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"Credit Default Swap Spreads: Funding Liquidity Matters!"

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Credit Default Swap Spreads: Funding Liquidity Matters!

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Abstract

This paper explores the relationship between funding liquidity and credit default swap (CDS) spreads, evidencing the effects of the regulatory changes brought about by the introduction of the *CDS Small Bang* reforms for CDS contracts on European reference entities in June 2009. Using panel estimations, this study provides evidence that a tightening of funding liquidity increases CDS spreads, an effect which is three times larger in magnitude for high-CDS entities compared to low-CDS firms. This relationship increases in magnitude and significance after the implementation of the CDS Small Bang reforms which introduced fixed coupons for trading CDSs, leading to the exchange of upfront fees between CDS contract parties.

Keywords: CDS spreads; CDS Small Bang; funding liquidity.

JEL Classification: G01, G12, G32

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1. Introduction

What determines the spreads on credit default swaps (CDS)? In this paper, we investigate how funding liquidity, defined as the ease with which traders can acquire funds and finance their operations, impacts CDS spreads. At least three clear motives for this examination can be identified: firstly, a tightening of funding constraints impairs the capacity of dealers to take sides in new CDS contracts as they face higher costs of hedging their positions and higher inventory costs (Tang and Yan, 2008); secondly, the Global Financial Crisis saw both a large drop in funding liquidity and the accusation that holding CDS positions exacerbated financial market complacency about risk; and thirdly, the set of regulatory reforms known as the CDS Small Bang, were introduced in the European market in June 2009 to facilitate standardization and central clearing. The introduction of this latter regulation gave rise to upfront fees that need to be exchanged between CDS buyers and sellers and are thus more likely to make spreads more sensitive to tightening funding conditions, given the additional funding to be raised.

The CDS market saw a period of unprecedented growth in the mid-2000s, with the gross notional amount of outstanding CDS contracts rising to approximately $57 trillion by June 2008 according to the Bank for International Settlements data. Tang and Yan (2008) argue that this growth stemmed from the need of banks and insurance companies to hedge their bond and loan exposures and from the willingness of hedge funds to use CDS as a tool for speculating on credit risk. Early studies (e.g., Longstaff *et al*., 2005) contend that CDS spreads (hereafter 'spreads'), which represent the premiums paid by the buyer to insure against the default of the reference name, mainly contain information relating to the credit risk of the reference entity. However, more recently, studies highlight the importance of liquidity components such as CDS liquidity (e.g., Tang and

Yan, 2008; Bongaerts *et al*., 2011; Coro *et al*., 2013; Pires *et al*., 2015) and individual firm equity liquidity (Das and Hanouna, 2009).

Although the effect of funding liquidity has been examined in other markets its influence in CDS markets remains under investigated. We remedy this by employing monthly data on a sample spanning the period January 2008 to March 2013[2], a balanced panel of CDS entities in the European iTraxx index and associated firm-specific credit and liquidity variables as well as macroeconomic factors which have been previously documented to affect spreads. The funding illiquidity[3] measures employed, namely the three-month European TED spread measure (*EuTed*) and the three-month Euribor-Eurepo spread (*EuRepo*), are related to interbank interest rates and reflect the cost of acquiring funds to finance operations.

Our panel estimations provide several new results. In particular, it is found that changes in funding illiquidity have a highly significant and positive effect on CDS spreads; in line with the hypothesis that a tightening of funding liquidity encourages CDS protection sellers to reduce the supply of contracts as they incur increased inventory and hedging costs, and subsequently reducing CDS liquidity. Notably, in the post-CDS Small Bang period we find that this positive effect is of much higher magnitude. Moreover, we find that changes in funding illiquidity have a three times larger effect on high-spread as compared to low-spread CDS entities, the former's higher default risk causing a higher sensitivity to funding liquidity considerations[4]. When we combine the post-Small Bang period and high-spread entities, it is found that funding liquidity changes are the most

[2] The sample starts in January 2008 to preserve the number of firms in our sample due to data availability on CDS quotes as well as associated stock market data on reference entities. The sample ends in March 2013, as the credit valuation adjustment applied to the price of derivative instruments to account for counterparty credit risk was implemented in the first quarter of 2013.

[3] Typically, the extant literature refers to funding 'illiquidity' measures rather than funding liquidity.

[4] Brunnermeier and Pedersen (2009) predict that riskier assets are more sensitive to funding effects. Pires *et al*. (2015) further evidence that other explanatory variables have a larger impact on high-spread entities.

important determinant of spread changes in terms of explanatory power, among all liquidity variables investigated.

Through this study we contribute to two strands of literature. Firstly, we add to the literature investigating the effects of funding constraints on financial markets (e.g., Brunnermeier and Pedersen, 2009; Gromb and Vayanos, 2002; Gromb and Vayanos, 2010; Comerton-Forde *et al*., 2010). Most notably, Brunnermeier and Pedersen (2009) theorize that under certain market conditions, such as when capital availability is scarce, a deterioration of funding liquidity negatively impacts investors willingness and ability to invest in high-risk securities as they add on more risk, thus leading to reductions in market liquidity and increased volatility. The resulting reduction in market liquidity further increases the sensitivity of market liquidity to future funding liquidity changes.

Secondly, by documenting that funding illiquidity changes affect spread changes, this paper contributes to the growing literature investigating the determinants of CDS spreads (e.g., Blanco *et al*. 2005; Tang and Yan, 2008; Ericsson *et al*. 2009; Greatrex 2009; Coro *et al*. 2013; Annaert *et al*. 2013; Galil *et al*. 2014; Pires *et al*. 2015). Research examining the determinants of spreads has gone a long way in explaining these, from early studies attributing the level of the spread of an entity mainly to credit risk variables (e.g. Longstaff *et al*. 2005, Zhang *et al*. 2009) to ascribing a substantial part of the spread variability to liquidity components and market-wide variables (e.g. Bongaerts *et al*. 2011; Coro *et al*. 2013; Galil *et al*. 2014; Pires *et al*. 2015). To this end, our work now stresses the importance of allowing for funding illiquidity.

The rest of the paper is organised as follows: section 2 outlines the hypotheses, data and variables to be used in the analysis and section 3 presents the models employed. Section 4 provides the empirical results, whilst section 5 details the robustness checks performed. Finally, section 6 presents some policy recommendations and section 7 concludes.

2. Hypotheses and Data

2.1 Hypotheses

When considering how funding illiquidity might affect CDS spreads, Kamga and Wilde (2017) consider that a funding liquidity contraction drives CDS traders to steer away from risky assets, thus reducing the liquidity of the CDS market, in line with the theoretical model proposed by Brunnermeier and Pedersen (2009). Furthermore, confirming these predictions, Junge and Trolle (2015) construct a measure of CDS market liquidity which correlates strongly, among other factors, with funding liquidity, and find that liquidity risk is priced in the cross-section of single-name CDS returns. The above-mentioned studies suggest that funding liquidity positively impacts CDS market liquidity. However, as shown, among others, by Bongaerts *et al*. (2011) and Coro *et al*. (2013), spreads are highly sensitive to changes in CDS liquidity, a deterioration of CDS liquidity increasing spreads, as CDS protection sellers require a premium for illiquidity. Therefore, we would expect funding illiquidity changes to positively impact CDS spread changes through their effect on CDS illiquidity.

Relatedly, the CDS Small Bang, was introduced in the European market on 20th June 2009 to facilitate standardization and central clearing. Before the protocol changes came to effect, trading of CDS contracts was done at a coupon rate that fixed the contract value to zero on the inception day, no upfront fee needing to be exchanged (Markit, 2009; Wang *et al*. 2018). Among other regulatory changes, the CDS Small Bang conventions restrict coupon rates to be fixed at 25bps, 100bps, 500bps and 1000bps (Markit, 2009). However, the introduction of fixed coupons gave rise to upfront fees that need to be exchanged between CDS buyers and sellers, the size of the fee depending on how far away the spread level is from the fixed coupons at which the contract settles (Wang *et al*. 2018). Periods when funding is tight should thus more strongly negatively affect spread liquidity after the implementation of the CDS Small Bang regulations, due to the need of paying additional upfront fees for trading CDS. The resulting decline in CDS liquidity would then be transmitted onto spreads as CDS traders require a premium for illiquidity.

Finally, *a priori*, it might be expected that high-spread CDS firms are more affected by changes in funding illiquidity as they carry relatively more default risk; a tightening of funding liquidity leading these entities closer to the default barrier compared to low-CDS spread firms. Moreover, on average, high-spread firms are more likely to have a spread further away from one of the fixed coupons introduced after the CDS Small Bang. Therefore, a higher fee would need to be exchanged between buyers and sellers for contracts written on high-spread reference entities, leading to a greater reduction in individual CDS liquidity and a higher spread.

The hypotheses examined in this study can be summarized as follows: *Firstly*, we argue that a tightening (relaxation) of funding liquidity increases (decreases) CDS spreads through its effect on CDS liquidity. *Secondly*, we suggest that the effect of funding liquidity changes on spread changes is stronger in the post-June 2009 period, due to the introduction of an upfront fee that is exchanged between CDS buyers and sellers, unless the spread level of an entity is exactly equal to one of the fixed coupon payments. *Thirdly*, we hypothesize that high-spread firms display more sensitivity to changes in funding liquidity than low-spread firms.

2.2 Data

Our dataset combines two main sources, Bloomberg and Thomson Reuters Datastream. From the former we source data on CDS spread mid, bid and ask quotes as well as market rates on the three-month Euribor rate and German Government BuBill maturing in three months.[5] From the latter, we source stock market data such as bid, ask and adjusted close stock prices for the reference entities on which the CDS contracts are written. Macroeconomic interest rate data such as the ten-year and three-year Euro-area Government Benchmark bond yields, stock market index and market wide implied volatility are also collected from Thomson Reuters Datastream. The three-month Eurepo rate is collected from the European Money Market Institute (EMMI) database.

The dataset covers a period of 63 months, from January 2008 to March 2013. The companies selected are all the non-financial companies included in the European iTraxx index on March 2013 (index roll 19)[6]. The Markit iTraxx Europe index comprises of 125 investment-grade entities with the most liquid single-name CDSs in the European market. The constituent list includes 100 non-financial firms and 25 companies that operate in the financial sector. Previous studies using data from the iTraxx Europe index include Alexander and Kaeck (2008) and Breitenfellner and Wagner (2012) which examine the determinants of the CDS indices, Berndt and Obreja (2010) who use index data to construct a factor mimicking economic catastrophe risk and Junge and Trolle (2015) who construct a new measure of CDS market liquidity and analyse whether liquidity risk impacts expected CDS returns.

Following Bai and Wu (2016), we restrict our sample to non-financial entities due to the important differences in terms of regulation, funding methods, corporate governance, agency problems, capital structure, leverage levels and calculation of distance-to-default

[5] Das and Hanouna (2009) and Nashikkar *et al.* (2011) also use CDS information obtained from Bloomberg in their analyses of determinants of CDS spreads and CDS bond-basis, respectively.

[6] The European Markit iTraxx index constituent list is reviewed with respect to liquidity and investment grade of entities every six months, with one index roll occurring in March and one in September. To preserve the number of companies in our cross-section, we also include any entities which were listed as part of the Markit iTraxx index as of March 2013, but which have been previously part of the Markit iTraxx Crossover Index encompassing the 75 most liquid sub-investment grade entities due to a rating downgrade event occurring during our sample period. It is worth noting that throughout the time frame of the study, the constituent list of the European iTraxx index changes are minor. This observation is also highlighted by Breitenfellner and Wagner (2012) who find only neglectable effects of index roll changes on spread changes.

measures between financial and non-financial firms highlighted by De Haan and Vlahu (2016) and Duan and Wang (2012). Furthermore, amongst others, Alexander and Kaeck (2008) provide evidence that several variables that affect CDS spreads of non-financial entities do not impact spreads of companies from the financial sector. Following the recommendations outlined in Coro et al. (2013), we further restrict our sample to include only CDS contracts that satisfy the following conditions: the CDS contract maturity is five years, the most-liquid CDS maturity (Meng and Gwilym, 2008), contracts are denominated in Euros, and the underlying debt is senior-unsecured. Finally, we only select entities for which we can source stock market data for the entire time-series from Thomson Datastream.

Restricting our data using the above-mentioned filters yields us a balanced panel of 76 European entities observed throughout a period of 63 months. In line with Collin-Dufresne *et al.* (2001), Coro *et al.* (2013), Galil *et al.* (2014) and Pires *et al.* (2015) we conduct our empirical analysis using monthly data, as CDS contracts are known to not trade frequently. In his analysis, Zhu (2006) finds that only 20% of days in his sample period contain valid CDS quotes.

2.3 Credit default swaps

Figure 1 plots the evolution of average CDS spread levels (panel (a)) and spread changes (panel (b)) over time. The solid lines represent averages for our entire sample, while the dotted lines represent averages for the top and bottom terciles of the respective distributions. We note a great deal of variation in spread levels and spread changes throughout our sample period. Investigating panel (a), we note that average spread levels fluctuated from highs of 253 bps in December 2008 to lows of 76 bps recorded in January 2008 and December 2009. Moreover, the average spread in the upper tercile of CDS spreads displays even greater variation, reaching peaks of 445 bps in December 2008 and

270 bps in September 2011 and lows of 104 bps in January 2008 and 108 bps in December 2009. Examining panel (b), we note that average spread changes also display variation throughout our sample, from large negative changes of -57 bps in January 2009 and -35 bps in October 2011 to large positive changes of +73 bps in October 2008. The very large variation in average spread changes for the top tercile of spreads during the financial crisis is also remarkable, spreads widening by 138 bps in October 2008 at the peak of the crisis and shrinking by 98 bps and 96 bps in January 2009 and April 2009, respectively.

In the empirical analysis, we focus on examining spread changes, rather than spread levels because, after examining stationarity via the panel unit root test of Levin *et al.* (2002), we cannot reject the null of a unit root for spread levels, whereas spread changes are stationary.[7] Moreover, as Ericsson *et al*. (2009) notes, spread differences should be harder to explain than CDS levels. Therefore, by performing our estimations in first differences, we perform a stricter test of CDS determinants. For each month *t* and company *i*, spread changes are calculated as the first difference of spread levels from the last day of each month, as shown in equation (1):

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

By performing panel regressions using first differences of our variables, rather than levels, we contribute to the growing literature examining the determinants of CDS spread changes (e.g. Collin-Dufresne *et al*, 2001; Ericsson *et al*, 2009; Greatrex, 2009).

2.4 Funding liquidity

Low funding liquidity leads CDS protection sellers to steer away from risky assets, thus decreasing the liquidity of the CDS market (Kamga and Wilde, 2017). This argument is supported by the findings of Tang and Yan (2008) who find that a tightening of funding

[7] Previous studies investigating the determinants of CDS spread changes in the European market (Coro *et al*, 2013; Annaert *et al*, 2013) and in the U.S. market (Galil *et al*, 2014) also found evidence of non-stationarity in spread levels.

liquidity determines dealers with excess inventory to face higher costs of hedging their positions and higher inventory costs, in turn affecting the supply of CDS contracts in the market. Separately, Junge and Trolle (2015) construct a measure of CDS market liquidity that correlates strongly, among others, with funding costs, and go on to find that liquidity risk is priced in the cross-section of single-name CDS returns. These arguments suggest that funding illiquidity affects spreads through their effect on CDS market illiquidity. As shown by Bongaerts *et al.* (2011), Coro *et al.* (2013) and Pires *et al*. (2015), CDS market liquidity, as well as individual CDS liquidity, are important determinants of spreads, a decrease in CDS liquidity leading to a widening of spreads.

Furthermore, we expect funding illiquidity changes to have a stronger impact on CDS spread changes after June 2009, due to the implementation of the CDS Small Bang which brought about a set of convention changes to the European CDS market meant to improve central clearing (Markit, 2009). Before the CDS Small Bang convention changes came into effect, CDS contracts were traded at a coupon rate that set the contract value to zero on the start date of the contract, thus no upfront fee was needed (Wang *et al*, 2018). According to Markit (2009), one of the changes implemented through the CDS Small Bang is the implementation of fixed coupons (25bps, 100bps, 500bps and 1000bps). If the spread of an entity at the date of the contract does not amount exactly to one of the implemented fixed coupons, upfront fees are exchanged depending on the spread level, with fees being larger the further away the spread is from the newly established fixed coupons. Periods of tight funding should have a large impact on spreads after the implementation of the new regulations, due to the need of paying additional fees for trading CDSs which would decrease CDS market liquidity. These effects are closely tied to those documented by Wang *et al.* (2018) in relation to the CDS Big Bang, a similar protocol to the CDS Small Bang implemented in the U.S. market prior to the introduction of the CDS Small Bang in the European market. Wang *et al.* (2018) go on to find that the higher funding cost due to the introduction of upfront fees for trading CDSs reduces CDS liquidity and increases spread volatility.

The above arguments suggest an expected positive relationship between funding illiquidity changes and spread changes, effect which should be larger after June 2009 due to the implementation of the CDS Small Bang regulations. We use two proxies to measure funding illiquidity. Firstly, we examine the European TED spread measure (*EuTed*) calculated as the difference between the three-month Euribor rate and three-month German Government BuBill. This measure can be considered a European equivalent of the widely used TED spread funding liquidity measure (Garleanu and Pedersen, 2011; Boudt *et al*, 2017) in the context of the European market. Secondly, in line with Moinas *et al*. (2018) and Dunne *et al.* (2013), we investigate a funding liquidity measure relying on repo rates, namely the Eurepo spread (*EuRepo*) calculated as the spread between the three-month Euribor and three-month Eurepo rates. The Eurepo rate is collected from the European Money Market Institute database and represents the rate at which one prime bank offers funds in Euro to another prime bank, with the Eurepo General Collateral serving as the collateral in the transaction (Moinas *et al*, 2018). As suggested by Moinas *et al*. (2018), a higher Eurepo spread indicates higher risk aversion and a higher preference for cash.

2.5 Control Variables

We investigate the presence of a relationship between changes in funding illiquidity and spread changes, while controlling for a set of additional firm-specific and macro-economic credit risk and liquidity variables previously documented to impact CDS spreads. The choice of control variables is inspired by the Merton (1974) model and by more recent studies documenting the influence of liquidity and macroeconomic factors on CDS spreads (e.g. Coro *et al*, 2013; Bongaerts *et al*, 2011; Annaert *et al*, 2013). A summary of the explanatory variables as well as a summary of the expected relationships between the changes in explanatory variables and changes in CDS spreads are presented in *Table 1*.

2.5.1 Stock return

The model introduced by Merton (1974) suggests that a decrease in a firm's market value of equity leads to a higher probability of default for the respective firm. In line with Galil *et al.* (2014), we use monthly stock returns as indicators of changes in a firm's market value of equity. We expect a negative relationship between stock returns and CDS spread changes as a decrease in stock returns would increase the probability of default of the firm, which would be captured through an increase in the spread of the respective entity.

2.5.2 Stock return volatility

In the framework of Merton (1974), higher firm value volatility increases the probability of reaching the default threshold. Therefore, higher firm value volatility would increase the CDS spread of an entity. However, firm value volatility is unobservable, but can be approximated through the historical volatility of stock returns (Alexander and Kaeck, 2008; Ericsson *et al.* 2009). Monthly volatility is measured as the monthly historical standard deviation of daily stock returns over the past month.

2.5.3 CDS volatility

High CDS volatility suggests that market participants revise their views on the creditworthiness of an entity quickly, reflecting uncertainty regarding the correct spread levels (Raunig, 2018). Therefore, an increase in CDS volatility is expected to lead to higher spreads, as CDS sellers seek compensation for increased uncertainty. CDS volatility is computed as the monthly historical standard deviation of daily spreads over the past month.

2.5.4 Scaled equity bid-ask spread

In the framework of Das and Hanouna (2009), CDS contract sellers actively hedge their positions. Since the cost of hedging increases with transaction costs, CDS sellers attempt to recover the increased cost of hedging their positions through a higher spread level. Following Amihud and Mendelson (1986) and Das and Hanouna (2009), we use the scaled equity bid-ask spread, measured as the difference between the ask and bid prices divided by the mid-point of the two, to proxy for equity illiquidity transaction costs which are expected to be positively related to CDS spreads.

2.5.5 Absolute CDS bid-ask spread

Tang and Yan (2008) and Pires et al. (2015) show that CDS illiquidity costs represent an important determinant of spreads. Moreover, Bongaerts *et al*. (2011) develop a model where CDS returns depend on CDS transaction costs, a liquidity premium being earned by the CDS contract seller. We follow Pires *et al.* (2015) and focus on the absolute, rather than the relative, bid-ask spread, as the authors convincingly show that the absolute measure should be used in the context of the CDS market.

2.5.6 Risk-free rate

The level of the riskless interest rate has been considered an important component of default probability since the model of Merton (1974). On one hand, an increase in the risk-free interest rate decreases the risk-adjusted default probability leading to a decrease in spreads (Longstaff and Schwartz, 1995; Collin-Dufresne *et al*, 2001). On the other hand, as Coro *et al.* (2013) argue, higher interest rates can also suppress growth through an increase in borrowing costs leading to an increase in spreads, such an effect being more prominent in a period of increased sovereign risk such as seen in the European market starting from late 2009. Therefore, we consider the relationship between the riskless interest rate and CDS spreads as undetermined and examine whether the effect of the risk-free rate on spreads changes throughout the different sample periods. Following Coro *et al.* (2013), the risk-free rate is measured through the Euro-area government bond with a maturity of 10-years.

2.5.7 Term structure slope

Alexander and Kaeck (2008) and Collin-Dufresne *et al.* (2001) suggest that an increase in the slope of the yield curve predicts economic growth and improves recovery rates, thus decreasing spreads. However, a steepening of the slope could also reduce the number of positive net present value projects available to firms, leading to an increase in default probability and an increase in spreads (Galil *et al,* 2014). Therefore, as with the risk-free rate, we leave the expected relationship between the slope of the term structure and CDS spreads as undetermined and examine whether the relationship changes within the different sub-samples investigated. The term-structure slope is measured through the difference between the ten-year and three-year Euro-area Government bond yields.

2.5.8 Market-wide volatility

Market-wide volatility can be considered a measure of business climate, an increase in market-wide volatility indicating heightened uncertainty regarding economic prospects, leading to an increase in spreads (Annaert *et al*, 2013; Greatrex, 2009). We measure market volatility through the VSTOXX implied volatility index obtained from options written on the Euro STOXX 50 index.

3. Methodology

To test the impact of funding illiquidity and other firm-specific and macroeconomic factors on CDS spread changes, we estimate a set of multivariate regressions depicted in equations (2), (3) and (4):

Model 1: $\Delta CDS_{i,t} = \alpha_0 + \beta_1 Stock\_return_{i,t} + \beta_2 \Delta Equity\_Vol_{i,t} + \beta_3 \Delta CDS\_Vol_{i,t} + \beta_4 \Delta Equity\_BAS_{i,t} + \beta_5 \Delta CDS\_BAS_{i,t} + \varepsilon_{i,t}$ **(2)**

Model 2: $\Delta CDS_{i,t} = \alpha_0 + \beta_1 Stock\_return_{i,t} + \beta_2 \Delta Equity\_Vol_{i,t} + \beta_3 \Delta CDS\_Vol_{i,t} + \beta_4 \Delta Equity\_BAS_{i,t} + \beta_5 \Delta CDS\_BAS_{i,t} + \beta_6 \Delta FL_t + \varepsilon_{i,t}$ **(3)**

Model 3: $\Delta CDS_{i,t} = \alpha_0 + \beta_1 Stock\_return_{i,t} + \beta_2 \Delta Equity\_Vol_{i,t} + \beta_3 \Delta CDS\_Vol_{i,t} + \beta_4 \Delta Equity\_BAS_{i,t} + \beta_5 \Delta CDS\_BAS_{i,t} + \beta_6 \Delta FL_t + \beta_7 \Delta Riskfree_t + \beta_8 \Delta Slope\_yield_t + \beta_9 \Delta Mkt\_volatility_t + \varepsilon_{i,t}$ **(4)**

In the models presented in equations (2)-(4), the dependent variable is the monthly CDS spread change, while the explanatory variables are as described in *Table 1*. ΔFL_t measures the monthly funding liquidity changes and is proxied, in turn, by monthly changes in the three-month European TED spread ($\Delta EuTed_t$) and three-month Eurepo spread ($\Delta EuRepo_t$). *Model 1* estimates the impact of firm-specific credit and liquidity factors on spread changes. *Model 2* augments *Model 1* alternatively with the two funding illiquidity factors to examine the influence of changes in funding illiquidity on spread changes when controlling for firm-specific determinants. Lastly, *Model 3* investigates the impact of funding illiquidity changes on spread changes when controlling for both firm-specific and macro-economic factors. Following Coro *et al*. (2013), all three models are estimated using firm-level fixed effects and standard errors clustered by firm to correct for autocorrelation and heteroskedasticity.

We estimate the above models on the entire sample of firms as well as on the top and bottom terciles (top and bottom 33%) of entities according to their spread levels. By performing these estimations, we can test whether spread changes of high spread (high default risk) firms react differently to changes in funding illiquidity and other explanatory variables than those of low spread (low risk) firms. In line with previous findings documented by Pires *et al*. (2015), we expect the effects of explanatory variables on spread changes of high CDS firms to be larger in magnitude than on low CDS firms, as negative shocks to either credit or liquidity variables would drive high CDS entities, which carry more credit and liquidity risk, closer to the default barrier.

Furthermore, we conduct a sub-sample analysis to isolate the effects of the regulatory changes introduced through the CDS Small Bang on June 20th, 2009. To this end, we split the sample in two sub-samples: a pre-CDS Small Bang period, from January 2008 to June 2009, which also demarks the Global Financial Crisis period[8], and a post-CDS Small Bang period, from July 2009 to March 2013. We estimate the three models during the two sub-samples separately using the entire sample of firms as well as the top and bottom terciles of entities according to their spread levels. We expect changes in funding illiquidity to have a more pronounced effect on spread changes in the post-CDS Small Bang sample due to the introduction of an upfront fee, which increases the funding cost for trading CDSs, reducing traders' willingness to trade, thus leading to a reduction in CDS market liquidity and an increase in spreads.

4. Empirical results

4.1 Descriptive statistics

Table 2 presents descriptive statistics for our dependent and independent variables along with CDS spread and funding liquidity levels. Panel (a) presents summary statistics for the whole sample, while panels (b) and (c) present results for the pre-CDS Small Bang and post-CDS Small Bang periods, respectively. All variables are calculated with monthly frequency. Investigating panel (a), we note that the average CDS spread for the entire sample is 119.66 bps, while the mean monthly spread change is 1.09 bps. We also observe large variations in the CDS spread levels between entities, the lowest spread recorded

[8] Galil et al. (2014) consider June 2009 as the last month of the most intense phase of the Global Financial Crisis.

being 20.53 bps, while the largest being 759.58 bps. Comparing the two funding liquidity measures, we note that the European TED spread has a larger mean value and displays higher volatility than the Eurepo spread. Moreover, monthly changes in the TED spread are, on average, larger in magnitude than those of the Eurepo spread.

Comparing the summary statistics of the pre-CDS Small Bang and post-CDS Small Bang periods, we note that the average CDS spread as well as the monthly average spread changes are larger in the former period. Moreover, all illiquidity and volatility variables are larger in the pre-CDS Small Bang period, funding illiquidity being approximately two times higher during this sub-sample. Together, these statistics highlight the heightened default risk during the Global Financial Crisis.

Table 3 presents time-series pairwise correlations between the explanatory variables included in our models. Panel (a) presents correlations observed throughout the whole sample, while Panels (b) and (c) illustrate the pairwise correlations during the pre-CDS Small Bang and post-CDS Small Bang periods, respectively. The signs of the correlations between the explanatory variables broadly confirm our expectations. The largest correlation of 0.68 is observed between the two funding liquidity proxies during the pre-CDS Small Bang period. However, these two variables are only included alternatively in the regression models.[9]

4.2 Results of regression estimations

4.2.1 Results for the full time-series sample

Table 4 presents the results of the multivariate regressions depicted in equations (2)-(4) for the entire time-series (January 2008 - March 2013). Panel (a) presents the results for the whole sample of firms, while panels (b) and (c) present the results for the sub-samples

[9] Variance inflation factors corresponding to the explanatory variables presented in *Model 3* do not typically exceed 2.

containing high and low CDS spread entities. We first draw our attention to panel (a). *Model 1* reflects the ability of firm-specific credit and liquidity variables to explain spread changes. We find that stock returns and changes in equity and CDS volatility, equity bid-ask spreads and CDS bid-ask spreads are highly significant determinants of CDS spread changes as previously documented by Coro *et al*. (2013), Pires *et al*. (2015) and Das and Hanouna (2009). Stock returns have an expected negative relationship with spread changes, while changes in volatility, equity bid-ask spreads and CDS bid-ask spreads display a positive relationship with spread changes. Together these variables explain 36.10% of CDS spread changes. Investigating *Model 2,* we find that the two funding illiquidity proxies, $\Delta EuTed_t$ and $\Delta EuRepo_t$, have a statistically significant positive relationship with CDS spread changes, in line with our hypothesis that a tightening of funding liquidity increases spreads. Coefficients of firm-specific explanatory variables remain significant and of the expected signs. *Model 3* investigates the effect of funding illiquidity changes on CDS spread changes when controlling for both firm-specific and macroeconomic variables. This specification explains up to 38.94% of spread changes. We find that both funding illiquidity coefficients remain significant, while their magnitude drops by approximately a half when controlling for macroeconomic variables. Investigating the macroeconomic control variables, we find that changes in risk free rate have a significant negative relationship with spread changes, while market volatility increases spreads. These results are in line with our hypotheses and with results from previous studies such as Collin-Dufresne *et al.* (2001). Changes in the term structure slope do not have a significant impact on spread changes.

Examining panels (b) and (c) of *Table 4,* we find that the positive relationship between funding illiquidity changes and spread changes remains significant when investigating high CDS firms' and low CDS firms' separately. The magnitude of the funding effect is approximately three times larger when investigating high- spread entities compared to the funding effect on low-spread entities. This highlights the fact that high-spread (higher default risk) entities are more sensitive to changes in funding conditions compared to low-spread (lower default risk) firms, consistent with the hypothesis that a tightening of funding liquidity would affect high risk firms more than low risk firms as investors shy away from riskier assets following a funding contraction (Brunnermeier and Pedersen, 2009). The coefficients of the variables explaining spread changes remain significant and of the same signs as in the estimation using the entire sample of firms, except for the coefficient of equity illiquidity which becomes insignificant when examining low spread entities.

4.2.2 Sub-sample results

Table 5 and *Table 6* present the results of the multivariate regressions during the two sub-samples: the pre-CDS Small Bang period (January 2008 – June 2009) and post-CDS Small Bang *period* (July 2009 – March 2013), respectively. Within *Table 5* and *Table 6*, panel (a) presents results for the entire sample of firms, while panels (b) and (c) present results for the high-spread and low-spread firms within the two subsamples, respectively.

Investigating *Table 5*, results suggest that funding illiquidity changes do not show a significant impact on CDS spread changes during the pre-CDS Small Bang period. We consider that this result arises because during the Global Financial Crisis, a period which overlaps with the pre-CDS Small Bang sub-sample, tightening of funding liquidity led to a reduction in CDS market liquidity and individual CDS illiquidity which dramatically increased the explanatory power of individual CDS illiquidity on CDS spread changes relative to explanatory factors. Indeed, the magnitude of the effect of CDS illiquidity changes on spread changes is much larger during the pre-CDS Small Bang period, compared to the period following the implementation of the regulatory changes. In a related study, Annaert *et al.* (2013) shows that CDS bid-ask spreads have a more pronounced effect on changes in the CDS price during the Global Financial Crisis compared to the pre-crisis period and that the explanatory power of CDS bid-ask spreads in univariate regressions grows from 0.30% before the crisis to 6.96% during the crisis.[10] Moreover, we note that the coefficients relating to stock returns, equity volatility, changes in CDS bid-ask spreads, risk free rate and term-structure slope are generally significant in both high and low subsamples as well as when considering the whole sample of firms. Interestingly, we obtain larger adjusted R^2 values, of up to 43.88%, when performing estimations on low spread entities suggesting that our explanatory variables explain better CDS spread changes of low-risk entities compared to those of high risk firms during this turbulent period.

Examining *Table 6*, we note that funding illiquidity changes have a positive and highly significant effect on CDS spread changes in the post-CDS Small Bang period. This is in line with our expectation, since the introduction of an upfront fee to be paid for all CDS transactions when the spread is not equal to one of the fixed coupons introduced by the CDS Small Bang regulations brings about an additional cost incurred by CDS traders which reduces their willingness to trade, reducing CDS market liquidity (Wang *et al*, 2018).[11] In turn, this leads to a premium being demanded by CDS sellers to compensate for illiquidity, increasing spreads (Bongaerts *et al*, 2011; Coro *et al*, 2013). The effect of funding illiquidity changes on spread changes is approximately three to five times larger in size for high CDS firms compared to low CDS firms. We also document that stock returns and changes in equity volatility, CDS bid-ask spreads, slope yield and market

[10] Employing univariate regressions, we further document that the explanatory power of CDS liquidity changes on spread changes is largest during the pre-CDS Small Bang sample, while funding liquidity changes tend to provide the highest explanatory power in relation to spread changes in the post-CDS Small Bang regime. Results are available upon request.

[11] Using multivariate regressions, we typically find that both funding liquidity proxies have a significant positive impact on CDS liquidity changes, confirming the transmission channel of funding costs to spreads. Results are available upon request.

volatility have a significant impact on spread changes when investigating the entire sample of firms as well as in the high and low-CDS subsamples. Interestingly, changes in risk-free rate display a positive relationship with spread changes. Although surprising at first, this result is in line with the hypothesis that an increase in risk free rates increases borrowing costs, thus suppressing growth as is the case in the European market after the end of 2009 (Coro et al, 2013). During the post-CDS Small Bang period, we find that the models can explain a larger part of spread changes when evaluating high-CDS firms. This result is in line with the findings of Pires *et al.* (2015) who document that the goodness of fit of models explaining spreads increases with CDS premiums. We obtain adjusted R^2 values reaching up to 45.34% for the entire sample of firms and 50.55% for high-CDS firms. However, our models perform worse in explaining spread changes of low risk firms after the implementation of the CDS Small Bang regulations compared to the period preceding the regulatory changes.

5. Robustness Checks

To further investigate the change in the effects of funding illiquidity changes and of other explanatory variables on spread changes before and after the implementation of the CDS Small Bang regulations, we re-estimate *Model 3* adding a dummy variable isolating the pre-CDS Small Bang period as well as interaction terms between all explanatory variables and the pre-CDS Small Bang dummy. The dummy takes the value of '1' between January 2008 and June 2009 and '0' otherwise. We estimate this model on the whole sample of firms as well as, separately, on the high-CDS and low-CDS subsamples. *Table 7* reports the results. We confirm that the positive effect of funding illiquidity changes on CDS spread changes is significantly lower in the pre-CDS Small Bang period, while the positive relationship between CDS illiquidity changes and spread changes is significantly larger in magnitude during this period. Additionally, we find that changes in the riskless interest rate have a stronger negative impact on spread changes before the implementation of the regulatory changes and that the relationship between changes in the term structure slope and spreads changes its sign after the CDS Small Bang. This supports the mixed evidence found by literature regarding the influence of changes in risk free rate and term structure slope on spread changes. Taken together, these results suggest that the effect of funding liquidity as well as of other explanatory variables display a strong time-varying behaviour, as previously noted by Alexander and Kaeck (2008) and Annaert *et al.* (2013).

Adding to the explanatory variables employed in the models estimated, we also considered estimating the effect of funding illiquidity changes on spread changes when accounting for the market return, as in Annaert et al. (2013). To proxy for market return we used the return on the Euro Stoxx 50 stock market index obtained from Thomson Datastream. However, due to the very large negative correlation between the market return and market volatility (-0.72 for the whole sample and -0.80 in the pre-CDS Small Bang sub-sample), we chose to report results for models using only market volatility to avoid multicollinearity. In unreported results, we note that there are no significant changes in the signs or magnitudes of the coefficients for the variables included in the models when replacing market volatility with the market return.

6. Policy Recommendations

The results of our analysis suggest that funding illiquidity changes are a significant determinant of CDS spread changes, especially during the period following the implementation of the CDS Small Bang regulatory framework in June 2009. While this result may be driven in part by the changing dynamics of the relationships between spreads and firm-specific liquidity factors and macroeconomic variables during our sample, the strong positive relationship between funding illiquidity changes and CDS spread changes observed post-June 2009 suggest the important role of the introduction of an upfront fee for trading CDSs as fixed coupons have been rolled out. This creates a trade-off between the main benefit of standardization which aims to reduce systemic risk and a rise in upfront funding costs (Wang *et al*, 2018). As suggested by Wang *et al*. (2018), the introduction of the new fee increases CDS liquidity and CDS volatility for entities which have a spread further away from the fixed coupon at the time of the transaction, in turn leading to a widening of spreads. These effects highlight the importance of considering funding liquidity effects when evaluating CDS spreads and standardization policies (Wang *et al*. 2018).

Furthermore, our results evidenced a pronounced time-varying effect of explanatory variables on spread changes, finding also documented by Alexander and Kaeck (2008) and Annaert *et al*. (2013). Particularly during market downturns such as the Global Financial Crisis, spreads display a higher sensitivity to CDS illiquidity and risk-free interest rates and a lower sensitivity to market volatility and funding liquidity. Therefore, in line with Annaert *et al*. (2013), we highlight the importance for regulators to constantly assess the relative importance of firm-specific credit risk and liquidity variables as well as macroeconomic variables in explaining spreads, so that the correct market signals are highlighted and appropriate policies are implemented.

7. Conclusions

This study explores the effect of funding illiquidity changes on CDS spread changes while controlling for other previously documented firm-specific and macroeconomic determinants of spreads. To the best of our knowledge, this is the first study exploring the effect of changes in funding illiquidity on CDS spread changes. Using panel estimations, we find that changes in funding illiquidity have a significant positive effect on spread changes. This is in line with the hypothesis that a tightening of funding liquidity determines CDS protection sellers to reduce the supply of contracts in the market as they incur inventory costs and worry about the costs of hedging their positions (Tang and Yan, 2008). Moreover, we find that the effect of funding illiquidity changes on CDS spread changes is larger in magnitude and more statistically significant in the period following the implementation of the CDS Small Bang regulations. In line with Wang *et al*. (2018), we attribute this relationship to the introduction of an upfront fee that needs to be exchanged between the CDS protection buyer and CDS seller unless the spread of the respective entity at the time of the transaction is exactly equal to one of the four fixed coupons implemented through the CDS Small Bang. Moreover, we find that the magnitude of the effect of funding illiquidity changes on CDS spread changes is larger for high-CDS entities compared to low-CDS entities.

By analysing our results, we can suggest two policy recommendations. Firstly, regulators need to consider the effect of funding illiquidity on CDS spreads when proposing new policy frameworks, our results suggesting that the introduction of the CDS Small Bang upfront fee creates a trade-off between standardization and funding costs, leading to a worsening of the linkage between funding conditions and CDS spreads as also suggested by Wang *et al*. (2018). Secondly, the time-varying nature of the relationships between explanatory variables and spread changes suggests that the determinants of CDS spreads need to be regularly investigated so that appropriate policies can be put in place according to what factors drive spreads in different periods.

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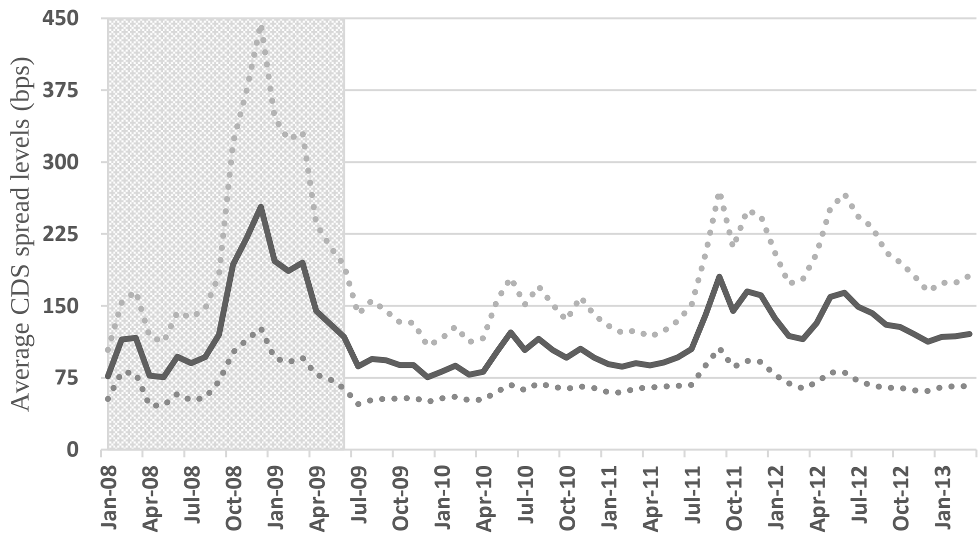
Figure 1: Average CDS spreads and CDS spread changes

In *Figure 1*, the solid line presents average CDS spread levels (Panel (a)) and average CDS spread changes (Panel (b)) for the entire sample of firms. The dotted lines present average CDS spread levels (Panel (a)) and average CDS spread changes (Panel (b)) for the top and bottom terciles of the respective distributions. The shaded area delimitates the period preceding the introduction of the CDS Small Bang regulatory changes (January 2008 - June 2009). Sample consists of monthly data on 76 non-financial entities included in the European iTraxx index on March 2013. Sample period: January 2008 - March 2013. CDS spread levels data is obtained from Bloomberg.

Panel (a): Average CDS spread levels



Panel (b): Average CDS spread changes

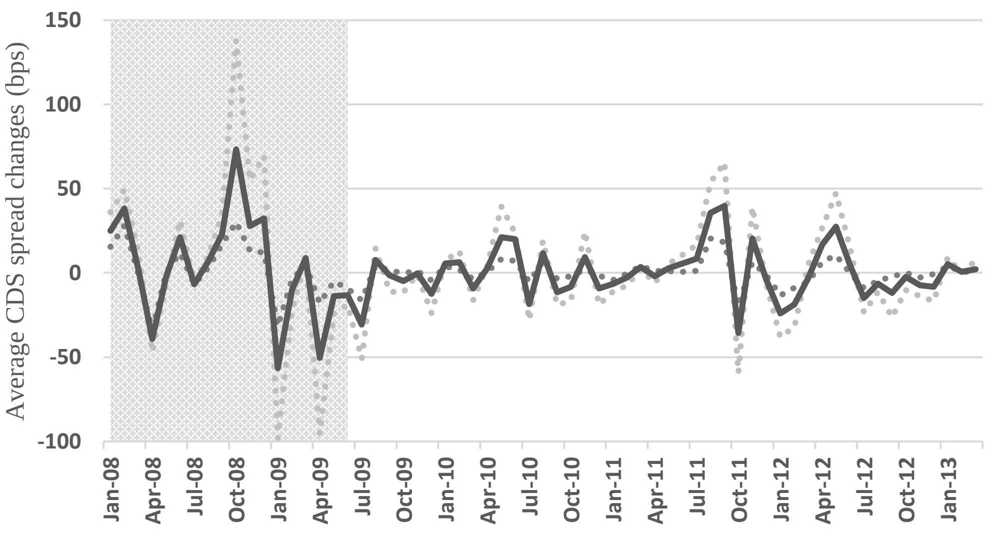


Table 1: Description of variables explaining CDS spread changes

Table 1 presents the explanatory variables used in panel regressions analysing CDS spread changes, their data source and predicted sign of the relationship with CDS spread changes. EMMI is the European Money Market Institute.

Explanatory Variable	Description	Predicted Sign	Data Source
Stock_return	Monthly stock return	-	Thomson Datastream
ΔEquity_Vol	Change in the historical standard deviation of stock returns	+	Thomson Datastream
ΔCDS_Vol	Change in the historical standard deviation of CDS spread levels	+	Bloomberg
ΔEquity_BAS	Change in the (scaled) difference between ask and bid equity prices, divided by the average of the two	+	Thomson Datastream
ΔCDS_BAS	Change in the (absolute) difference between ask and bid CDS prices	+	Bloomberg
ΔEuTed	Change in the difference between the 3-month Euribor rate and the 3-month German Government BuBill	+	Bloomberg
ΔEuRepo	Change in the difference between the 3-month Euribor rate and the 3-month Eurepo rate	+	Bloomberg / EMMI
ΔRisk-free	Change in the 10-year Euro-area Government Bond Yield	+/-	Bloomberg
ΔSlope_yield	Change in the difference between the 10-year and 3-year Euro-area Government Bond Yield	+/-	Bloomberg
ΔMkt_volatility	Change in the implied volatility as measured by the Euro Stoxx 50 volatility index	+	Thomson Datastream

Table 2: Summary statistics of the dataset

Table 2 presents summary statistics of the European iTraxx index sample consisting of 76 non-financial firms examined throughout the study. Panel (a) presents summary statistics for the entire sample (January 2008 - March 2013). Panel (b) presents summary statistics for the period preceding the CDS Small Bang (January 2008 - June 2009). Panel (c) presents summary statistics for the post-CDS Small Bang period (July 2009 - March 2013). The statistics are calculated using a sample consisting of 76 non-financial companies included in the European iTraxx index. *CDS* represents the mid CDS spread (in basis points). *ΔCDS* is the monthly change in the mid-CDS spread (in basis points). All other variables are as described in Table 1.

Panel (a): Whole Sample (January 2008 – March 2013)

Variable	Mean	Median	Maximum	Minimum	Std. Dev.
CDS	119.664	95.165	759.580	20.533	82.691
ΔCDS	1.091	-0.185	472.219	-257.884	33.678
Stock_return	-0.407	0.173	53.375	-66.988	8.890
ΔEquity_Vol	-0.000	-0.041	20.071	-18.638	0.968
ΔCDS_Vol	0.039	-0.168	133.171	-97.640	9.531
ΔEquity_BAS	0.001	-0.001	8.906	-8.910	0.365
ΔCDS_BAS	0.004	-0.039	28.114	-20.276	3.411
EuTed	0.727	0.583	2.824	0.057	0.552
ΔEuTed	-0.012	-0.027	2.151	-1.029	0.362
EuRepo	0.540	0.414	1.822	0.185	0.355
ΔEuRepo	-0.007	-0.008	0.663	-0.534	0.176
ΔRisk-free	-0.048	-0.043	0.411	-0.642	0.238
ΔSlope_yield	0.016	0.007	0.621	-0.506	0.188
ΔMkt_volatility	0.045	-1.194	20.29	-11.560	6.094

Table 2: Summary statistics of the dataset - continued

Panel (b): Pre-CDS Small Bang period (January 2008 – June 2009)

Variable	Mean	Median	Maximum	Minimum	Std. Dev.
CDS	134.504	98.447	759.580	20.533	109.702
ΔCDS	3.667	1.988	389.983	-257.884	49.718
Stock_return	-2.929	-2.303	53.375	-66.988	11.465
ΔEquity_Vol	0.042	-0.053	20.071	-18.638	1.511
ΔCDS_Vol	0.228	-0.224	133.171	-97.641	14.553
ΔEquity_BAS	0.003	0.001	5.849	-5.712	0.259
ΔCDS_BAS	0.266	-0.001	28.114	-20.276	3.840
EuTed	1.172	0.928	2.824	0.479	0.774
ΔEuTed	-0.027	-0.075	2.151	-1.029	0.636
EuRepo	0.813	0.736	1.822	0.394	0.398
ΔEuRepo	-0.012	-0.054	0.663	-0.534	0.279
ΔRisk-free	-0.051	-0.117	0.411	-0.642	0.272
ΔSlope_yield	0.077	0.080	0.621	-0.296	0.217
ΔMkt_volatility	0.677	-1.369	20.29	-9.233	8.166

Panel (c): Post-CDS Small Bang period (July 2009 – March 2013)

Variable	Mean	Median	Maximum	Minimum	Std. Dev.
CDS	113.398	94.392	572.741	24.650	67.188
ΔCDS	0.061	-0.548	472.219	-253.347	24.414
Stock_return	0.603	0.775	34.979	-62.260	7.385
ΔEquity_Vol	-0.017	-0.038	3.792	-2.784	0.630
ΔCDS_Vol	-0.036	-0.162	131.366	-85.804	6.518
ΔEquity_BAS	0.000	0.000	8.906	-8.910	0.399
ΔCDS_BAS	-0.101	-0.058	21.311	-19.647	3.218
EuTed	0.550	0.499	1.377	0.057	0.291
ΔEuTed	-0.007	-0.017	0.559	-0.249	0.146
EuRepo	0.431	0.345	1.216	0.185	0.271
ΔEuRepo	-0.005	-0.008	0.335	-0.248	0.110
ΔRisk-free	-0.047	-0.039	0.382	-0.553	0.223
ΔSlope_yield	-0.009	0.002	0.406	-0.506	0.170
ΔMkt_volatility	-0.208	-1.044	11.030	-11.560	5.011

Table 3: Time-series pairwise correlations of variables explaining CDS spread changes

Table 3 presents time-series pairwise correlations of the explanatory variables used in panel regressions explaining CDS spread changes. Panel (a) presents correlations for the entire sample (January 2008 - March 2013). Panel (b) presents correlations for the pre-CDS Small Bang period (January 2008- June 2009). Panel (c) presents correlations for the post-CDS Small Bang period. All variables are as described in Table 1.

Panel (a): Whole sample (January 2008 – March 2013)

	Stock_return	*ΔEquity_Vol*	*ΔCDS_Vol*	*ΔEquity_BAS*	*ΔCDS_BAS*	*ΔEuTed*	*ΔEuRepo*	*ΔRisk-free*	*ΔSlope_yield*
ΔEquity_Vol	-0.24								
ΔCDS_Vol	-0.17	0.35							
ΔEquity_BAS	-0.03	0.04	0.02						
ΔCDS_BAS	-0.16	0.05	0.08	0.03					
ΔEuTed	-0.09	0.17	0.09	0.01	0.10				
ΔEuRepo	-0.20	0.37	0.23	0.02	0.16	0.65			
ΔRisk-free	0.23	-0.03	-0.03	-0.01	-0.18	-0.10	-0.07		
ΔSlope_yield	-0.07	0.24	0.16	-0.01	0.11	0.07	0.30	0.23	
ΔMkt_volatility	-0.38	0.47	0.30	0.02	0.16	0.37	0.54	-0.34	0.20

Panel (b): Pre-CDS Small Bang period (January 2008 – June 2009)

	Stock_return	*ΔEquity_Vol*	*ΔCDS_Vol*	*ΔEquity_BAS*	*ΔCDS_BAS*	*ΔEuTed*	*ΔEuRepo*	*ΔRisk-free*	*ΔSlope_yield*
ΔEquity_Vol	-0.21								
ΔCDS_Vol	-0.22	0.38							
ΔEquity_BAS	-0.01	0.05	0.01						
ΔCDS_BAS	-0.18	0.07	0.16	0.08					
ΔEuTed	-0.13	0.23	0.13	0.04	0.13				
ΔEuRepo	-0.21	0.45	0.33	0.04	0.11	0.68			
ΔRisk-free	0.20	-0.01	0.01	-0.05	-0.38	-0.13	0.04		
ΔSlope_yield	-0.16	0.34	0.30	-0.01	0.10	0.06	0.31	-0.02	
ΔMkt_volatility	-0.39	0.61	0.43	0.03	0.16	0.45	0.66	-0.06	0.54

Panel (c): Post-CDS Small Bang period (July 2009 – March 2013)

	Stock_return	*ΔEquity_Vol*	*ΔCDS_Vol*	*ΔEquity_BAS*	*ΔCDS_BAS*	*ΔEuTed*	*ΔEuRepo*	*ΔRisk-free*	*ΔSlope_yield*
ΔEquity_Vol	-0.28								
ΔCDS_Vol	-0.12	0.29							
ΔEquity_BAS	-0.04	0.05	0.03						
ΔCDS_BAS	-0.13	0.05	0.01	0.02					
ΔEuTed	-0.04	-0.01	-0.05	0.00	0.07				
ΔEuRepo	-0.23	0.17	0.02	0.02	0.24	0.55			
ΔRisk-free	0.27	-0.06	-0.07	0.00	-0.06	-0.09	-0.23		
ΔSlope_yield	0.06	0.13	0.01	-0.01	0.11	0.15	0.37	0.39	
ΔMkt_volatility	-0.37	0.26	0.11	0.02	0.16	0.27	0.39	-0.57	-0.11

Table 4: Determinants of CDS spread changes

Table 4 presents coefficient estimates of panel regressions explaining CDS spread changes. Panel (a) presents results for all sample of firms. Panel (b) presents results for high CDS spread firms (top tercile of firms CDS spreads). Panel (c) presents results for low CDS spread firms (bottom tercile of firms CDS spreads). The dependent variable is the change in the CDS mid-price. All explanatory variables are as described in Table 1. Regressions estimated using firm-level fixed effects and standard errors clustered by firm to correct for autocorrelation and heteroskedasticity. t-statistics are reported in parentheses. *, ** and *** represent significance at the 10%, 5% and 1% levels, respectively. Sample period: January 2008 - March 2013.

Panel (a): Whole Sample of firms

Dep. Var: ΔCDS	**Model 1**	**Model 2**		**Model 3**	
Constant	0.66***	0.74***	0.77***	-0.14	-0.12
	(17.82)	(16.56)	(15.96)	(-0.92)	(-0.72)
Stock_return	-0.95***	-0.95***	-0.93***	-0.76***	-0.75***
	(-10.99)	(-10.79)	(-10.46)	(-8.05)	(-7.89)
ΔEquity_Vol	3.34***	2.99***	2.62***	2.29***	2.17***
	(4.45)	(4.17)	(3.70)	(3.38)	(3.22)
ΔCDS_Vol	0.75***	0.74***	0.72***	0.72***	0.71***
	(4.70)	(4.62)	(4.41)	(4.26)	(4.19)
ΔEquity_BAS	3.31**	3.29**	3.32**	3.31**	3.31**
	(2.17)	(2.21)	(2.22)	(2.35)	(2.35)
ΔCDS_BAS	3.91***	3.86***	3.83***	3.62***	3.61***
	(12.75)	(12.41)	(12.20)	(11.13)	(11.09)
ΔEuTed		**6.05*** **		**3.13** **	
		(4.59)		**(2.56)**	
ΔEuRepo			**13.19*** **		**7.33*** **
			(4.18)		**(2.83)**
ΔRisk-free				-18.69***	-18.87***
				(-6.04)	(-6.10)
ΔSlope_yield				0.47	-0.73
				(0.22)	(-0.36)
ΔMkt_volatility				0.44***	0.41***
				(3.73)	(3.90)
N	4788	4788	4788	4788	4788
Adj. R^2	36.10%	36.50%	36.49%	38.94%	38.93%

Table 4: Determinants of CDS spread changes - continued

Panel (b): High CDS entities

Dep. Var: ΔCDS	***Model 1***	***Model 2***		***Model 3***	
Constant	1.05***	1.21***	1.27***	-0.70**	-0.64**
	(12.88)	(10.93)	(11.52)	(-2.30)	(-2.02)
Stock_return	-1.28***	-1.26***	-1.21***	-0.94***	-0.92***
	(-8.42)	(-8.12)	(-7.69)	(-5.39)	(-5.08)
ΔEquity_Vol	5.97***	5.46***	5.01***	4.18***	4.00***
	(5.46)	(5.50)	(5.22)	(4.68)	(4.52)
ΔCDS_Vol	0.60***	0.58***	0.54***	0.54***	0.52***
	(3.14)	(3.04)	(2.79)	(2.87)	(2.72)
ΔEquity_BAS	3.32**	3.22**	3.36**	3.42**	3.48**
	(1.99)	(2.04)	(2.05)	(2.30)	(2.29)
ΔCDS_BAS	4.04***	3.98***	3.94***	3.60***	3.58***
	(9.61)	(9.41)	(9.12)	(8.33)	(8.18)
ΔEuTed		**11.70*** **		**6.82** **	
		(3.58)		**(2.28)**	
ΔEuRepo			**25.08*** **		**15.63** **
			(3.36)		**(2.48)**
ΔRisk-free				-38.42***	-38.83***
				(-6.07)	(-6.16)
ΔSlope_yield				9.19*	6.74
				(1.76)	(1.37)
ΔMkt_volatility				0.67***	0.64***
				(2.70)	(2.78)
N	1638	1638	1638	1638	1638
Adj. R^2	36.15%	36.83%	36.75%	40.75%	40.73%

Panel (c): Low CDS entities

Dep. Var: ΔCDS	***Model 1***	***Model 2***		***Model 3***	
Constant	0.39***	0.45***	0.47***	0.11	0.12*
	(47.80)	(25.94)	(20.93)	(1.49)	(1.75)
Stock_return	-0.53***	-0.53***	-0.52***	-0.38***	-0.38***
	(-11.53)	(-11.21)	(-10.94)	(-7.29)	(-7.13)
ΔEquity_Vol	1.71***	1.38**	0.93	0.37	0.30
	(2.85)	(2.34)	(1.63)	(0.63)	(0.52)
ΔCDS_Vol	0.37***	0.36***	0.34***	0.30***	0.30***
	(5.33)	(5.14)	(4.76)	(4.16)	(4.07)
ΔEquity_BAS	-0.38	-0.18	-0.30	0.46	0.36
	(-0.23)	(-0.12)	(-0.21)	(0.43)	(0.34)
ΔCDS_BAS	3.42***	3.32***	3.29***	3.04***	3.05***
	(13.75)	(13.93)	(13.91)	(11.89)	(11.88)
ΔEuTed		**4.51*** **		**2.11** **	
		(4.48)		**(2.30)**	
ΔEuRepo			**10.69*** **		**4.12* **
			(4.04)		**(1.80)**
ΔRisk-free				-6.14***	-6.21***
				(-4.92)	(-4.95)
ΔSlope_yield				0.76	0.05
				(0.56)	(0.04)
ΔMkt_volatility				0.47***	0.46***
				(6.47)	(7.09)
N	1575	1575	1575	1575	1575
Adj. R^2	34.47%	35.73%	35.92%	40.23%	40.15%

Table 5: Determinants of CDS spread changes – Pre-CDS Small Bang period

Table 5 presents estimates of panel regressions explaining CDS spread changes before the implementation of the CDS Small Bang regulatory changes. Panel (a) presents results for all sample of firms. Panel (b) presents results for high CDS spread firms (top tercile of firms CDS spreads). Panel (c) presents results for low CDS spread firms (bottom tercile of firms CDS spreads). The dependent variable is the change in the CDS mid-price. All explanatory variables are as described in Table 1. Regressions estimated using firm-level fixed effects and standard errors clustered by firm to correct for autocorrelation and heteroskedasticity. t-statistics are reported in parentheses. *, ** and *** represent significance at the 10%, 5% and 1% significance levels. Sample period: January 2008 - June 2009.

Panel (a): All firms

Dep. Var: ΔCDS	***Model 1***	***Model 2***		***Model 3***	
Constant	-0.33	-0.24	-0.32	-1.88***	-1.87***
	(-0.64)	(-0.43)	(-0.61)	(-3.03)	(-3.17)
Stock_return	-0.71***	-0.71***	-0.71***	-0.57***	-0.57***
	(-5.04)	(-4.87)	(-5.03)	(-3.28)	(-3.20)
ΔEquity_Vol	3.57***	3.42***	3.53***	2.89***	2.88***
	(4.30)	(4.28)	(4.41)	(3.44)	(3.52)
ΔCDS_Vol	0.70***	0.70***	0.70***	0.71***	0.71***
	(4.18)	(4.14)	(4.16)	(4.16)	(4.16)
ΔEquity_BAS	4.96	4.89	4.96	4.56	4.57
	(1.56)	(1.55)	(1.56)	(1.60)	(1.60)
ΔCDS_BAS	5.95***	5.92***	5.95***	5.15***	5.15***
	(8.96)	(8.68)	(8.93)	(6.50)	(6.53)
ΔEuTed		**1.84**		**0.24**	
		(1.08)		**(0.18)**	
ΔEuRepo			**0.59**		**0.23**
			(0.17)		**(0.05)**
ΔRisk-free				-28.74***	-28.82***
				(-3.74)	(-3.60)
ΔSlope_yield				8.16*	8.00*
				(1.89)	(1.78)
ΔMkt_volatility				0.17	0.18
				(0.79)	(0.72)
N	1368	1368	1368	1368	1368
Adj. R^2	36.53%	36.53%	36.48%	38.72%	38.71%

Table 5: Determinants of CDS spread changes – Pre-CDS Small Bang period - continued

Panel (b): High CDS entities

Dep. Var: ΔCDS	**Model 1**	**Model 2**		**Model 3**	
Constant	-0.15	0.04	0.11	-3.78***	-3.59***
	(-0.12)	(0.03)	(0.09)	(-2.77)	(-2.82)
Stock_return	-1.11***	-1.10***	-1.09***	-0.97***	-0.97***
	(-3.72)	(-3.58)	(-3.73)	(-3.12)	(-2.97)
ΔEquity_Vol	7.51***	7.27***	7.06***	6.60***	6.42***
	(6.05)	(5.74)	(6.98)	(5.40)	(5.49)
ΔCDS_Vol	0.43**	0.42**	0.40**	0.44*	0.42*
	(2.31)	(2.26)	(2.06)	(1.91)	(1.86)
ΔEquity_BAS	3.94	3.69	3.85	4.83	4.86
	(1.39)	(1.29)	(1.32)	(1.63)	(1.60)
ΔCDS_BAS	6.25***	6.20***	6.24***	4.78***	4.74***
	(6.44)	(6.21)	(6.36)	(3.72)	(3.66)
ΔEuTed		**4.27**		**1.67**	
		(1.03)		**(0.48)**	
ΔEuRepo			**9.71**		**13.63**
			(0.87)		**(1.18)**
ΔRisk-free				-60.16***	-61.95***
				(-3.12)	(-3.07)
ΔSlope_yield				22.24**	22.46*
				(1.98)	(1.83)
ΔMkt_volatility				0.14	-0.06
				(0.22)	(-0.10)
N	468	468	468	468	468
Adj. R^2	34.66%	34.64%	34.61%	38.33%	38.46%

Panel (c): Low CDS entities

Dep. Var: ΔCDS	**Model 1**	**Model 2**		**Model 3**	
Constant	-1.01***	-0.93***	-1.02***	-1.52***	-1.55***
	(-4.14)	(-3.45)	(-3.85)	(-4.25)	(-4.30)
Stock_return	-0.53***	-0.52***	-0.53***	-0.39***	-0.37***
	(-5.25)	(-5.04)	(5.31)	(-3.26)	(-3.17)
ΔEquity_Vol	2.70***	2.52***	2.76***	1.34	1.41
	(3.54)	(3.21)	(3.25)	(1.27)	(1.34)
ΔCDS_Vol	0.13	0.12	0.13	0.03	0.04
	(1.36)	(1.24)	(1.43)	(0.31)	(0.36)
ΔEquity_BAS	3.20**	3.07**	3.21**	2.98**	3.07**
	(2.15)	(2.02)	(2.15)	(1.98)	(2.05)
ΔCDS_BAS	5.41***	5.34***	5.41***	4.73***	4.75***
	(5.52)	(5.41)	(5.52)	(4.54)	(4.59)
ΔEuTed		**1.61**		**0.53**	
		(1.65)		**(0.50)**	
ΔEuRepo			**-0.53**		**-5.16**
			(-0.15)		**(-1.51)**
ΔRisk-free				-8.97***	-8.82***
				(-3.14)	(-3.05)
ΔSlope_yield				4.41*	3.34
				(1.83)	(1.29)
ΔMkt_volatility				0.31*	0.46***
				(1.86)	(3.53)
N	450	450	450	450	450
Adj. R^2	41.51%	41.64%	41.37%	43.57%	43.88%

Table 6: Determinants of CDS spread changes – Post-CDS Small Bang period

Table 6 presents estimates of panel regressions explaining CDS spread changes after the implementation of the CDS Small Bang regulatory changes. Panel (a) presents results for all sample of firms. Panel (b) presents results for high CDS spread firms (top tercile of firms CDS spreads). Panel (c) presents results for low CDS spread firms (bottom tercile of firms CDS spreads). The dependent variable is the change in the CDS mid-price. All explanatory variables are as described in Table 1. Regressions estimated using firm-level fixed effects and standard errors clustered by firm to correct for autocorrelation and heteroskedasticity. t-statistics are reported in parentheses. *, ** and *** represent significance at the 10%, 5% and 1% levels. Sample period: July 2009 – March 2013.

Panel (a): All firms

Dep. Var: ΔCDS	**Model 1**	**Model 2**		**Model 3**	
Constant	1.13***	1.31***	1.25***	1.34***	1.56***
	(13.33)	(13.73)	(14.66)	(10.57)	(12.47)
Stock_return	-1.19***	-1.16***	-1.07***	-0.96***	-0.88***
	(-10.66)	(-10.75)	(-9.83)	(-8.45)	(-7.84)
ΔEquity_Vol	2.94***	3.01***	1.90**	2.18***	1.51*
	(3.23)	(3.33)	(2.25)	(2.71)	(1.89)
ΔCDS_Vol	0.72**	0.75**	0.75**	0.73**	0.74**
	(2.18)	(2.28)	(2.19)	(2.07)	(2.06)
ΔEquity_BAS	2.71**	2.67**	2.69**	2.69**	2.60**
	(2.16)	(2.29)	(2.37)	(2.34)	(2.41)
ΔCDS_BAS	2.77***	2.68***	2.43***	2.60***	2.40***
	(9.71)	(9.86)	(8.04)	(8.82)	(7.71)
ΔEuTed		**29.66*** **		**23.40*** **	
		(11.34)		**(8.38)**	
ΔEuRepo			**46.40*** **		**50.08*** **
			(11.45)		**(14.58)**
ΔRisk-free				2.48*	8.77***
				(1.74)	(5.98)
ΔSlope_yield				-10.40***	-21.96***
				(-5.18)	(-10.14)
ΔMkt_volatility				0.95***	0.91***
				(6.95)	(7.42)
N	3420	3420	3420	3420	3420
Adj. R^2	37.31%	40.51%	41.24%	43.91%	45.34%

Table 6: Determinants of CDS spread changes – Post-CDS Small Bang period - continued

Panel (b): High CDS entities

Dep. Var: ΔCDS	***Model 1***	***Model 2***		***Model 3***	
Constant	1.57***	1.84***	1.75***	1.93***	2.26***
	(16.35)	(15.55)	(16.99)	(7.87)	(9.22)
Stock_return	-1.67***	-1.59***	-.1.41***	-1.19***	-1.05***
	(-12.87)	(-12.48)	(-11.04)	(-9.79)	(-8.41)
ΔEquity_Vol	6.93***	7.39***	5.56***	5.47***	4.28***
	(4.67)	(5.21)	(4.13)	(4.24)	(3.57)
ΔCDS_Vol	0.14	0.14	0.15	0.10	0.11
	(1.07)	(1.19)	(1.13)	(0.77)	(0.89)
ΔEquity_BAS	2.92*	2.79**	3.00**	2.69**	2.73**
	(1.93)	(2.10)	(2.13)	(2.27)	(2.28)
ΔCDS_BAS	2.68***	2.56***	2.27***	2.42***	2.17***
	(9.03)	(9.93)	(7.96)	(9.06)	(7.70)
ΔEuTed		**48.00*** **		**36.17*** **	
		(8.65)		**(6.39)**	
ΔEuRepo			**75.82*** **		**77.94*** **
			(14.78)		**(14.86)**
ΔRisk-free				3.45	12.99***
				(0.88)	(3.27)
ΔSlope_yield				-11.90**	-29.42***
				(-2.39)	(-5.71)
ΔMkt_volatility				1.79***	1.77***
				(9.23)	(8.81)
N	1170	1170	1170	1170	1170
Adj. R^2	39.39%	43.68%	44.51%	48.80%	50.55%

Panel (c): Low CDS entities

Dep. Var: ΔCDS	***Model 1***	***Model 2***		***Model 3***	
Constant	0.61***	0.67***	0.65***	0.59***	0.69***
	(8.38)	(9.13)	(9.78)	(6.30)	(7.58)
Stock_return	-0.55***	-0.55***	-0.50***	-0.39***	-0.35***
	(-8.50)	(-8.49)	(-8.50)	(-6.69)	(-6.56)
ΔEquity_Vol	1.85***	1.82***	1.08**	1.23**	1.03*
	(3.34)	(3.21)	(2.20)	(2.00)	(1.93)
ΔCDS_Vol	-0.06	0.02	-0.01	-0.04	-0.03
	(-0.67)	(0.20)	(-0.15)	(-0.40)	(-0.35)
ΔEquity_BAS	-0.76	-0.12	-0.69	0.71	0.25
	(-0.93)	(-0.19)	(-1.17)	(0.90)	(0.36)
ΔCDS_BAS	1.42***	1.38***	0.98***	1.24***	1.00***
	(5.89)	(5.96)	(5.08)	(5.31)	(5.11)
ΔEuTed		**11.03*** **		**6.40*** **	
		(5.73)		**(3.77)**	
ΔEuRepo			**26.79*** **		**28.35*** **
			(10.32)		**(9.69)**
ΔRisk-free				1.17	4.58***
				(1.20)	(4.47)
ΔSlope_yield				-5.15***	-12.91***
				(-3.75)	(-7.73)
ΔMkt_volatility				0.61***	0.51***
				(12.09)	(10.20)
N	1125	1125	1125	1125	1125
Adj. R^2	21.58%	24.70%	31.33%	34.67%	41.30%

Table 7: Determinants of CDS spread changes with pre-CDS Small Bang interaction effects

Table 7 presents the determinants of CDS spread changes using panel regressions with pre-CDS Small Bang interaction effects. Panel (a) presents results for the entire firm sample. Panel (b) presents results for the high CDS firms (top tercile of CDS spread distribution). Panel (c) presents results for low CDS firms (bottom tercile of CDS spread distribution). *Pre-SB* is a dummy variable taking the value of 1 during the period preceding the CDS Small Bang (January 2008 - June 2009) and 0 otherwise. Regressions estimated using firm-level fixed effects and firm-clustered standard errors to correct for autocorrelation and heteroskedasticity. t-statistics presented in parentheses. *, ** and *** represent significance at the 10%, 5% and 1% significance levels, respectively. Sample: January 2008 – March 2013.

Dep.Var: ΔCDS	Panel (a): All sample		Panel (b): High CDS		Panel (c): Low CDS	
Constant	1.34***	1.56***	1.52***	1.82***	0.81***	0.93***
	(7.84)	(9.23)	(3.58)	(4.22)	(6.66)	(7.52)
Stock_return	-0.96***	-0.87***	-1.10***	-0.96***	-0.42***	-0.36***
	(-8.50)	(-7.90)	(-6.35)	(-5.56)	(-7.28)	(-7.09)
ΔEquity_Vol	2.20***	1.52*	5.53***	4.56***	0.81	0.35
	(2.73)	(1.91)	(4.67)	(4.15)	(1.28)	(0.60)
ΔCDS_Vol	0.73**	0.74**	0.24*	0.25*	0.32***	0.32***
	(2.08)	(2.07)	(1.81)	(1.80)	(2.90)	(3.01)
ΔEquity_BAS	2.69**	2.59**	2.68**	2.67**	0.65	-0.18
	(2.35)	(2.41)	(2.29)	(2.31)	(1.05)	(-0.39)
ΔCDS_BAS	2.61***	2.41***	2.52***	2.27***	1.72***	1.38***
	(8.88)	(7.76)	(9.39)	(7.94)	(6.10)	(5.82)
ΔEuTed	**23.42*** **		**34.93*** **		**9.92*** **	
	(8.41)		**(6.53)**		**(5.04)**	
ΔEuRepo		**50.05*** **		**75.22*** **		**32.99*** **
		(14.64)		**(14.31)**		**(9.81)**
ΔRisk-free	2.48*	8.77***	0.14	9.46***	3.12***	7.01***
	(1.75)	(6.00)	(0.04)	(2.61)	(2.93)	(5.83)
ΔSlope_yield	-10.43***	-21.97***	-9.62**	-26.93***	-5.06***	-13.33***
	(-5.21)	(-10.18)	(-2.03)	(-5.39)	(-4.02)	(-8.70)
ΔMkt_volatility	0.95***	0.91***	1.72***	1.69***	0.64***	0.55***
	(6.97)	(7.44)	(8.38)	(8.02)	(9.85)	(-8.32)
Pre-SB	-3.22***	-3.43***	-4.70***	-4.86***	-2.01***	-2.18***
	(-6.15)	(-6.83)	(-4.07)	(-4.37)	(-5.78)	(-6.37)
Stock_return Pre-SB*	0.39*	0.31	0.30	0.17	0.08	0.03
	(1.93)	(1.52)	(0.80)	(0.46)	(0.79)	(0.28)
ΔEquity_Vol Pre-SB*	0.71	1.38	-1.03	-0.20	-0.82	-0.33
	(0.68)	(1.33)	(-0.58)	(-0.12)	(-0.70)	(-0.27)
ΔCDS_Vol Pre-SB*	-0.01	-0.03	0.45**	0.42**	-0.03	-0.03
	(-0.04)	(-0.07)	(2.18)	(1.97)	(-0.18)	(-0.17)
ΔEquity_BAS Pre-SB*	1.82	1.92	2.74	2.86	-5.35	-4.23
	(0.58)	(0.62)	(0.75)	(0.77)	(-0.42)	(-0.33)
ΔCDS_BAS Pre-SB*	2.56***	2.77***	2.16**	2.38**	3.21***	3.56***
	(3.39)	(3.66)	(2.02)	(2.23)	(4.00)	(-7.44)
ΔEuTed Pre-SB*	**-23.18*** **		**-31.48*** **		**-10.05*** **	
	(-8.14)		**(-5.30)**		**(-4.50)**	
ΔEuRepo Pre-SB*		**-49.85*** **		**-65.74*** **		**-35.39*** **
		(-10.44)		**(-6.33)**		**(-7.44)**
*ΔRisk-free * Pre-SB*	-31.11***	-37.47***	-60.80***	-71.83***	-14.66***	-18.35***
	(-4.06)	(-4.65)	(-3.14)	(-3.57)	(-4.20)	(-4.94)
*ΔSlope_yield * Pre-SB*	18.58***	29.95***	30.31**	46.07***	7.99***	16.11***
	(3.65)	(5.35)	(2.31)	(3.21)	(3.03)	(6.14)
ΔMkt_volatility Pre-SB*	-0.79***	-0.74***	-1.64***	-1.63***	-0.11	0.02
	(-3.19)	(-2.78)	(-3.16)	(-2.94)	(-0.77)	(0.16)
N	4788	4788	1638	1638	1575	1575
Adj. R^2	42.38%	42.92%	44.42%	44.98%	46.30%	48.64%