What determines euro area bank CDS spreads ?

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Introduction

In recent years, market participants and regulators alike have begun to look to bank credit default swap (CDS) spreads as indicators of bank credit risk. Indeed, since the financial crisis began in mid-2007, bank CDS spreads have increased considerably, and by as much as several hundred basis points for some banks. Recent regulatory initiatives have also used CDS spreads for pricing government guarantees for bank debt and for recapitalization instruments (ECB, 2008a and 2008b). However, little is known about the determinants of bank CDS spreads and, in particular, the degree to which credit risk or some other factors might account for these increases.

Recent studies focusing on non-financial firms indeed suggest that, in addition to credit risk, CDS spreads reflect other factors such as liquidity (see e.g. Tang and Yan, 2008). Yet, because banks are considerably more opaque than non-financial firms and banks' business models are different, it is an open question whether the results for non-financial firms also apply to banks.

This article presents an empirical analysis of the determinants of CDS spread changes for 31 listed euro area banks over the period from 1 January 2004 to 22 October 2008. Interestingly, to date hardly any attempt has been made to assess the determinants of CDS spreads for financial institutions. [1] In choosing the determinants of changes in CDS premia, we use variables suggested by structural credit risk models as well as a variable reflecting CDS market liquidity. We also find that adding variables reflecting general economic conditions (which could potentially capture factors such as systematic credit risk or risk aversion) improves the explanatory power of our model.

The analysis reveals three main results. First, the determinants of changes in bank CDS spreads exhibit significant time variation. Second, variables suggested by structural credit risk models are not significant in explaining bank CDS spread changes, either in the period prior to the crisis or in the crisis period itself. However, some of the variables proxying for general economic conditions are significant, but the magnitude of the coefficient estimates and their sign have changed over time. Third, CDS market liquidity became a significant factor in explaining bank CDS spread changes when the crisis broke out in the summer of 2007.

The remainder of this article is organised as follows. Section 1 gives some background information on credit default swaps. In Section 2, we discuss the potential determinants of CDS spreads, which include credit risk, CDS market liquidity and general economic conditions. Section 3 presents our data and model. Section 4 reports the results of our empirical analysis. The last section concludes.

(1) Notable exceptions are Düllmann and Sosinska (2007), who analyse the CDS spreads for 3 German banks and Raunig and Scheicher (2009), who contrast bank CDS spreads to those in other industries.

1. Credit default swaps: background information

Credit default swaps are credit derivatives traded on over-the-counter (OTC) markets, and which function like a traded insurance contract in which a protection buyer accepts to pay a periodic fee (called "spread" or "premium") in exchange for a payment by the protection seller in the case of a credit event (bankruptcy, failure to pay, etc.) on a reference entity. Credit default swap spreads should be therefore closely linked to the credit quality of the reference entity and should represent a measure of its credit risk. In recent years, CDS spreads have acquired a prominent role as market-based credit indicators thanks to stellar growth of the CDS market. For instance, the Bank for International Settlements (BIS) estimates the outstanding amounts on CDS to have risen from about 6 trillion USD in December 2004 to 57 trillion USD in June 2008.

The remainder of this section describes the recent evolution of euro area bank CDS spreads before comparing CDS spreads with other indicators of credit risk.

1.1 Recent evolution of euro area bank CDS spreads

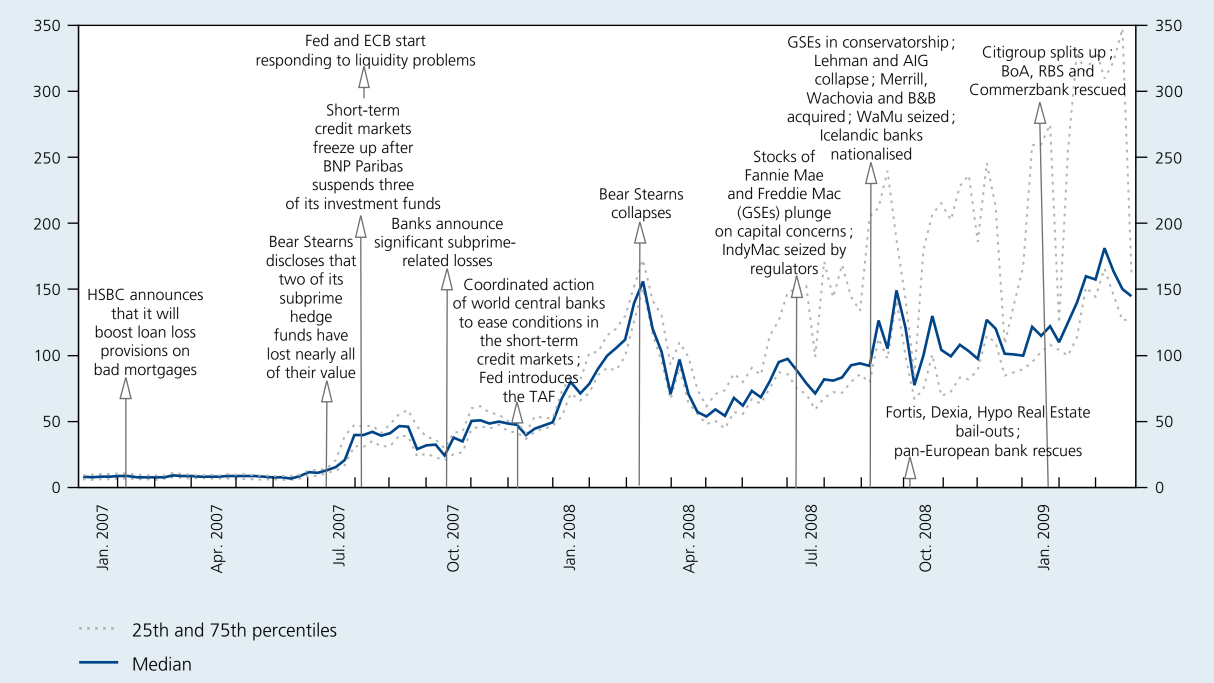
Chart 1 and the subsequent discussion illustrate the evolution of CDS spreads of a sample of large euro area banks between 1 January 2007 and 31 March 2009 (Section 3 details the sample design and composition).

Chart 1 shows that, prior to the summer of 2007, CDS spreads of large euro area banks were relatively low and exhibited low variation. Indeed, the median CDS spread was about 10 basis points (bps), a level similar to what had been observed since early 2004.

Following the announcement by Bear Stearns on 16 July 2007 that two of its subprime hedge funds had lost nearly all of their value, euro area bank CDS spreads started to widen significantly. Over the next few months, spreads further increased due to investors' concerns about the exposure of banks to subprime mortgages, before somehow stabilising in mid-December following monetary actions by central banks around the world and the introduction of the Term Auction Facility (TAF) by the Federal Reserve (Fed).

CHART 1 CDS SPREADS OF LARGE EURO AREA BANKS, 1 JANUARY 2007 – 31 MARCH 2009

(in basis points)



Source: Datastream, ECB and NBB.
Note: see Section 3 for details about the sample design and composition.

This stabilisation proved to be relatively short-lived as euro area bank CDS spreads started to rise again in early 2008 up to the bail-out of Bear Stearns by the Fed on 14 March. Following the subsequent announcement by the US Treasury of a major package to reform regulation of US financial markets and prevent future financial crises, CDS spreads of euro area banks started to decline significantly in late March. In May, however, this very rapid decline came to a halt perhaps as a result of the negative turn of the global corporate sector credit cycle and weakening housing markets in some euro area countries.

After a moderate increase throughout the summer of 2008, euro area financial institutions' CDS spreads surged in late September, following the failure of Lehman Brothers, the effects of which rapidly spread throughout the financial system contributing to a sudden evaporation of liquidity in many markets. In Europe, the initial market responses to the various national measures announced in early October was positive, as suggested by the marked decrease in bank CDS spreads. However, spreads continued to remain at historically high levels after these interventions, and even through March 2009, suggesting that market participants continued to perceive a high level of systemic risk.

1.2 Comparison of CDS spreads with other indicators of credit risk

CDS spreads are only one of the several indicators available to the market to assess credit risk. Two other well-known measures for credit risk are bond yield spreads and credit ratings.

Bond yield spreads represent the difference between the yield on a risky asset and an equivalent risk-free asset, often proxied by the yield on a government bond or a swap contract. Compared to bond spreads, CDS spreads have two main advantages. First, they do not have to be computed vis-à-vis a risk-free benchmark, as they are directly observable. Second, CDS spreads have been found to react more quickly to information regarding the changes in the credit quality of the underlying name compared to the bond market (Hull et al., 2004).

Credit ratings represent a rating agency's opinion of the creditworthiness of an issuer and the likelihood that an obligation will be repaid on time, in full, with interest. Credit ratings are primarily based on public information supplemented with private information obtained by the rating agency from the issuer.

One important difference between credit ratings and CDS spreads (and also bond spreads) is the frequency at which they change. While CDS and bond spreads potentially change on a daily basis, credit ratings are revised infrequently, as credit rating agencies have rating stability as one of their objectives. If all three measures of credit risk were based on the same information, we would expect credit rating changes to lag behind CDS and bond spread changes. However, as mentioned above, credit rating agencies also base their ratings on private information which is potentially not reflected in CDS and bond spreads. As a result, it is possible that rating changes lead CDS and bond spread changes.

Several papers focusing on bond spreads (see Norden and Weber, 2004, for a review) have found that the bond market anticipates negative but not positive rating events. Interestingly, two studies (Hull et al., 2004, and Norden and Weber, 2004) have confirmed these findings for the CDS market using a set of mostly non-financial firms.

Box 1 further investigates the relationship between CDS spreads and credit ratings for a set of European and US banks. Understanding whether market indicators such as CDS spreads anticipate rating changes is important for at least three reasons. First, from a financial stability perspective, it is important to understand whether CDS spreads are an effective tool to detect and forecast changes in banks' financial condition (assuming than this is proxied by credit rating events). Second, from the point of view of credit rating agencies, it may be interesting to learn whether credit ratings (which are mostly based on public information and reviewed infrequently) may see their accuracy improved when supplemented with information from the CDS market. Third, from an investor's standpoint, it might be interesting to exploit signals coming from CDS spreads if they lead credit rating events.

Box 1 – The relationship between CDS spreads and credit ratings for European and US banks

The purpose of this box is to study the lead-lag relationship between two measures of credit risk (CDS spreads and long-term credit ratings) for a set of banks and, more particularly, to see whether CDS spreads anticipate credit rating events.

The sample consists of daily CDS spreads and long-term ratings from Moody's for 83 banks over the period from 1 January 2003 to 22 October 2008. Both European and US credit institutions are included in the sample, in order to have the largest possible number of credit rating events (a forthcoming NBB working paper provides more information on the sample design and composition). Unsurprisingly, positive rating events (defined as upgrades, positive outlooks and reviews for upgrade) dominate the 2004 to 2006 period whereas negative events (defined as downgrades, negative outlooks and reviews for downgrade) are much more prevalent in 2007 and 2008. An interesting feature of the sample is that it is characterised by much larger movements in CDS spreads than those observed in Hull et al. (2004) and Norden and Weber (2004), particularly at the end of the period considered.

The empirical analysis is conducted by implementing an event-study methodology and bootstrap technique employed by Hull et al. (2004). We first create an adjusted CDS spread for each bank by subtracting a CDS market index spread from the bank's CDS spread. We then consider the changes in adjusted CDS spreads that occur over different time intervals (e.g. [-90 days, -61 days], [-60 days, -31 days], etc.) preceding and following the day on which a particular rating event takes place, defined as event time day zero. (1) The table below reports the results of this exercise.

MEAN CHANGE IN THE ADJUSTED CDS SPREAD DURING AN INTERVAL PRIOR TO OR FOLLOWING A RATING EVENT OCCURRING AT TIME $t=0$

(in basis points)

	Time interval	[–90, –61]	[–60, –31]	[–30, –1]	[–1, 1]	[1, 10]
Downgrades	N. of events: 15					
	Mean	22.447**	24.445*	58.779*	–14.845	13.273
	p-values	0.020	0.064	0.065	0.745	0.367
Negative outlooks and reviews for downgrade	N. of events: 32					
	Mean	–0.460	8.785	27.469***	–1.469	6.184**
	p-values	0.534	0.146	0.008	0.560	0.030
Upgrades	N. of events: 12					
	Mean	1.227	2.436	–0.425	–1.942**	0.701
	p-values	0.703	0.916	0.454	0.010	0.756
Positive outlooks and reviews for upgrade	N. of events: 16					
	Mean	–8.592***	6.352	–5.741**	–1.510**	–0.875
	p-values	0.004	0.976	0.018	0.042	0.202

Note: The time interval [$-n_1$, $-n_2$] is from n_1 business days before the rating event to n_2 business days before the rating event. The time interval [1, 10] is from 1 day after the rating event to 10 days after the rating event. The adjusted CDS spread is the actual CDS spread observed on a given day adjusted for a CDS market index. The test considers whether the adjusted CDS spread change for a rating event over a given interval is significantly greater than (smaller than) zero for negative (positive) events. Values significant at 1 p.c., 5 p.c., 10 p.c. are identified by ***, **, *.

(1) Note that we disregard a rating event when it follows the previous event by less than 90 days in order to avoid as far as possible contaminating our results.

The results in the table show that, in line with the existing literature, negative rating events are anticipated by the CDS market. Anticipation in the CDS market is present in the case of actual downgrades, as we observe a significant increase (at the 5 p.c. or 10 p.c. statistical significance level) in the CDS spreads from 90 trading days before the downgrade event (day zero). Interestingly, uncertainty about the rating downgrade seems to wane, as prices rise more when we move closer to the downgrade announcement. A similar but somewhat weaker pattern is observed for negative outlooks and reviews for downgrade: CDS spreads increase significantly (at the 1 p.c. statistical significance level) only in the 30 days preceding the rating event. (1)

As far as positive rating events are concerned, the table reveals some anticipation by the CDS market, mostly of the positive outlooks and reviews for upgrade. However, although the results for these types of events are statistically significant, they are small from an economic point of view, as CDS spread changes are all lower than 10 bps in absolute value (compared to at least 22 bps for the negative rating events). This result is in line with the existing literature whose main conclusion is that the market anticipates positive rating events to a much smaller extent than negative ones.

There are at least two possible reasons for the stronger anticipation of negative rating events by the CDS market. First, bad news (which drives negative rating events) may have a larger impact than positive news on investors, thereby translating into a stronger effect on spreads. Second, downgrades are associated with larger rating changes than upgrades in our sample, as evidenced by the fact that only 1 out of the 12 upgrades represents a two-notch rating move, while 5 out of the 15 downgrades are two-notch or three-notch rating changes. We expect the CDS market to anticipate more strongly news which is of a higher importance.

Finally, it is important to point out that our results are also consistent with the fact that credit rating agencies may simply adjust their ratings following changes in CDS spreads. Moody's (2006 and 2007) argues for instance that the market and its own credit ratings react in the same way to news about a company, but that the market moves first and instantaneously, thereby creating a gap between the ratings and the trading levels for the CDS. Moody's subsequently reacts to reduce this gap if news about the issuer is confirmed. The more significant the news and the larger the gap between Moody's credit rating and the market, the higher the probability that Moody's will act.

(1) The evidence of a post-announcement effect for negative outlooks and reviews for downgrade does not seem to be robust, as shifting the post-announcement time interval by only 2 days (i.e. from [+ 1 day, + 10 days] to [+ 3 days, +12 days] or [- 1 day, + 8 days]) returns insignificant results. Note that all our other results hold up to this type of robustness check.

2. The determinants of CDS spreads

Credit risk should be the most important determinant of CDS spreads, as credit default swaps are insurance premia against default of the underlying reference entity. However, other factors related to liquidity or general economic conditions may also play a role. This section discusses more fully variables which are likely to explain the behaviour of CDS spreads in general, but with an eye on the banking sector.

2.1 Variables implied by structural credit risk models

We begin with credit risk factors. In this article, credit risk is proxied by the variables suggested by structural credit risk models initiated by Black and Scholes (1973) and Merton (1974), i.e. the risk-free interest rate, leverage and asset volatility (see Box 2).

Box 2 – The Merton model

Miller and Modigliani (1958) used no arbitrage arguments to derive their well-known irrelevance theorem regarding the use of risk-free debt versus equity. In an economy with neither taxes nor default costs, the total value of the firm is invariant to the capital structure. In the subsequent decade, the potential default costs were introduced and hence theorists started to treat debt as a risky asset. Still, little guidance was given on the valuation of risky debt. Black and Scholes (1973) and Merton (1973, 1974) initiated in their seminal papers the classical theory of risky debt valuation (also called the contingent claim approach or the structural approach).

Merton (1974) considers a firm with an extremely simplified capital structure. This firm has one single homogeneous class of debt outstanding, a zero-coupon bond of nominal value B. The firm promises to pay B on maturity date T. Prior to T, the firm cannot default, issue new senior debt, pay out any cash dividends or make share repurchases. The value of the firm's asset (A) is assumed to follow a diffusion process. The value of the firm is critical for the pay-offs the bond holder will receive at maturity date. If the asset value is higher than the nominal value of the bond, the bond will be repaid and the market value of the equity position will be the residual claim of the difference between the asset value at maturity (A(T)) and B. However, if the asset value is not sufficient to repay B, the bond holder will get the remaining asset value A(T) (< B) whereas the equity holder will invoke his limited liability. The following table summarises the cash flows:

	Bond holder	Equity holder
A(T) > B	B	A(T) – B
A(T) < B	A(T)	0
Pay-off	min(B, A(T)) = B – max(B – A(T), 0)	A(T) – min(A(T), B) = max(A(T) – B, 0)

The pay-off structure clearly reveals that the position of the equity holder can be described as a long European call on the assets with the nominal value of the zero-coupon bond (B) as strike price. (1) The position of the risky bond holder is equivalent to a position in a risk-free bond with the same maturity and a short European put on the assets of the firm. The strike price is also B.

By viewing corporate liabilities as options on the assets of the firm and using the Black and Scholes formula for pricing European put options, Merton (1974) explicitly linked the value of credit risky securities to three variables: the risk-free interest rate, the volatility of the firm's asset value and leverage.

The intuition for each of these variables is as follows. Since bond holders can be thought of as having shorted a put on the assets of the firm, they must be rewarded for the risk that they take. First, higher asset volatility increases the probability that the firm will default on its debt and that the put option will be exercised. Therefore, investors will demand a higher premium to hold corporate debt. Second, the higher the leverage, the more likely it becomes that the firm's assets will drop below the nominal value of its debt at maturity. Again, the higher probability of default will imply a higher risk premium. Finally, a higher risk-free rate makes the firm value process drift at a faster rate from the default boundary, and thus reduces default probability. A lower risk premium thus follows.

(1) A European option is an option that cannot be exercised before expiry day.

RISK-FREE INTEREST RATE

In the Merton model, the risk-free interest rate represents the drift of the value of the assets. An increase in the interest rate implies an increase in the expected growth rate of the firm's value. This leads to decreasing credit spreads as default becomes less likely.

The negative relationship between the risk-free interest rate and credit spreads can also be explained in a macroeconomic setting. Higher interest rates are usually associated with higher economic growth, which should therefore lead to lower default risk hence lower credit spreads. In the long run, however, higher interest rates may also lead to higher funding costs, which may reduce the negative association between the risk-free rate and credit spreads.

LEVERAGE

In the Merton model, the debt-to-asset ratio (leverage) has a positive impact on the credit spread. A higher leverage ratio implies that the asset value can less easily cover debt repayments, increasing the probability of default and credit spreads. Hence, structural credit risk models posit a negative relation between the firm's asset value and its credit spreads.

As the market value of firms' assets cannot be observed, this value is usually proxied by the equity value (returns) for publicly-traded companies. If stock returns fall, the leverage in terms of market value will increase. In turn, higher leverage leads to higher credit spreads. A negative relation between stock returns and credit spreads is thus expected.

ASSET VOLATILITY

Higher asset volatility leads to higher credit spreads because it increases the likelihood that the firm's asset value will fall below the value of the required debt repayment. In practice, asset volatility is often proxied by equity volatility. An increase in equity volatility thus raises the probability that the credit spreads will widen.

2.2 CDS market liquidity

Several papers have documented that CDS spreads seem to be too high to be explained simply by the variables implied by structural credit risk models and that factors linked to CDS market liquidity are also likely to play a role (see, e.g., Bongaerts et al., 2008, and Tang and Yan, 2008).

We therefore introduce a bank-specific CDS liquidity factor and measure it as the bid-ask spread, i.e. the difference between the bid and ask quotes. Arguably, liquidity has multiple facets and can only be imperfectly described by a single statistic. Our choice to use the bid-ask spread is primarily motivated by the lack of data on other proxies of CDS market liquidity; however, there are a number of reasons for relying on this indicator. First, the above-mentioned papers report substantial correlations between the bid-ask spread and other liquidity proxies (e.g. number of quotes per CDS, data on trades or volume of orders). Second, unreported regressions show that the CDS bid-ask spread appears to be unrelated to the other determinants of CDS spreads in our sample. This suggests that the bid-ask spread broadly captures CDS market liquidity and is not being "contaminated" by variables implied by structural credit risk models and by general economic variables.

As protection sellers demand an additional premium for liquidity risk, higher bid-ask spreads are expected to be associated with higher CDS premia.

2.3 Variables reflecting general economic conditions

Most papers exploring the explanatory power of credit risk and liquidity variables for bond and CDS spreads find that regression residuals still contain some degree of common variation, indicating that some common factors are missing from the regression specification (see, e.g., Collin-Dufresne et al., 2001, for bond spreads). It is likely that such common variation reflects factors such as systematic credit risk or risk aversion, which vary according to the state of the business cycle. It is still an open question why these factors are significant, since one would expect their effects to have already been captured by individual credit risk variables.

The following conjectures can nevertheless be made. First, systematic credit risk may impact CDS spread changes because the probability of default increases (and the recovery rate decreases) in periods of economic downturn; hence the risk premium may increase. Second, risk aversion may matter because investors are more concerned with safety in periods of economic downturn, so the required risk premium may also increase.

Given this evidence and the associated conjectures, we introduce several variables that are known to proxy for business conditions, market conditions and/or uncertainty.

SLOPE OF THE TERM STRUCTURE

The slope of the term structure (the spread between the long-term and the short-term rate) is widely acknowledged as a business cycle predictor (see, e.g., Mishkin, 2007). A high slope anticipates improving economic activity, which might in turn increase a firm's growth rate and reduce its default probability. Therefore, a negative relation with credit spreads is expected. A negative relation can also be inferred from the expectations hypothesis of the term structure, which states that an increase in the slope implies an increase in the expected short-term interest rates. Similarly to the discussion of the risk-free interest rate above, an increase in the slope is expected to reduce a firm's default risk.

SWAP SPREADS AND CORPORATE BOND SPREADS

The swap spread (i.e. the difference between a swap rate and a government bond rate of the same maturity) reflects the perceived risk that swap counterparties will fail. Similar to Düllmann and Sosinska (2007), we use the swap spread as an indicator of credit risk in the banking sector, since banks are the most active dealers in the swap market. A positive expected relation with bank CDS spreads thus follows.

Like several other studies (e.g. Collin-Dufresne et al., 2001), we consider the bond yield spread between high- and low-rated securities as a general indicator of credit risk in the economy and therefore expect a positive impact on CDS spreads.

STOCK MARKET RETURN

General business climate improvements (as proxied by an increase in the stock market return) will reduce probabilities of default and will increase recovery rates. A negative relation with CDS spreads thus follows.

STOCK MARKET VOLATILITY

Volatility in the stock market is used as a measure of economic uncertainty, the assumption being that the more volatile the market, the more uncertainty there is about economic prospects. A positive relationship between stock market volatility and CDS spreads is therefore expected.

In the remainder of this article, we analyse the role of the above-mentioned factors in explaining CDS spread changes for a sample of large euro area banks, the composition of which is detailed in the next section.

3. Data description and model specification

3.1 Data description

The analysis uses individual CDS data for 31 listed euro area banks over the period from 1 January 2004 to 22 October 2008. [1] The selection of the banks was based on the availability of CDS quotes and stock prices in Datastream. [2]

We use 5-year CDS quotes for senior debt issues since these contracts are generally considered to be the most liquid segment of the market. In addition, we work with mid-quotes, which correspond to market-observed (and not extrapolated) spreads, and we use weekly changes, since daily CDS spreads are known to be scanty (see, e.g., Zhu, 2006). Finally, only underlying names with at least 10 weekly credit spread changes are retained, resulting in an unbalanced panel of 5,214 observations with on average 20.6 spreads available per week. We also make use of data on the long-term rating of each bank, which enables results for banks in different rating categories to be compared.

Table 1 presents some descriptive statistics on weekly CDS spread changes of banks across rating categories. In order to account for any structural change that may have occurred after the outbreak of the financial crisis, statistics are not only reported for the entire sample period, but also for the following two sub-periods: 1 January 2004 to 15 July 2007 ("pre-crisis period") and 16 July 2007 to 22 October 2008 ("crisis period"). [3]

Table 1 shows that the average CDS spread change was 0.44 basis points per week over the entire sample period. The descriptive statistics confirm that bank credit spreads varied much more after the crisis began. Furthermore, the volatility (standard deviation) of CDS spread changes is higher for A- than for AA-rated banks, both in the pre-crisis and in the crisis period. Finally, and somewhat surprisingly, average CDS spread changes are slightly higher for AA- than A-rated banks.

(1) Including bank CDS spreads after the end of October 2008 would cause the results to be affected by different government interventions whose application to specific banks is not always identifiable.

(2) The exact composition of the sample is as follows: Dexia, KBC (BE); BNP Paribas, Crédit Agricole, Natixis, Société Générale, Unibail (FR); Bayerische Hypo- und Vereinsbank, Commerzbank, Deutsche Bank, IKB Deutsche Industriebank (DE); Banco de Sabadell, Banco Santander, Banco Bilbao Vizcaya Argentaria (ES); EFG Eurobank Ergasias (GR); Allied Irish Banks, Anglo Irish Bank, Bank of Ireland, Irish Life & Permanent (IE); Banca Italease, Banca Monte dei Paschi di Siena, Banca Popolare di Milano, Banco Popolare, Mediobanca, Ubi Banca, UniCredito Italiano (IT); ING, Fortis Netherlands (NL); Banco BPI, Banco Comercial Português, Banco Espirito Santo (PT).

(3) As mentioned in Section 1, the week of 16 July 2007 is the week during which Bear Stearns disclosed that two of its subprime hedge funds had lost nearly all of their value amid a rapid decline in the market for subprime mortgages, an event seen by many as signalling the start of the crisis.

$R_{m,t}$

TABLE 1 DESCRIPTIVE STATISTICS ON WEEKLY BANK CDS SPREAD CHANGES: BREAKDOWN BY LONG-TERM CREDIT RATING AND TIME PERIOD

	All banks	AA-rated banks	A-rated banks	No rating
Whole period: 1 January 2004 – 22 October 2008				
Mean	0.44	0.40	0.37	0.85
Minimum	–251.20	–155.00	–251.20	–143.30
Maximum	262.50	156.70	262.50	112.50
Std. Deviation	13.49	11.98	14.32	15.95
N(obs)	5,214	2,488	2,071	655
Pre-crisis period: 1 January 2004 – 15 July 2007				
Mean	–0.05	–0.03	–0.05	–0.09
Minimum	–18.90	–4.30	–14.50	–18.90
Maximum	19.70	9.80	17.00	19.70
Std. Deviation	1.46	0.94	1.75	1.96
N(obs)	3,782	1,798	1,490	494
Crisis period: 16 July 2007 – 22 October 2008				
Mean	1.73	1.52	1.43	3.72
Minimum	–251.20	–155.00	–251.20	–143.30
Maximum	262.50	156.70	262.50	112.50
Std. Deviation	25.59	22.67	26.89	31.89
N(obs)	1,432	690	581	161

Note: The table reports the mean, minimum, maximum, standard deviation (in basis points) and number of CDS spread changes on respectively the entire sample of banks, AA- and A-rated banks, as well as banks without a long-term rating (including 9 observations with a BBB rating). CDS spreads are from Datastream and long-term credit ratings are from Fitch Ratings.

TABLE 2 EXPLANATORY VARIABLES AND EXPECTED SIGNS ON THE COEFFICIENTS IN THE EMPIRICAL ANALYSIS

Variable	Description	Expected sign
Δi_t	Change in 2-year euro area government bond yield	–
$R_{i,t}$	Bank stock return	–
$\Delta vol_{i,t}$	Change in weekly historical standard deviation, computed using daily bank stock returns	+
$\Delta liq_{i,t}$	Change in absolute CDS bid-ask spread	+
$\Delta slope_t$	Change in the slope of the term structure, i.e. change in the difference between the 10-year minus the 5-year euro area government bond yield	–
$\Delta swap_t$	Change in 5-year swap spread, i.e. change in the difference between the 5-year European swap rate and the 5-year euro area government bond yield	+
$\Delta bspread_t$	Change in the difference between the Merrill Lynch 5-year BBB and AAA corporate bond spread	+
$R_{m,t}$	Stock market return, proxied by the Datastream euro area stock market index return	–
$\Delta volimp_t$	Change in stock market volatility, computed using the weekly change of the VSTOXX index	+

3.2 Model specification

In order to analyse the main determinants of weekly CDS spread changes, we estimate the following equation:

$$\Delta CDS_{i,t} = \alpha_1 + \alpha_2\ \Delta i_t + \alpha_3\ R_{i,t} + \alpha_4\ \Delta vol_{i,t} + \alpha_5\ \Delta liq_{i,t} + \alpha_6\ \Delta slope_t + \alpha_7\ \Delta swap_t + \alpha_8\ \Delta bspread_t + \alpha_9\ R_{m,t} + \alpha_{10}\ \Delta volimp_t + \varepsilon_{i,t}$$

where the subscripts i and t identify respectively the bank and the time period; Δ denotes weekly changes; CDS is the bank CDS spread; the variable i is the 2-year euro area government bond yield; R and vol are the bank stock return and its volatility (both measured on a weekly basis), liq is the CDS bid-ask spread; $slope$ is the spread between the 10-year and 5-year euro area government bond yield; $swap$ is the spread between the 5-year European swap rate and the 5-year euro area government bond yield; $bspread$ is the spread between the 5-year BBB- and AAA-rated corporate bond spreads; R_m and $volimp$ are the stock market return and its volatility (both measured on a weekly basis).[1] All variables are expressed in percentage points, except CDS which is in basis points. Table 2 provides the exact definition of all the explanatory variables and the expected signs of their coefficients.

Table 3 reports summary statistics for each variable, for the whole period and for the two sub-periods.

As shown in the table, the crisis period was accompanied by an increase in credit risk (as reflected by the negative change in interest rates, negative bank stock returns and positive change in volatility), worsening liquidity conditions in the CDS market (positive change in the bid-ask spread) and deteriorating general economic conditions (positive

(1) We tried different maturities for i_t, $slope_t$ and $swap_t$, with very similar results to those reported in the article.

TABLE 3 DESCRIPTIVE STATISTICS ON THE EXPLANATORY VARIABLES: BREAKDOWN BY TIME PERIOD

	Δi_t	$R_{i,t}$	$\Delta vol_{i,t}$	$\Delta liq_{i,t}$	$\Delta slope_t$	$\Delta swap_t$	$\Delta bspread_t$	$R_{m,t}$	$\Delta volimp_t$
Whole period: 1 January 2004 – 22 October 2008									
Mean	0.00	–0.04	0.04	0.09	0.00	0.00	0.01	0.06	0.16
Minimum	–0.58	–81.09	–22.93	–75.00	–0.19	–0.15	–0.51	–10.98	–8.90
Maximum	0.41	73.42	33.67	100.00	0.16	0.23	0.66	5.12	15.99
Std. Deviation	0.12	5.09	1.59	4.27	0.04	0.04	0.09	2.26	2.95
N(obs)	5,214	5,214	5,214	4,802	5,214	5,214	4,885	5,214	5,214
Pre-crisis period: 1 January 2004 – 15 July 2007									
Mean	0.01	0.46	0.00	–0.01	–0.01	0.00	0.00	0.39	–0.06
Minimum	–0.22	–11.61	–10.97	–25.00	–0.18	–0.13	–0.34	–6.55	–8.90
Maximum	0.25	32.24	9.71	25.00	0.07	0.06	0.43	4.45	11.69
Std. Deviation	0.08	2.78	0.77	1.87	0.03	0.02	0.07	1.70	2.03
N(obs)	3,782	3,782	3,782	3,463	3,782	3,782	3,453	3,782	3,782
Crisis period: 16 July 2007 – 22 October 2008									
Mean	–0.02	–1.37	0.15	0.34	0.01	0.01	0.03	–0.82	0.73
Minimum	–0.58	–81.09	–22.93	–75.00	–0.19	–0.15	–0.51	–10.98	–8.63
Maximum	0.41	73.42	33.67	100.00	0.16	0.23	0.66	5.12	15.99
Std. Deviation	0.18	8.45	2.76	7.49	0.07	0.06	0.13	3.15	4.51
N(obs)	1,432	1,432	1,432	1,339	1,432	1,432	1,432	1,432	1,432
***t*-test: pre-crisis vs. crisis period**									
t-test value	–7.17***	–8.04***	1.94*	1.69*	7.06***	5.00***	8.87***	–13.84***	6.34***

Note: The table reports the mean, minimum, maximum, standard deviation (in p.c.) and number of observations on each explanatory variable. All variables are measured on a weekly basis and are summarised in Table 2. The last row presents the results of *t*-tests for the equality of the means of each explanatory variable across the pre-crisis and crisis periods; ***, ** and * denote significance at the 1 p.c., 5 p.c. and 10 p.c. levels, respectively.

corporate bond and swap spread changes, negative stock market returns and strong increase in stock market volatility).[1] The existence of a significant difference between the pre-crisis and the crisis periods is further confirmed by the last row of Table 3, which reports the results of t-tests for the equality of the means of each explanatory variable across the sub-periods. These tests show that the differences in means across the sub- periods were all statistically significant at the 10 p.c. level and often at the 1 p.c. level.

Finally, an informal comparison of the standard deviations of each variable between the pre-crisis and crisis periods suggests that the volatility of all of these variables increased strongly after mid-July 2007.

4. Empirical results

We estimate the model using ordinary least squares with White cross-section standard errors and covariance to allow for general contemporaneous correlation between the bank residuals.[2]

Table 4 presents the estimation results for the whole period and our full sample of banks, as well as results for sub-samples based on time periods (pre-crisis and crisis) and credit ratings (AA and A). The last column of the table reports the results of a t-test for equality of the coefficients in the pre-crisis and crisis periods.

Table 5 provides information on the marginal contributions of each variable (in percent) to the overall explanatory power of our regressions for the different time periods and rating categories considered.

4.1 Variables implied by structural credit risk models

Looking at Table 4, variables proxying for credit risk are generally statistically insignificant at the 5 p.c. level, except the change in the risk-free rate (Δi_t) in the regression for AA-rated banks (pre-crisis period) and the bank stock return ($R_{i,t}$) in the regression for A-rated banks (whole sample period), both with the expected negative sign. The R-squared decomposition in Table 5 further shows that the marginal contribution of the credit risk variables to the R-squared never exceeds about 20 p.c. in the regressions.

(1) Note, however, that the positive slope of the yield curve in the crisis period suggests an improvement in general economic conditions.

(2) We rely on ordinary least squares because we find no evidence of bank fixed or random effects.

The insignificance of the credit risk variables in the pre-crisis period echoes warning signals concerning the "global mispricing of risk" sent by several observers before the crisis struck. The insignificance of these variables in the crisis period is somewhat more surprising.

One reason for the insignificance of the credit risk variables may be that structural credit risk models are less applicable to banks than non-banks given the proxy that we use for leverage (stock return). However, there are at least two additional explanations. First, this article focuses on high credit-quality banks (almost exclusively rated A or above), while existing studies which find that credit risk variables play an important role in explaining CDS spreads often consider firms (banks and most often non-banks) of much lower credit quality (typically rated BBB or below). Obviously, credit risk variables are more likely to matter for low credit-quality firms, as they are closer to the default barrier. Second, we report results for relatively long time periods, which increases the likelihood of obtaining insignificant results if the coefficients are time-varying. One-year rolling regressions reported in a companion working paper (Annaert et al., forthcoming) show precisely that the statistical significance of the credit risk variables is highly time-dependent.

This last result shed light on those by Raunig and Scheicher (2009), who contrast the behaviour of financial and non-financial CDS spreads during two main periods (October 2003 to June 2007 and August to December 2007). Regarding the first sub-period, which is very similar to ours, the authors find that the risk-free rate and the idiosyncratic volatility affect bank CDS premia only to a small extent. Regarding the second sub-period, which is much shorter than ours, the authors find that the impact of the risk-free rate and idiosyncratic volatility is identical for banks and non-banks (i.e. negative and significant for the first variable, and positive and significant for the second). Interestingly, when we shorten the crisis period to August to December 2007, we also find that the risk-free rate and the idiosyncratic volatility are significant with the expected sign. It thus seems that the relationship between variables implied by structural credit risk models and bank CDS spreads was quite strong in the first few months of the crisis but that it disintegrated afterwards.

4.2 CDS market liquidity

Looking at Table 4, the change in CDS bid-ask spread ($\Delta liq_{i,t}$) is insignificant in the pre-crisis period but is significant with the expected positive sign in the crisis period for the two rating categories considered. The R-squared decomposition in Table 5 further shows that

TABLE 4 DETERMINANTS OF WEEKLY BANK CDS SPREAD CHANGES: BREAKDOWN BY CREDIT RATING AND TIME PERIOD

	Whole period: 1 Jan. 2004 – 22 Oct. 2008	Pre-crisis period: 1 Jan. 2004 – 15 Jul. 2007	Crisis period: 16 Jul. 2007 – 22 Oct. 2008	*t*-test pre-crisis vs. crisis period
Panel A: all banks				
Credit risk				
Δi_t	–12.71 (–1.54)	–1.04 (–0.84)	–10.47 (–0.76)	–0.68
$R_{i,t}$	–0.44 (–1.54)	0.00 (–0.12)	–0.49 (–1.47)	–1.46
$\Delta vol_{i,t}$	–1.03 (–1.27)	–0.03 (–0.36)	–1.22 (–1.36)	–1.32
CDS market liquidity				
$\Delta liq_{i,t}$	0.82*** (4.04)	0.02 (0.77)	0.92*** (3.80)	3.73***
General economic conditions				
$\Delta slope_t$	–39.13* (–1.89)	–4.79 (–1.34)	–26.21 (–0.75)	–0.61
$\Delta swap_t$	116.87*** (5.89)	10.17* (1.79)	115.34*** (5.45)	4.81***
$\Delta bspread_t$	–10.95 (–1.60)	3.77*** (2.73)	–22.28** (–2.21)	–2.56**
$R_{m,t}$	–0.49 (–1.03)	–0.03 (–0.53)	–1.19 (–1.37)	–1.34
$\Delta volimp_t$	–0.01 (–1.09)	0.00 (0.72)	–0.01 (–1.50)	–1.57
Adj. R^2 (in p.c.)	27.79	4.72	31.03	
N(obs)	4,484	3,145	1,339	
Panel B: AA-rated banks				
Credit risk				
Δi_t	–13.94 (–1.26)	0.14 (0.14)	–13.09 (–0.70)	–0.71
$R_{i,t}$	–0.57 (–1.56)	–0.05*** (–3.39)	–0.67 (–1.58)	–1.47
$\Delta vol_{i,t}$	–0.81 (–0.80)	0.03 (0.47)	–0.93 (–0.83)	–0.86
CDS market liquidity				
$\Delta liq_{i,t}$	0.56* (1.79)	0.00 (0.40)	0.76* (1.71)	1.71*
General economic conditions				
$\Delta slope_t$	–46.45* (–1.66)	–0.89 (–0.31)	–37.71 (–0.80)	–0.78
$\Delta swap_t$	149.16*** (5.60)	5.22 (1.01)	154.23*** (5.33)	5.08***
$\Delta bspread_t$	–8.17 (–0.97)	3.32*** (3.51)	–17.25 (–1.35)	–1.61
$R_{m,t}$	–0.69 (–1.21)	–0.02 (–0.33)	–1.45 (–1.38)	–1.36
$\Delta volimp_t$	–0.01* (–1.66)	0.00 (–0.12)	–0.02** (–2.10)	–2.09**
Adj. R^2 (in p.c.)	30.60	8.09	34.89	
N(obs)	2,143	1,491	652	

Note: Panels A, B and C present the estimation results for CDS spreads on respectively the whole sample of banks, AA- and A-rated banks. The model is estimated using ordinary least squares with White cross-section standard errors and covariance to allow for general contemporaneous correlation between the bank residuals. *t*-statistics are given between brackets. The *t*-statistics in the last column refer to the *t*-statistics of a test for equality of the coefficients in the pre-crisis and crisis periods; ***, ** and * denote significance at the 1 p.c., 5 p.c. and 10 p.c. levels, respectively.

TABLE 4 DETERMINANTS OF WEEKLY BANK CDS SPREAD CHANGES: BREAKDOWN BY CREDIT RATING AND TIME PERIOD (continued)

	Whole period: 1 Jan. 2004 – 22 Oct. 2008	Pre-crisis period: 1 Jan. 2004 – 15 Jul. 2007	Crisis period: 16 Jul. 2007 – 22 Oct. 2008	*t*-test pre-crisis vs. crisis period
Panel C: A-rated banks				
Credit risk				
Δi_t	–12.78**	–1.58	–11.66	–0.93
	(–1.99)	(–0.99)	(–1.09)	
$R_{i,t}$	–0.38	0.00	–0.45	–1.49
	(–1.47)	(–0.12)	(–1.49)	
$\Delta vol_{i,t}$	–1.02	–0.02	–1.26	–1.50
	(–1.34)	(–0.30)	(–1.52)	
CDS market liquidity				
$\Delta liq_{i,t}$	1.17***	0.08	1.22***	3.25***
	(3.71)	(1.53)	(3.49)	
General economic conditions				
$\Delta slope_t$	–41.77**	–7.06*	–27.40	–0.66
	(–2.10)	(–1.69)	(–0.89)	
$\Delta swap_t$	113.25***	12.19**	108.77***	5.03***
	(6.10)	(2.19)	(5.90)	
$\Delta bspread_t$	–16.28*	5.53***	–31.68***	–3.53***
	(–1.90)	(2.93)	(–3.05)	
$R_{m,t}$	–0.18	–0.08	–0.56	–0.65
	(–0.44)	(–1.02)	(–0.75)	
$\Delta volimp_t$	0.00	0.00	0.00	–0.21
	(0.02)	(0.45)	(–0.14)	
Adj. R^2 (in p.c.)	36.48	6.98	39.44	
N(obs)	1,794	1,241	553	

Note: Panels A, B and C present the estimation results for CDS spreads on respectively the whole sample of banks, AA- and A-rated banks. The model is estimated using ordinary least squares with White cross-section standard errors and covariance to allow for general contemporaneous correlation between the bank residuals. *t*-statistics are given between brackets. The *t*-statistics in the last column refer to the *t*-statistics of a test for equality of the coefficients in the pre-crisis and crisis periods; ***, ** and * denote significance at the 1 p.c., 5 p.c. and 10 p.c. levels, respectively.

the contribution of the bid-ask spread to the variance in CDS spread changes explained by the model surged after mid-July 2007, especially for A-rated banks.

These results are not inconsistent with existing studies on non-banks, which show that the CDS bid-ask spread does help in explaining CDS spreads, but that its impact depends on the sample considered or the explanatory variables chosen (see, e.g., Tang and Yan, 2008, and Das and Hanouna, 2009). Our results suggest that an additional dimension driving the significance of the bid-ask spread is the time period considered.

The insignificance of the bid-ask spread in the pre-crisis period may be attributed to the global mispricing of risk noted by several observers. The significance of this variable after mid-July 2007 suggests that the liquidity premium earned by protection sellers in the CDS market has increased in recent months, especially for lower-rated banks.

4.3 Variables reflecting general economic conditions

Looking at each variable in turn, the following observations can be made in Table 4.

First, the coefficient on the slope of the term structure ($\Delta slope_t$) has the expected negative sign but is only significant in the regressions which cover the entire sample period. One possible explanation might be that the impact of this variable can only be assessed over sufficiently long time periods, which include substantial movements in the yield curve.

Second, the regression coefficient on the swap spread ($\Delta swap_t$) is generally significant across sub-periods and it has the expected positive sign. This coefficient is much larger in the crisis period than in the pre-crisis period. Indeed, looking at the results for the entire sample of banks, an increase of 13 bps (i.e., one standard deviation) in the swap spread change leads to an increase of 15 bps in bank CDS spread changes after the start of the crisis,

TABLE 5 MARGINAL CONTRIBUTION OF VARIABLES PROXYING FOR CREDIT RISK, CDS MARKET LIQUIDITY AND GENERAL ECONOMIC CONDITIONS TO THE PERCENTAGE OF TOTAL EXPLAINED VARIANCE

	Whole period: 1 Jan. 2004 – 22 Oct. 2008	Pre-crisis period: 1 Jan. 2004 – 15 Jul. 2007	Crisis period: 16 Jul. 2007 – 22 Oct. 2008
Panel A: all banks			
Credit risk	21.75	17.75	14.93
CDS market liquidity	35.11	9.40	55.37
General economic conditions	43.14	72.85	29.70
Panel B: AA-rated banks			
Credit risk	3.72	11.51	3.54
CDS market liquidity	22.53	19.69	26.71
General economic conditions	73.74	68.79	69.75
Panel C: A-rated banks			
Credit risk	20.46	16.10	15.85
CDS market liquidity	35.52	9.70	52.70
General economic conditions	44.02	74.21	31.45

Note: This table shows the marginal contribution (in p.c.) of each block of variables (credit risk variables, liquidity variable and variables proxying for general economic conditions) to the total adjusted R^2 of the regression relative to the contribution of the two other blocks of variables. Formally, the marginal contribution mc_k of the k^{th} block of variables ($k=1, 2, 3$) is defined as:

$$\frac{R^2 - R^2_k}{\sum^n_{k=1}(R^2 - R^2_k)}$$

, where mc_k is ≥ 0 and R^2_k is computed with the k^{th} block of variables excluded. Credit risk variables are Δi_t, $R_{i,t}$ and $\Delta vol_{i,t}$; CDS market liquidity is measured by $\Delta liq_{i,t}$; variables reflecting general economic conditions are $\Delta slope_t$, $\Delta swap_t$, $\Delta bspread_t$, $R_{m,t}$ and $\Delta volimp_t$. Table 2 provides the exact definition of all the explanatory variables.

compared with only 1 bps before. The much larger coefficient observed in the crisis period might be attributed to a re-pricing of credit risk in the banking sector, with changes in the likelihood of bank failure (as measured by the swap spread) translating into higher CDS spreads changes after mid-July 2007.

Third, corporate bond spread changes ($\Delta bspread_t$) are significant with the expected positive sign in the pre-crisis period, both for AA- and A-rated banks. However, in the crisis period, they are insignificant for AA-rated banks, and significant with the wrong sign for A-rated banks. One reason for this rather counter-intuitive result appears to be the joint increase in corporate bond spreads and decrease in CDS spreads of AA- and A-rated banks, which took place in early October 2008 following the first wave of government interventions. Unreported regressions confirm that if we shorten the crisis period to 16 July 2007 – 5 October 2008, corporate bond spread changes have a positive and significant impact on CDS spread changes of AA- and A-rated banks.

Fourth, the stock market return ($R_{m,t}$) and the stock market volatility ($\Delta volimp_t$) are usually insignificant across regressions.

Interestingly, the R-squared decomposition in Table 5 shows that, while 70 p.c. of the explained variation in CDS spread changes of A- and AA-rated banks was related to variables proxying for general economic conditions in the pre-crisis period, this proportion fell to 30 p.c. for A-rated banks while remaining constant for AA-rated banks in the crisis period. This result is consistent with a well-established finding in the credit risk literature, namely that more highly-rated firms tend to be more sensitive to general economic variables than lower-rated firms, which are in turn more sensitive to idiosyncratic factors (Düllmann and Sosinska, 2007).

Finally, looking at Table 4, we see that the adjusted R-squared of the regressions estimated over the whole sample period is between 25 and 40 p.c., which is similar to what other studies on non-financial sector CDS spreads have reported. However, we observe that there is a substantial difference between the adjusted R-squared of the pre-crisis and crisis periods. This last result highlights once again the strong increase in significance of some of our explanatory variables after the start of the crisis.

Conclusion

In recent years, market participants and regulators alike have begun to look to bank credit default swap spreads as indicators of bank credit risk. However, like bond spreads, CDS spreads may also reflect other factors, including a liquidity premium, systematic credit risk or risk aversion. This article presents an empirical analysis of the determinants of euro area bank CDS spread changes before and after the start of the financial crisis. In analysing changes in CDS premia, we use variables suggested by structural credit risk models as well as an indicator of liquidity in the CDS market and several variables proxying for general economic conditions.

A first result is that the determinants of bank CDS spreads are highly time-varying. This finding, which echoes similar results in studies for bond spreads, calls for some caution regarding the use of models which attempt to explain bank CDS spreads. These models must be re-estimated frequently.

A second finding is that variables suggested by structural credit risk models are insignificant, both before and after the start of the crisis, in explaining bank CDS spread changes. In addition, some of the variables proxying for general economic conditions are significant, but the magnitude of the coefficient estimates and their sign changed when the crisis started. These findings suggest that financial institutions' CDS spreads should be examined together with other market indicators (e.g. Expected Default Frequencies, equity prices, etc.).

Finally, CDS market liquidity appears to have become a significant factor in explaining European bank CDS spread changes when the crisis broke out. This finding suggests that the role of CDS market liquidity should be estimated explicitly when analysing CDS spreads. Most existing studies still treat liquidity as being part of the regression residual.

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