholes, M., 1973. The pricing of options and corporate liabilities. Journal of Political Economy 81, 637-654.

Blanco, R., Brennan, S. and Marsh, I.W. (2005) "An empirical analysis of the dynamic relation between investment grade bonds and credit default swaps", *Journal of Finance*, 60, 2255–2281.

Boehmer, R.D., Danielsen, B.R., Sorescu, S.M., 2006. Short-sale constraints, differences of opinion, and overvaluation. Journal of Financial and Quantitative Analysis 41, 455.

Boehmer, E., Jones, C.M., Zhang, X., 2008. Which Shorts are Informed? The Journal of Finance 63, 491-527.

Cao, C., F. Yu, Z. Zhong, 2007. The Information Content of Option-Implied Volatility for Credit Default Swap Valuation.Forthcoming, Journal of financial markets.

Campbell, J. Y., and G. B. Taksler. 2003. Equity Volatility and Corporate Bond Yields. *Journal of Finance* 58:2321–49.

Collin-Dufresne, P., Solnik, B., 2001. On the term structure of default premia in the swap and LIBOR markets. Journal of Finance 56 (3), 1095e1115.

Cremers, M., J. Driessen, P. Maenhout, and D. Weinbaum. 2004. Individual Stock-Option Prices and Credit Spreads. Yale ICF Working Paper, Yale School of Management.

D'Avolio, G., 2002. The market for borrowing stock. Journal of Financial Economics 66, 271–306.

Diether, K., Lee, K-H., Werner, I.M., 2008. Short-Sale Strategies and Return Predictability. Review of Financial Studies, forthcoming.

Desai, H., Ramesh, K., Thiagarajan S.R., Balachandran B.V., 2002. An Investigation of the Information Role of Short Interest in the Nasdaq Market. The Journal of Finance, 57 (5), 2263–2287.

Diamond, D.W., Verrecchia, R.E., 1987. Constraints on short-selling and asset price adjustment to private information. Journal of Financial Economics 18, 277-311.

Duffie, D., 1999. Credit swap valuation. Financial Analysts Journal (January/ February), 73–87.

Duffie, D., Pedersen, L.H., Singleton, K.J., 2003. Modeling sovereign yield spreads: a case study of Russian debt. Journal of Finance 58 (1), 119e160.

Ericsson, J., K. Jacobs, and R. Oviedo. 2009. The Determinants of Credit Default Swap Premia. *Journal of Financial and Quantitative Analysis*, 44 109-132.

Fabozzi, F. J., X. Cheng, and R.-R. Chen (2007, March). Exploring components of credit risk in credit default swaps. *Finance Research Letters 4* (1), 10–18.

Forte, S., and Peña, J.I., 2007, *"Credit Spreads: Theory and Evidence on the*

Informational Content of Stocks, Bonds and CDS. Journal of Banking and Finance 33, 2013-2025.

Greatrex, C. A. (2009). The credit default swap market's determinants. The Journal of Fixed Income 18, 3, 18-32.

Jarrow, R.A., Lando, D., Turnbull, S.M., 1997. A Markov model for the term structure of credit spreads. Review of Financial Studies 10 (2), 481-523.

Jarrow, R.A., Turnbull, S.M., 1995. Pricing derivatives with credit risk. Journal of Finance 50 (1), 53-85.

Jones, C.M., Lamont, O.A., 2002. Short-sale constraints and stock returns. Journal of Financial Economics 66, 207–239.

Houweling, P., and T. Vorst. 2005. Pricing Default Swaps: Empirical Evidence. *Journal of International Money and Finance* 24:1200–25.

Hull, J., Predescu, M. and White, A. (2004) "The relationship between credit default swap spreads, bond yields, and credit rating announcements", *Journal of Banking and Finance*, 28, 2789–2811.

Hull, J., White, A., 2000. Valuing credit default swaps I: no counterparty default risk. The Journal of Derivatives 8 (1), 29-40.

Longstaff, F. A., S. Mithal, and E. Neis. 2005. Corporate Yield Spreads: Default Risk or Liquidity? New Evidence from the Credit-Default-Swap Market. *Journal of Finance* 60:2213–53.

Longstaff, F.A., Schwartz, E.S., 1995. Valuing credit derivatives. Journal of Fixed Income June, 6-12.

Litterman, R., Iben, T., 1991. Corporate bond valuation and the term structure of credit spreads. Journal of Portfolio Management Spring, 52-64.

Merton, R.C., 1974. On the pricing of corporate debt: the risk structure of interest rates. Journal of Finance 29 (2), 449-469.

Norden, L., and M. Weber. 2004. Informational Efficiency of Credit Default Swap and Stock Markets: The Impact of Credit Rating Announcements. *Journal of Banking and Finance* 28:2813–43.

Pan, J. and Singleton, K.J. (2008) “Default and recovery implicit in the term structure of sovereign CDS spreads”, Journal of Finance, 63, 2345 – 2384.

Petersen, M. A. 2009. Estimating Standard Errors in Finance Panel Data Sets: Comparing Approaches. *Review of Financial Studies* 22:435–480.

Senchack, A.J., Starks, L.T., 1993. Short-Sale Restrictions and Market Reaction to Short-Interest Announcements. Journal of Financial and Quantitative Analysis 28, 177–194.

Tang, D.Y., Yan, H., 2007. Liquidity and credit default swap spreads. Working paper, University of Hong Kong and University of South Carolina.

Zhang, B.Y., H. Zhou, and H. Zhu, 2008, Explaining credit default swap spreads with equity volatility and jump risks of individual .Review of Financial Studies 22,:5099-5131

Table 1
Summary statistics

The table reports the summary statistics of all regression variables for the whole sample and three subgroups by ratings. The sample covers 368 entities over the period 1 January, 2006 to 1 September 2008. Panel A reports the summary statistics of all firm-specific regression variables. These variables include five-year CDS spreads (CDS) and recovery rates (Recovery) reported by Markit for senior unsecured obligations with modified restructuring clauses; the amount of stock that is lent out for short-selling as a percentage of the total amount available for stock lending (Utilisation); firm level equity return volatility (Historical volatility and Intraday volatility); and firms' balance sheet information, including the leverage ratio, return on equity, and dividend payout ratio. Panel B reports the summary statistics of the macro-financial variables: market return (S&P 500 return) and volatility (VIX), short term rate (3-Month Treasury rate) and term spread (10Y-3M).

Panel A: Firm-specific variables

Credit Rating Category	AAA to A		BBB		BB and below		Whole sample	
Variable	Mean	Std dev	Mean	Std dev	Mean	Std dev	Mean	Std dev
CDS (bps)	33.72	29.53	67.80	67.43	259.28	220.47	88.98	131.13
Recovery (%)	39.74	0.96	39.69	0.98	40.71	5.58	39.90	2.59
Utilisation (%)	6.61	12.40	11.11	17.59	22.04	24.23	11.58	18.33
Historical Volatility (%)	1.47	0.52	1.69	0.54	2.33	0.85	1.71	0.66
Intraday Volatility (%)	2.19	1.38	2.51	1.59	3.66	2.42	2.62	1.79
Leverage (%)	16.84	12.02	22.97	13.91	37.67	20.72	23.43	16.44
Return on Equity (%)	2.33	2.72	1.62	7.38	-1.51	14.47	1.28	8.30
Dividend Payout Ratio (%)	0.54	0.44	0.53	1.39	0.40	3.04	0.51	1.64

Panel B: Macro-financial variables

	Mean	Std dev
S&P 500 return (%)	16.02	7.48
VIX (%)	18.29	5.84
3-Month Treasury rate (%)	3.73	1.43
Term spread 10Y-3M (%)	0.67	1.02

Table 2
Determinants of CDS spreads-Univariate regressions

The univariate regressions use weekly data to explain the determination of five-year CDS spreads for 368 entities with senior unsecured obligations with a modified restructuring clause from 1 January, 2006 to 1 September 2008.entities. The OLS regressions specify that

$$CDS_{i,t} = \alpha + \beta_e\ ExplantoryVariable_{i,,t-1} + \varepsilon_{i,t.}$$

Explanatory variables include lagged firm specific and macro-financial variables including: the amount of stock that is lent out for short-selling as a percentage of the total amount available for stock lending (utilisation); recovery rates reported by Markit; firm level equity return historical volatility, Intraday volatility; firms' balance sheet information, including the leverage ratio, return on equity, and dividend payout ratio; and macro-financial variables including the market return (S&P 500 return) and volatility (VIX), short rate (3-Month Treasury rate) and term spread (10Y-3M). Numbers in parentheses are *t*-statistics based on clustered standard errors that adjust for firm effects (see Peterson 2009).

	Dependant variable: Five-year CDS spread (bps)										
Explanatory Variables	Utilisation	Recovery	Historical Volatility	Intraday Volatility	Return on Equity	Dividend payout ratio	Leverage	Spot rate	Term spread	VIX	Market return
Intercept	67.62	-306.16	-104.98	9.58	95.27	91.01	-0.32	195.54	63.75	-8.80	97.25
	(15.72)	*(-2.91)*	*(-5.78)*	*(1.63)*	*(16.77)*	*(15.69)*	*(-0.04)*	*(14.54)*	*(15.82)*	*(-1.91)*	*(15.10)*
Coefficient	1.96	9.94	111.49	30.59	-4.08	-1.86	3.71	-28.41	38.52	5.36	-256.67
	(5.85)	*(3.78)*	*(8.92)*	*(9.39)*	*(-3.77)*	*(-0.94)*	*(8.53)*	*(-12.39)*	*(12.34)*	*(12.17)*	*(-10.27)*
Adjusted R^2	0.07	0.03	0.32	0.17	0.07	0.01	0.26	0.10	0.09	0.06	0.02

Table 3

Determinants of CDS spreads-Multivariate regressions

The multivariate regressions use weekly data to explain the determination of five-year CDS spreads for 368 entities with senior unsecured obligations with a modified restructuring clause from 1 January, 2006 to 1 September 2008.entities. The OLS regressions specify that

$$CDS_{i,t} = \alpha + \beta_s Utilisation_{i,,t-1} + \beta_v \, Volatility_{i,,t-1} + \beta_r \, Rating_{i,,t-1} + \beta_m \, Macro_{i,,t-1} + \beta_f \, Firm_{i,,t-1} + \beta_r \, Recovery_{i,,t-1} + \varepsilon_{i,t}$$

Explanatory variables include lagged firm specific and macro-financial variables including: credit rating dummies; the amount of stock that is lent out for short-selling as a percentage of the total amount available for stock lending (utilisation); recovery rates reported by Markit; firm level equity return historical volatility, Intraday volatility; firms' balance sheet information, including the leverage ratio, return on equity, and dividend payout ratio; and macro-financial variables including the market return (S&P 500 return) and volatility (VIX), short rate (3-Month Treasury rate) and term spread (10Y-3M). Numbers in parentheses are *t*-statistics based on clustered standard errors that adjust for firm effects (see Peterson 2009).

Regression	1		2		3	
	Coefficient	*t*-stat	Coefficient	*t*-stat	Coefficient	*t*-stat
Intercept	17.71	*(2.86)*	18.87	*(0.21)*	23.68	*(0.26)*
AA	2.94	*(0.46)*	0.39	*(0.03)*	-0.58	*(-0.05)*
A	19.70	*(3.05)*	-13.68	*(-1.09)*	-13.33	*(-1.18)*
BBB	50.16	*(7.22)*	-2.14	*(-0.16)*	-2.95	*(-0.24)*
BB	202.20	*(11.22)*	84.15	*(4.74)*	81.72	*(4.82)*
B	332.89	*(7.32)*	197.22	*(4.45)*	193.94	*(4.48)*
CCC	647.16	*(2.99)*	680.84	*(4.60)*	688.76	*(4.63)*
Recovery			-0.73	*(-0.32)*	-0.73	*(-0.32)*
Spot Rate			-12.76	*(-4.89)*	-13.75	*(-5.59)*
Term spread			-3.90	*(-2.16)*	-4.60	*(-2.57)*
VIX			0.25	*(0.99)*	0.25	*(1.00)*
Historical Volatility			44.68	*(5.24)*	43.63	*(5.39)*
Intraday Volatility			4.30	*(3.57)*	4.22	*(3.45)*
Market return			-20.54	*(-1.52)*	-19.16	*(-1.45)*
Leverage			1.86	*(5.49)*	1.75	*(5.25)*
Return on Equity			-1.19	*(-2.35)*	-1.17	*(-2.39)*
Dividend Payout Ratio			-0.43	*(-0.52)*	-0.51	*(-0.63)*
Utilisation					0.41	*(2.12)*
Adjusted R^2	0.43		0.62		0.63	

Table 4
Determinants of CDS spread changes

The regressions examine the determination of weekly changes in five-year CDS spreads for 368 entities with senior unsecured obligations with a modified restructuring clause from 1 January, 2006 to 1 September 2008.entities. The OLS regressions specify that

$$\Delta CDS_{i,t} = \alpha + \beta_s\, \Delta Utilisation_{i,,t} + \beta_v \Delta Volatility_{i,,t} + \beta_m \Delta Macro_{i,,t} + \beta_f\, \Delta Firm_{i,,t} + \varepsilon_{i,t}$$

Explanatory variables include contemporaneous weekly changes in firm specific and macro-financial variables including: the amount of stock that is lent out for short-selling as a percentage of the total amount available for stock lending (utilisation); firm level equity return historical volatility, Intraday volatility; firms' balance sheet information, including the leverage ratio, return on equity, and dividend payout ratio; and macro-financial variables including the market return (S&P 500 return) and volatility (VIX), short rate (3-Month Treasury rate) and term spread (10Y-3M). Δ represents the first difference in variables. Numbers in parentheses are *t*-statistics based on clustered standard errors that adjust for firm effects (see Peterson 2009).

Regression	1		2	
	Coefficient	*t*-stat	Coefficient	*t*-stat
Intercept	2.08	*(18.16)*	2.10	*(17.48)*
Δ Spot Rate	-9.58	*(-2.44)*	-10.15	*(-2.54)*
Δ Term spread	0.31	*(4.70)*	0.30	*(4.46)*
Δ VIX	14.27	*(18.59)*	14.06	*(17.41)*
Δ Historical Volatility	45.11	*(4.35)*	43.73	*(4.13)*
Δ Intraday Volatility	-0.18	*(-1.24)*	-0.30	*(-2.29)*
Market return	-18.86	*(-14.75)*	-18.75	*(-13.88)*
Δ Leverage	0.15	*(1.16)*	0.13	*(1.15)*
Δ Return on Equity	0.00	*(-0.11)*	0.00	*(-0.03)*
Δ Dividend Payout Ratio	0.12	*(0.88)*	0.12	*(0.88)*
Δ Utilisation			0.02	*(2.53)*
Adjusted R^2	0.10		0.11	

Table 5
Extended regressions using Short-interest

The extended regressions use weekly data to explain the determination of five-year CDS spreads for 368 entities with senior unsecured obligations with a modified restructuring clause from 1 January, 2007 to 1 September 2008.entities. The OLS regressions specify that

$$CDS_{i,t} = \alpha + \beta_s\, ShortInterest_{,,t-1} + \beta_v\, Volatility_{i,,t-1} + \beta_r\, Rating_{i,,t-1} + \beta_m\, Macro_{i,,t-1}$$
$$+ \beta_f\, Firm_{i,,t-1} + \beta_r\, Recovery_{i,,t-1} + \varepsilon_{i,t}$$

Explanatory variables include lagged firm specific and macro-financial variables including: credit rating dummies; short-interest and short-interest (%) scaled by the number of shares outstanding; recovery rates reported by Markit; firm level equity return historical volatility, Intraday volatility; firms' balance sheet information, including the leverage ratio, return on equity, and dividend payout ratio; and macro-financial variables including the market return (S&P 500 return) and volatility (VIX), short rate (3-Month Treasury rate) and term spread (10Y-3M). Numbers in parentheses are *t*-statistics based on clustered standard errors that adjust for firm effects (see Peterson 2009).

Regression	1		2		3		4		5		6	
	Coefficient	*t*-stat	Coefficient	*t*-stat	Coefficient	*t*-stat	Coefficient	*t*-stat	Coefficient	*t*-stat	Coefficient	*t*-stat
Intercept	0.74	*(7.54)*	0.28	*(5.61)*	0.46	*(3.59)*	-2.21	*(-2.57)*	-2.32	*(-2.74)*	-1.60	*(-1.89)*
Short interest	<0.01	*(3.06)*							<0.01	*(2.99)*		
Short interest (%)			17.70	*(10.96)*							7.90	*(4.85)*
AA					-0.21	*(-1.64)*	-0.02	*(-0.13)*	0.01	*(0.04)*	-0.03	*(-0.39)*
A					-0.04	*(-0.30)*	-0.19	*(-1.24)*	-0.08	*(-0.44)*	-0.17	*(-1.64)*
BBB					0.34	*(2.52)*	-0.06	*(-0.39)*	0.08	*(0.41)*	-0.10	*(-0.89)*
BB					2.04	*(8.29)*	0.85	*(3.79)*	0.99	*(4.05)*	0.62	*(3.29)*
B					3.21	*(6.73)*	1.74	*(4.18)*	1.81	*(4.39)*	1.46	*(3.82)*
CCC					5.65	*(2.69)*	6.76	*(4.23)*	5.80	*(4.48)*	6.62	*(4.52)*
Recovery							0.87	*(0.39)*	0.86	*(0.39)*	0.82	*(0.38)*
Spot Rate							0.22	*(4.40)*	0.21	*(4.09)*	0.15	*(3.23)*
Term spread							0.37	*(6.17)*	0.35	*(5.65)*	0.29	*(5.03)*
VIX							0.01	*(2.57)*	0.01	*(2.44)*	0.01	*(1.84)*
Historical Volatility							47.60	*(4.37)*	46.19	*(4.29)*	25.59	*(3.04)*
Intraday Volatility							7.02	*(5.36)*	7.02	*(5.45)*	5.73	*(4.92)*
Market return							-132.98	*(-6.75)*	-136.89	*(-7.13)*	-134.73	*(-7.40)*
Leverage							2.32	*(5.18)*	2.28	*(5.09)*	1.91	*(5.05)*
Return on Equity							-1.64	*(-2.69)*	-1.52	*(-2.55)*	-1.10	*(-2.10)*
Dividend Payout Ratio							-1.10	*(-1.39)*	-1.11	*(-1.42)*	-1.04	*(-1.60)*
Adjusted R^2	0.10		0.39		0.40		0.60		0.61		0.65	

Figure 1
Five-year CDS spreads (Basis Points) by rating groups

The figure plots the weekly time series of average five-year CDS spreads for 368 entities with senior unsecured obligations with a modified restructuring clause from 1 January, 2007 to 1 September 2008.