The Determinants of Bank CDS spreads:

Evidence from the financial crisis

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Abstract

Based on a sample of mid-tier and top-tier internationally active banks with five-year senior CDS, this paper investigates the determinants of CDS spreads and whether CDS spreads can be considered a good proxy of bank performance. The analysis encompasses three time periods: a pre-crisis period (1 January 2005 - 30 June 2007); a crisis period (1 July 2007 - 31 March 2009) and a post-crisis period (1 April 2009 – 30 June 2011) and focuses exclusively on bank specific balance sheet ratios. The results of the empirical analysis indicate that bank CDS spreads, both in the pre-crisis period, but expecially in the crisis period, reflect the risk captured by bank balance sheet ratios. We find that the determinants of bank CDS spreads vary strongly across time, as economic and financial conditions vary. TIER 1 ratio and leverage appear insignificant in all of the three periods considered, while liquidity indicators become significant only during the crisis and post crisis period.

Keywords: credit default swaps (CDS) spreads; financial crisis; bank risk; balance sheet ratios

JEL Classification: G01; G21

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1. Introduction

Banks have played a crucial role in the making and spread of the recent financial crisis. Indeed, at the most critical moment of the crisis, the key player was none other than a bank, Lehman Brothers, whose default sparked the most acute phase, and had a number of immediate repercussions on the whole system.[1] The demise of the American investment bank is considered an important event not only because it was responsible for a sudden collapse in global business confidence – it was the first time that a major bank was allowed to fail - but also because it marked a watershed in the history of credit default swaps (CDS). The bankruptcy of Lehman Brothers in September 2008 and, shortly afterwards, the near downfall of the insurance conglomerate American International Group (AIG), both of which were involved in the CDS sector, polarised attention towards the CDS activities of the major international banks.

CDS, the most widespread form of credit derivative, have been, according to some, responsible for exacerbating the effects of the recent financial crisis (Dickinson, 2008; Stulz, 2009; Kress, 2010). CDS were originally created in the 1990s by JP Morgan, and consist of an agreement between two parties, the so-called protection buyer and protection seller. The protection seller undertakes, in exchange for a premium paid by the protection buyer, to pay out if a specific credit event[2] occurs, typically the default of a third debtor, the so-called reference entity. CDS are thus contracts that make it possible to isolate and transfer credit risk (Ashraf *et al.*, 2007, Jarrow, 2011). Owing to these constituent features, CDS spreads have become increasingly popular as a simple, direct indicator of a firm's credit risk, especially during the financial crisis.[3] As pointed out by Hart and Zingales (2010), a CDS can be seen as a bet on an institution's strength and therefore its price or spread reflects the probability that the debt will not be repaid in full. Put simply, the CDS spread can be seen as an indication of the risk the bank will fail. When banks' risk increase, one would expect CDS spreads to increase thus providing direct market discipline and influence bank risk

taking behaviour (and/or trigger regulatory action). However, in practice the functioning of this market discipline mechanism is not clear cut and depends both on the financial system institutional structure (for example, the design of the safety net, the strength of property rights, the incentives to information disclosure) and on investors' behaviour and macroeconomic conditions. Balasubramnian and Cyree (2011) document that the yields spreads on bank-issued subordinated notes and debentures (SNDs) are sensitive to bank risk, but the presence of implicit guarantees such as the too-big-to-fail policy, may reduce the levels to which they reflect bank-specific risks. A number of studies seem to indicate that, because of its inherent characteristics, the CDS market is more efficient than the bond market in pricing credit risk and in anticipating rating changes (Zhu, 2004; Di Cesare and Guazzarotti, 2010). Nonetheless, the recent financial crisis cast doubt on the effectiveness of CDS spreads as an indicator of risk, as it became evident that the dramatic increases in CDS spreads could not be fully explained by increases in banks credit risk. During the period 1 July 2007 to 31 March 2009 CDS spread values grew considerably and displayed record peaks (see Figure 1) that can only be explained taking into account the overall market situation.

As pointed out by Annaert *et al*. (2010), CDS spread changes that are driven by the increased credit risk of individual financial institutions should signal to regulators that they need to pay closer attention to the institution's financial health. On the other hand, when CDS spread changes are not related to fundamentals (as during the crisis period), the market's ability to correctly price for risk becomes questionable.

This paper aims to build upon this recent strand of the literature (Eichengreen *et al.*, 2009; Huang *et al.*, 2009; Raunig and Scheicher, 2009; Annaert *et al.*, 2010; Constantinos, 2010; Demirgüç-Kunt and Huizinga, 2010; Hart and Zingales, 2010; and Norden and Weber, 2010) by investigating the determinants of CDS spreads to understand whether CDS spreads can be considered a good proxy

for bank risk. In particular, we estimate the relationship between bank balance sheet ratios and bank CDS spreads both in the pre-crisis period, in the crisis and post-crisis period.

This paper makes three contributions to the related literature. Firstly, this study is one of few concerned exclusively with bank CDS spreads at an international level: most other studies examine a mix of industrial and financial firms.[4] A number of reasons led to the decision to consider only CDSs spreads in the banking sector. Very little is known about what actually drives credit spreads in general and bank CDS spreads in particular (Annaert *et al.*, 2010). Moreover, variables that are found to affect credit spreads of non-financial companies often lose their explanatory power when applied to financials (e.g. Boss and Scheicher, 2005; Raunig and Scheicher, 2008).

Our second contribution relates to the analysis of the determinants of CDS spreads; we chose to concentrate only on bank balance sheet ratios, rather than considering both market-specific and firm-specific factors; with the sole exception of leverage. To the best of our knowledge, no study in the related literature has used specifically balance sheet variables to explain variation in CDS spreads. Most empirical papers (see for example Collin-Dufresne *et al.,* 2001; Bystrom, 2005; Zhang *et al.*, 2005; Das *et al.*, 2006; Duffie *et al.*, 2007; Das *et al.*, 2008) investigating the explanatory power of credit risk variables for bond and CDS include in the model several variables to proxy for business conditions, market conditions and/or uncertainty (term structure of interest rates, market return, market volatility, etc.). We are conscious of the influence market variables have on CDS spreads, however in this paper, because of the time period considered, we decided to focus only on the correlation between balance sheet ratios and CDS spreads. In periods of financial stress, market data fluctuate wildly, therefore biasing the relationship with accounting variables. Moreover, changes in market data during a crisis period do not necessarily reflect the changes in credit risk but may be driven by investors' panic and lack of trust. Finally, this paper is one of the first contributions on bank CDS spreads that also takes into account the post-crisis period.

The results of the empirical analysis can be summarised as follows. Firstly, bank CDS spreads reflect the risk captured by bank balance sheet ratios. Hence bank CDS spreads are a good proxy of bank risk. Secondly, the relationship between bank CDS spreads and balance sheet ratios becomes stronger during the crisis and post-crisis period. Thirdly, bank CDS spreads seems to be influenced by different variables in the pre-crisis and crisis period. Fourthly, variables that a priory would be considered as determinants of CDSs spread, the TIER 1 Ratio and the Leverage, appear insignificant in all of the periods considered. Finally, as expected, the bank CDS market in the pre-crisis period showed little interest in any of the liquidity indices considered.

The remainder of the paper is organised as follows. Section 2 presents a review of the relevant literature. Sections 3 and 4 discuss data and empirical methodology respectively. Sections 5 and 6 present empirical results and robustness tests. Finally, Section 7 summarises the major findings and concludes the paper.

2. Literature review

Research on CDS spreads is still limited, mostly because the credit derivatives market in general and the CDS market in particular has only gained a substantial size since the early 2000s.[5]

The CDS literature is composed of two groups of studies, one focussing on the pricing characteristics of CDS spreads, and the other investigating the determinants of CDS spreads and their variation.

To the first group belong the empirical analyses that demonstrate the price leadership of CDS spreads over corporate bond spreads in measuring firm-specific credit risk. Various reasons underlie this claim. Hull *et al.* (2004), Das and Hanouna (2006), Zhu (2006) and Ericsson *et al.* (2009) point out that CDS contracts are quoted directly in term of spreads[6], while bond spreads require a number of complicating assumptions and calculations, for example, the specification of a benchmark risk

free yield curve before credit spreads can be calculated. Blanco *et al.* (2005), Zhu (2006), Alexopoulou *et al.* (2009), and Norden and Weber (2009) show that the CDS market leads the corporate bond market in terms of price discovery. Volz and Wedow (2010), Constantinos (2010), Flannery (2010), Norden and Weber (2010) find that CDS markets convey information on banks' default risk that is suited to play an important role in enhancing market discipline. In particular, they believe that the CDS market is of particular importance for banking supervisors.

The second group comprises the empirical analyses that investigate the determinants of CDS spreads. The credit risk literature identifies two different approaches: the structural approach and the reduced form approach.

The structural models, derived from the option pricing model originally developed by Black and Scholes (1973), are based on firms' structural variables, in other words firm-specific (i.e. rating, leverage, market capitalisation, asset volatility, stock price changes, etc.) and market-specific factors (i.e. term structure of interest rates, market return, market volatility, etc.), and consider default a function of endogenous elements. The first author to apply the option pricing model to insolvency was Merton (1974), who based his formulation on the assumption that insolvency arises solely and exclusively if at bond maturity date a firm's assets are worth less its liabilities. Subsequently, a number of generalizations on Merton's model were proposed, the first by Black and Cox (1976) (cf. also Longstaff and Schwartz, 1995; Anderson and Sundaresan, 1996; Anderson *et al.*, 1996; Mella-Barral, 1997; and Zhou, 2001). These considered the possibility of default prior to bond maturity if the value of the firm's assets fell below a certain level, the threshold or default boundary.

The reduced form models emerged in the second half of the 1990s thanks to contributions from a number of scholars (the most significant were Lando, 1994, 1998; Jarrow and Turnbull, 1995; Madan and Unal, 1995; Jarrow *et al.*, 1997; Duffie and Singleton, 1999; and more recently Hull and

White, 2000, 2001). Reduced form models are a recent approach to credit risk, and treat default as a sudden surprise, a totally exogenous event that is unrelated to the firm's balance sheet. The reason for default is not specified.

The structural models have been widely preferred to the reduced form models by practitioners in the field of credit risk, because the reduced form approach has been criticised on the grounds of the weak economic rationale for the occurrence of a default event (Alexopoulou *et al.*, 2009).

There is a substantial literature that builds on the structural models to analyse movements in CDS spreads.[7] Among the studies focusing on the structural models' theoretical determinants of CDS spreads are Aunon-Nerin *et al.* (2002), Benkert (2004), Zhang *et al.* (2005) and Abid and Naifar (2006). Recent empirical studies on the determinants of CDS spreads include, among others, Annaert *et al*. (2010), Eichngreen *et al*. (2009), Ericsson *et al.* (2009) and Di Cesare and Guazzarotti (2010). More recently, alongside the two groups of studies on CDS spreads mentioned above, a new current of research has emerged that examines the relationship between CDS spreads and rating announcements (Daniels and Shin Jensen, 2004; Hull *et al.*, 2004; Norden and Weber, 2004; Blanco *et al.*, 2005; and Lehnert and Neske, 2006). Previously, research had analysed the impact of credit rating announcements on stock prices, bond prices or both.

Loosely following the strand of literature on structural models, this paper investigates the determinants of bank CDS spreads, building upon the works of Annaert *et al.* (2010), Boss and Scheicher (2005), Raunig and Scheicher (2008), among others.

3. Data Sample and Descriptive Statistics

3.1 Data description

The study considers only mid-tier and top-tier international banking groups (by total assets) with five-year senior CDS spreads. The decision to focus on CDS spreads in the banking sector had a

decisive impact on sample size, given that only a limited number of banks are involved in CDS activities, and in credit derivatives in general. Indeed this type of business is highly concentrated among a restricted number of big banks.[8] There are overall 89 international banks with senior CDS spreads at 5 years. In addition, the decision to use quarterly balance sheet data rather than annual data reduced the sample as not all banks with CDS contracts report financial data on a quarterly basis. For these reasons, the final sample is thus composed of 57 international banks, 43 of which European, 7 are US, 4 are Australian and 3 Japanese banks. See Table A in the appendix for details on the final sample.

The overall time horizon comprises the period from 1 January 2005, the year in which International Accounting Standards (IAS/IFRS) became mandatory for the preparation of consolidated financial statements of European banks, to 30 June 2011, the last data available at the time of this study. This time period is then divided into three sub-period. The first sub-period is the pre-crisis period (from 1 January 2005 through 30 June 2007). This time was typified by very moderate CDS spreads. It is widely accepted that the outbreak of the sub-prime crisis occurred in July 2007. Therefore, we specify our second sub-period, the crisis period (from 1 July 2007 to 31 March 2009). During this time, CDS spread values grew considerably and displayed record peaks. We decided to end the crisis period at March 2009, as in subsequent months bank CDS spreads (and notably peak values), levelled off at values below those seen previously (see Figure 1) but higher than pre-crisis period values (European Central Bank, 2009b; Bank for International Settlements, 2010). Finally, our third period encompasses the less acute phase of the crisis (or post crisis period) and covers the most immediate aftermath of the crisis to date (from 1 April 2009 to 30 June 211). This period thus examines the beginning of the recovery phase, when bank CDS spreads began gradually to decrease.

[Insert Figure 1]

3.2 Dependent variable

This paper uses as dependent variable five-year senior CDS spreads in the banking sector. CDS spreads were chosen since they are widely considered an excellent indicator of markets' perception of a firm's default risk. The chosen data category, collected from Datastream, is 'CDS Premium Mid', which corresponds to the average of 'CDS premium bid' and 'CDS premium offered', and shows the mid rate spread between the entity and the relevant benchmark curve. The rate is expressed in basis points (bp). This study uses five-year quotes in so far as this is the benchmark maturity in the CDS market. Senior CDS spreads were used since senior offers better data coverage than subordinated. Quarterly CDS spreads were used, a choice strictly related to the type of explanatory variables considered (balance sheet variables). The daily frequency of CDS spreads was adjusted to that of the explanatory variables.

Table A in the appendix presents descriptive statistics of senior 5 year CDS spreads for the 57 banks comprsing our sample in the pre-crisis period (1 January 2005 - 30 June 2007), for the crisis period (1 July 2007 - 31 March 2009) and for the post crisis period (1 April 2009 - 30 June 2011).

Prior to the recent financial crisis, the CDS spreads of sample banks, regardless of geographical area, were moderate and fairly homogeneous. In particular, average CDS spread values ranged from 6.21 bp (Rabobank) to 68.13 bp (Banque Federale des Banques). The standard deviation of CDS spreads of the banks in the study were all below average values. Furthermore, the majority of sample banks recorded very similar minimum values, ranging from 1 to 12 bp. The same is true of peak values that ranged between 20 and 40 bp on average.

Conversely, clear differences between geographical areas emerge from analysis of CDS spreads in the second period. During the crisis, though all sample bank CDS spreads showed a tendency to

grow, in geographical terms such growth was heterogeneous. The Anglo-Saxon countries were worst hit by the financial crisis: first and foremost the US, followed by Ireland and the UK, due principally to the prevalence of the Originate to Distribute (OTD) banking model, but also to excessive financial leverage. Average CDS spread values, but in particular exceptionally high peak values, well in excess of average sample bank values, were recorded by US banks: Washington Mutual Inc. (maximum: 6,235 bp), National City Corporation (maximum: 2,969), Wachovia Corporation (maximum: 1,560 bp); by Irish banks: Anglo Irish Bank Corporation (maximum: 950 bp), Bank of Ireland (maximum: 670 bp), Allied Irish Banks (maximum: 646 bp); and by UK banks: Bradford & Bingley (maximum: 1,591 bp), HBOS PLC (maximum: 500 bp), and Alliance & Leicester (maximum: 471 bp). All were thrown into crisis due to massive losses on structured financial products and, with the exception of Washington Mutual Inc., were bailed out though take-overs by other more solid banks, governments bailouts (nationalisation or recapitalisation), or cash injections from their respective central banks.

The remaining sample banks recorded more moderate average and peak CDS spread values that were nevertheless above average values in the preceding period, evidence of a reasonable ability to withstand the difficulties that overwhelmed the Anglo-Saxon banks. The sole exceptions were the Spanish banks Caja De Ahorros De Valencia Castellon Y Alicante Bancaja (maximum: 1,148 bp) and Caja de Madrid (maximum: 750 bp), the Belgian banks Fortis (maximum: 666 bp) and Dexia SA (maximum: 550 bp), and the Austrian bank Erste Group Bank AG (maximum: 487 bp).

During the crisis the standard deviations of CDS spreads were below average values; in certain cases standard deviations equalled zero when banks formally had a CDS contract but traded very little. This was the case of the French Banque Federale Des Banques, and, in the pre-crisis period, the Spanish Banco de Sabadell SA.

Finally, in the post crisis period (1 April 2009 - 30 June 2011), Table A shows that just under half of sample banks recorded lower average CDS spread values than during the crisis period. Nevertheless, almost all peak values were lower, with the exception of most of Portuguese, Spanish, Irish and Italian banks. In the post crisis period, bank CDS spreads of these countries, due to national debt crisis, grew again despite not to levels reached in the previous acute phase of the crisis.[9] Minimum values were higher than the previous period. The standard deviations of sample bank CDS spreads were almost all below average values.

3.3 Explanatory variables

This study uses as explanatory variables eight balance sheet ratios, in order of analysis profile pre-calculated by Bloomberg on the Global format. Quarterly data was selected rather than annual data to make available a higher number of observations for analysis.

The eight balance sheet ratios by management area and their hypotesed relationship (irrespective of the time horizon considered) with the dependent variable are outlined below and summarised in Table 1.

Asset quality

Loan Loss Reserve/Gross Loans (%), qa1.

This ratio expresses the percentage value of total credits appropriated to the depreciation fund. It is a reserve for losses expressed as percentage of total loans. The higher the ratio, the lower the quality of the loan portfolio. Hence, an increase in qa1 should lead to an increase CDS spreads.

Unreserved Impaired Loans/Equity (%), qa2.

This ratio is also known as the 'capital impairment ratio'. An increase in the ratio should signal a greater probability of default. As such, a positive relationship between change in qa2 and change in CDS spreads is hypothesised.

Capital

TIER 1 Ratio[10] *(%),* pat1.

This ratio measures the capital adequacy of a bank. In particular, TIER 1 capital ratio measures the ability of the bank to absorb losses. The higher the ratio, the higher the risk buffer and the lower should be the CDS spreads. Hence, a negative sign is expected.

Leverage: Equity/Total Assets (%), pat2.

There are different definitions of leverage - balance sheet, economic, and embedded - and no single measure can capture all dimensions simultaneously. The first definition is based on balance sheet concepts, the second on market-dependent future cash flows, and the third on market risk. Balance sheet leverage is the most visible and widely recognised form and it is one adopted in this study. The leverage ratio, defined as Equity/Total Assets, reflects the level of indebtedness of a firm. One would expect that as equity diminishes, with constant total assets, the proportion of debts to total assets should increase, as should the level of indebtedness and hence the risk of default. A negative sign is therefore expected between Leverage and CDS spreads.

With the choice of these two variables, we are close to Almer *et al.* (2008) who investigated the determinants of short-and long-term bank CDS spreads using cross-sectional regressions; the authors also used as explanatory variables the following: 'Insolvency Factors': Loan Loss Reserve (%), Loan Loss Provision (%), % of Problem Loans, Pre-Tax-Profit (%) and Long-term Rating.

Furthermore, leverage is the only explanatory variable used in this paper that is also present in Merton's model.

Operations

ROA (Return On average Assets) (%), op1.

This ratio is an indicator of the return on a firm's investments. The sign linking ROA to CDS spreads is uncertain, as the market may interpret the relationship between these variables either negatively or positively. In particular, a bank that undertakes numerous investments (low ROA) may be perceived by the market as being very risky. In this case, low ROA values would correspond to high CDS spreads. On the other hand, the market may react positively if it assumed that high levels of investment are capable of creating positive income and future cash flows. In this case moderate ROA values would correspond to low CDS spreads.

Further, a negative relationship between ROA and CDS may be due to a decrease (or an increase) in operating income at the same level of investment. In such case, a decrease (increase) in ROA would correspond to an increase (decrease) in CDS spreads.

ROE (Return On average Equity) (%), op2.

This ratio is an index of the return on own equity. The higher ratio, the lower the perceived default risk. Hence, a negative sign is expected.

Liquidity[11]

Net Loans/Deposits & Short Term Funding (%), liq1.

The loan-to-deposit ratio is a measure of liquidity. The relationship linking this index to CDS spreads is uncertain. The relationship can be interpreted positively when banks with fewer deposits,

and hence lower liquidity, are not perceived positively by the market. An increase in liq1 should therefore correspond to growth in CDS spreads. On the other hand, the relationship can be interpreted negatively when a high level of loans, for the same level of deposits, is perceived by the market as a positive signal, since sample banks are commercial banks and loans represent their core business. Growth in liq1 should therefore correspond to a decrease in CDS spreads.

Liquid Assets/Deposits & Short Term Funding (%), liq2.

A further measure of liquidity is the ratio of Liquid Assets to Deposits and Short Term Funding. The higher this percentage, the more liquid the bank and the less vulnerable to a classic run. Hence, a negative sign is expected. An increase in liq2 should decrease CDS spreads. Similarly, Almer *et al.* (2008) considered as 'Illiquidity Factors' also the ratio of Total Money Market Funding to Total Liabilities (the so-called % of Wholesale Funding).

[Insert Table 1]

Table 2 reports descriptive statistics relating to the eight balance sheet variables of the sample banks for the pre-crisis period (1 January 2005 - 30 June 2007), the crisis period (1 July 2007 - 31 March 2009) and the post crisis period (1 April 2009 - 30 June 2011).

Unlike CDS spreads, the values of balance sheet variables did not change significantly from the pre-crisis period to the crisis period. The only exception is the average value of qa2. Furthermore, most sample banks recorded homogeneous values for almost all variables in all periods, with the exception of the banks that incurred vast losses during the crisis and/or were bailed out by government intervention (principally the UK, Irish and US banks).

In particular, the average value of qa1 remained substantially unchanged, from the pre-crisis period to the crisis period for almost all banks in the study. Conversely, the other indicator of asset quality, qa2, fell considerably, probably due to the numerous capital increases carried out by the banks in difficulty during the crisis. The average qa2 value of the sample banks decreased from 137 per cent in the pre-crisis period to 28 per cent during the crisis. This fall was principally attributable to two banks, Banco Espirito Santo and Credit Suisse, both of which recorded a significant fall in this index. Conversely, other sample banks – principally the UK, Irish and US banks – recorded strong growth in qa2 during the crisis. Such growth was the result of deterioration in the quality of capital, and affected the Belgian banks Dexia and KBC Groep NV, the Austrian Raiffeisen International Bank Holding, the Swedish Swedbank AB and the Japanese Mizuho Financial Group.

The variables relating to the banks' financial structure, pat1 and pat2, remained substantially unchanged from the pre-crisis period to the crisis period. Overall, the majority of sample banks, despite being adversely affected by the crisis, exhibited a capital coefficient (pat1) well above the minimum regulatory threshold both before and during the crisis. The average value of pat2 declined from 5.3 per cent in the pre-crisis period to 5.1 per cent during the crisis. However, while the ratio of Equity to Total Assets remained substantially unchanged during the crisis for the majority of UK banks, it showed a tendency to increase for large European banks, but above all for US commercial banks. Overall, at a global level, the financial leverage of the sample banks remained high.

The profitability indices, op1 and op2, both declined, but at different rates. In particular, the average op1 value of sample banks fell by three percentage points, while average op2 values halved from 18 per cent to 4 per cent. During the crisis, negative average ROA and ROE values were recorded principally by UK, Irish and US banks.

The two liquidity indices considered, liq1 and liq2, show fairly similar average values between the pre-crisis period and the crisis period. In particular, the former ratio decreased slightly from 82 per cent to 80 per cent, while the latter decreased slightly from 48 per cent to 46 per cent.

The last panel of Table 2 highlights how in the post crisis period the average value of all eight balance sheet variables remained substantially unchanged with respect to the previous period. The exceptions were qa1, op1 and op2. In particular, in the post crisis period the average value of qa1 showed a tendency to grow (from 1.6 per cent to 2.5 per cent) principally due to an increase in devaluation of loans. The average value of the two income ratios continued to fall in the post crisis period, principally due to a significant deterioration in the asset quality of most sample banks. From the crisis period to the post crisis period, op1 declined from 0.5 per cent to 0.1 per cent, while op2 fell from 4 per cent to 1.8 per cent. Finally, the average value of the two liquidity indices increased in the post crisis period: liq1 increased from 80 per cent to 87 per cent, principally thanks to a moderate recovery, while liq2 grew from 46 per cent to 48 per cent.

[Insert Table 2]

Time-series graphs were plotted to show the relationship between average bank CDS spreads and each explanatory variable. Furthermore, correlation coefficients were calculated between balance sheet variables and CDS spreads. Figure A in the appendix shows the time series graphs of average CDS spreads versus the eight balance sheet variables for the pre-crisis period (January 2005 - June 2007) and the crisis period (July 2007 - March 2009).[12] The panels in Figure A show a clear reversal in the CDS trend and in that of the majority of explanatory variables at the start of the third quarter of 2007, the time of the outbreak of the financial crisis. Furthermore, for most graphs, the relationships observed in Figure A are readily interpreted principally during the crisis period.

During this period, the signs predicted in Table 1 were largely confirmed (with the exception of pat1). Panel A shows the relationship between average CDS spreads and average qa1 values while Panel B presents the relationship between average CDS spreads and average qa2 values. As predicted, the time series of average CDS spreads versus average qa1 values, in the period between July 2007 and March 2009, showed the positive trend expected. Conversely, the relationship between average CDS spreads and average qa2 values showed a negative sign rather than the positive one expected.

Panel C presents the time-series of average CDS spreads versus average pat1 values. The relationship is positive in the crisis period, contrary to what was expected. CDS spreads thus tended to increase, rather than to decrease, with growth in pat1.

Panel D presents the time-series of average CDS spreads versus average of pat2 values. In this case, during the crisis period, the expected sign (negative) was respected. As equity decreased, with total assets held constant, the incidence of debts on total assets increased, as did the level of indebtedness and consequently the risk of default. Panel D illustrates that sample banks displayed high levels of leverage, not only in the crisis period but also in the pre-crisis period, when bank CDS spreads remained low. This implies that until the onset of the crisis, markets were not concerned by the very high leverage of banks. Only at the outbreak of the crisis (July 2007) did CDS spread values begin to rise significantly. Hence the outbreak of crisis was one of factors responsible for growth in bank CDS spreads, and not excessive leverage itself, although excessive bank leverage is considered one of the determinants of the crisis. In other words, contrary to what was expected, Leverage was not among the key determinants of bank CDS spreads.

This result seem to contradict those of the structural models' approach in general and the recent conclusions of Di Cesare e Guazzarotti (2010) in particular, who find that leverage remains one of the most significant variables in explaining CDSs spreads for US non-financial firms even during

the crisis period. However, it is important to recall that leverage of a bank is fundamentally a different variable from a firm's leverage. Indeed, prior to the crisis, quantitative limits on bank leverage were rare and only post-crisis there are talks of introducing bank leverage limits as an additional prudential tool to complement minimum capital adequacy requirements. Our study underlines the difference between the financial and non-financial sector CDSs and casts doubts on the predicitive value of models and combine both financial and non-financial firms. This outcome confirms the findings of Annaert *et al.* (2010), according to which variables that are found to affect credit spreads of non-financial companies often lose their explanatory power when applied to financials.

Panel E shows the relationship between average CDS spreads and average op1 values while Panel F shows the relationship between average CDS spreads and average of op2 values. Panel E highlights a clearly negative relationship during the crisis. Hence the market gives a negative interpretation to low ROA in times of crisis. Panel F also shows a negative relationship: moderate ROE values increase the perceived probability of default.

Panel G presents the time-series of average CDS spreads versus average of liq1 values and highlights a negative relationship during the crisis, particularly from 2008 onwards. The market thus interprets positively a high level of loan activity in times of crisis. Panel H presents the time-series of average CDS spreads versus average liq2 values. In this case also the expected sign (negative) is respected.

Table 3 shows the correlations between each explanatory balance sheet variable and CDS spreads, both for the pre-crisis period (January 2005 - June 2007) and for the crisis period (July 2007 - March 2009). Since results for the post crisis period are not significantly different from the crisis period, these are not reported.

Table 3 shows a reversal in the trend of CDS spreads and the majority of explanatory variables (6 variables out of 8) at the start of the third quarter 2007, with the outbreak of the financial crisis. Furthermore, Table 3 highlights how the expected signs (illustrated in Table 1) are principally respected during the crisis. The sole exception is the sign of the TIER 1 Ratio (qa1), which differs from that expected during the crisis period.[13]

[Insert Table 3]

4. Empirical Methodology

To determine whether balance sheet data explains bank CDS spreads, we follow a panel data regression. Indeed, as our sample includes banks having both sufficient valid CDS spreads and quarterly accounting data (recall that the sample includes only mid-tier and top-tier international banking groups with five-year senior CDS spreads) it is not a random sample and it is possible to assume that our results could not be generalised to all banks.

In particular, we specify the following generic model:

$$CDS_{it} = \alpha + \beta(BankBSratios)_{it} + d_{crisis} + \varepsilon_{it} \quad (1)$$

where *i* is the subscript identifying the bank and *t* indicates the time period (the quarter in progress). In this model we introduce only time-varying bank-specific explanatory variables (balance sheet ratios: *BankBSratios*) but not time-varying market-wide explanatory variables. d_{crisis} is the dummy variable that identifies the outbreak of the recent financial crisis (1 July 2007) and ε_{it} is the error.

In the first instance, the regressions were conducted covering the entire time horizon (1 January 2005 - 30 June 2011); a first regression including only the eight balance sheet variables; a second one including the eight variables plus the dummy crisis (from 1 July 2007).

Subsequently, to determine whether the relationship between bank CDS spreads and balance sheet data changes with varying macroeconomic and financial conditions, three further panel regressions were performed: one on the period preceding the crisis (1 January 2005 - 30 June 2007), one the crisis period (1 July 2007 - 31 March 2009) and a last one on the post crisis period (1 April 2009 - 30 June 2011).[14]

In all the regressions, levels rather than differences were used, for both dependent and explanatory variables. Note that the goal of this paper is not to predict but to explain credit spreads, hence, we use contemporaneous dependent and explanatory variables.

5. Results

Table 4 reports the results of the first two panel regressions (without and with the dummy crisis), both conducted on the entire time horizon (1 January 2005 - 30 June 2011). For both regressions the final sample consisted of 1256 observations for 57 banks. Table 4 indicates that the balance sheet variables explain nearly 64 per cent of bank CDS spreads (Adjusted R-squared value); and that the balance sheet indices and the dummy crisis together explain 67 per cent of bank CDS spreads (Adjusted R-squared). From the first panel regression it emerges that, with the exception of liq1, all the explanatory variables are significant and have the expected sign (with two exceptions: qa2 is negative rather than positive, and pat1 is positive rather than negative).

In the case of qa2, Panel B in Figure A shows how the relationship between this variable and bank CDS spreads was inversely proportionate during both the pre-crisis and the crisis periods. In particular, Panel B highlights how, in the pre-crisis period, high qa2 values corresponded to very low CDS spreads. This implies that in the pre-crisis period, the market was not concerned with the poor quality of bank loan portfolios. Moreover, Panel B shows that in the crisis period, a fall in qa2 resulted in a rise rather than a fall in bank CDS spreads. The abrupt decrease in this relationship is

most probably attributable to the numerous capital increases carried out by many banks in difficulty during the crisis. Evidently, recapitalisation, particularly through injection of government funds, was perceived negatively by the market, as a sign of crisis in the banking sector. This may have contributed to the increase in bank CDS spreads. For an explanation of the reasons for the unexpected sign of pat1, see the discussion of the crisis period regression panel below.

From the second regression panel it emerges that the dummy crisis is significant and therefore indicates that the crisis was a relevant event in the relationship between bank CDS spreads and balance sheet data, as expected.

To understand whether the relationship between bank CDS spreads and balance sheet data changes with varying macroeconomic conditions, two further panel regressions were conducted, one on the sub-period1 January 2005 - 30 June 2007, the other on the sub-period 1 July 2007 - 31 March 2009. The final sample consisted of 506 observations for 53 banks in the pre-crisis period and 354 observations for 55 banks in the crisis period (see Table 4).

Table 4 shows that the explanatory power of the balance sheet variables thus grew 5 per cent with the transition from the pre-crisis period to the crisis period (in terms of Adjusted R-squared). The lower explanatory power of the balance sheet ratios during the pre-crisis period is simply because bank CDS spreads were flat at that time. As bank CDS spreads grew, so did the explanatory power of the balance sheet variables. Overall, the Adjusted R-squared value well in excess of 50 per cent in both periods demonstrates how bank CDS spreads in the pre-crisis period, but above all in the crisis period, reflect a great deal of the risk expressed by the balance sheet variables. These results confirm those reported by Annaert *et al.* (2010), which suggest that the variables used by structural credit risk models are not significant in explaining bank CDS spread changes in the period prior to the crisis.

In the period preceding the crisis qa1 and op1 are the only significant variables and the sign respect those predicted. The results in Table 4 shows a positive relationship between qa1 and bank CDS spreads. In terms of the relationship between op1 and CDS spreads, in the pre-crisis period the relationship was positive. Hence in the pre-crisis period, a decrease in op1 brought about a decrease rather than an increase in bank CDS spreads: evidently, the market associated the fall in ROA with a high level of investment capable of generating positive cash and income flows in future.

It also emerges that, as expected, in the pre-crisis period the bank CDS market did not pay attention to any liquidity index. The liquidity crisis (in terms of both market liquidity risk and funding risk) was the last manifestation of the recent financial crisis. This outcome confirms the findings of the study by Almer *et al.* (2008), according to which 'Liquid Factors' did not have a significant impact on bank CDS spreads in the pre-crisis period.

In the crisis period, on the other hand, the number of significant explanatory variables increased with respect to the previous period This indicates that the CDS market probably pays greater attention to balance sheet indices particularly in periods of financial stress. However, only one of the explanatory variables that were significant during the crisis was significant also during the pre-crisis period: qa1. This implies that the type of variables to which the market pays attention tends to vary as economic and financial conditions vary. This is in line with the finding of Annaert *et al.* (2010) who finds that the determinants of bank CDS spreads vary strongly across time. This finding also confirms similar results in studies for bond spreads and indicates that models which attempt to explain changes in bank CDS spreads must be re-estimated as macroeconomic conditions change in order to give the "right" information to regulators and policy makers. The variables which were significant during the crisis are qa1, pat1, op2 and liq1. Conversely, op1 lost significance during the crisis period. In particular, as predicted, we find a positive relationship between qa1 and bank CDS spreads and a negative relationship between op2 and bank CDS spreads.

An analysis of the signs of two of the four significant variables reveals that the probability of default tends to increase principally for banks that in recent years had a poor quality loan portfolio, and/or lower returns on equity. This outcome confirms the findings of the study by Calice and Iannidis (2009), according to which Large Complex Financial Institutions (LCFIs) with large exposure to problems assets tend to be adeversely affected by the widening of credit spreads.

Our results also show that during the crisis period, the relationship between liq1 and CDS spreads was negative. During the crisis period, the decrease of liq1 was due principally to a decrease in loans (the so-called credit crunch phenomena) and was accompanied by an increase of bank CDS spreads.

Pat1, a significant explanatory variable during the crisis, has a different sign from the one expected: positive rather than negative. Pat1 was also positive during the pre-crisis period, although not significant. This positive relationship implies that the growth in pat1 was accompanied, in both the pre-crisis and the crisis period, by an increase rather than a decrease in the perceived probability of bank default. As Panel C of Figure A indicates, the positive relationship between pat1 and CDS spreads is particularly evident in the crisis period. The positive (rather than negative) sign of pat1 in Table 4 suggests that the market, above all in the crisis period, lacked faith in this capital index. The banks in difficulty in the final period, with rapidly growing CDS spreads, had a TIER 1 Ratio well in excess of the minimum requirement and also above the average for their geographical area. What emerges is thus the limited efficacy of the capital index TIER 1 Ratio in safeguarding banks from the potential risk of default. This is confirmed, at least in part, by the Basel Committee December 2010 final document (Basel 3), that focuses, among other things, on improving the quality of regulatory capital. [15]

From the results presented Table 4 it is also evident that qa2 and liq2 are not significant variables either in the pre-crisis or in the crisis period.

Finally, to investigate whether the relationship between bank CDS spreads and balance sheet data changes in the post crisis period (1 April 2009 - 30 June 2011), a fifth panel regression was performed (see Table 4).

The final sample consisted of 396 observations for 47 banks. The results show that in the period that takes into account the less acute phase of the crisis (and the beginning of the recovery phase), the relationship between balance sheet variables and bank CDS spreads becomes stronger. In the post crisis period both liquidity ratios considered (liq 1 and liq2) are significant. This may reflect the increased attention paid by regulators to bank liquidity in the post crisis period. In December 2010 the Basel Committee announced the introduction of two new liquidity standars for banks: the Liquidity Coverage Ratio (LCR), rule of short term, and the Net Stable Funding Ration (NSFR), longer-term structural rule. [16]

[Insert Table 4]

6. Robustness Tests

As the main goal of this paper is not to predict but to explain credit spreads, in the empirical analysis we used contemporaneous dependent and explanatory variables. However, bank CDS spreads may precede balance sheet data or react to the publication of results. To test this hypothesis, a number of further regressions were carried out.

The first group of regressions considered bank CDS spreads at time t-1, the preceding quarter, and balance sheet data at time t, the quarter considered. The second group of panel regressions considered bank CDS spreads at time t+1, the quarter following, and balance sheet variables a time t. Both regressions with bank CDS spreads at time t-1 and those with bank CDS spreads at time t+1 were conducted on the overall period considered (1 January 200530 June 2011) and on all sub-periods. Table 5, however, presents the results of the three sub-periods only: the pre-crisis period (1

January 2005 - 30 June 2007), the crisis period (1 July 2007 - 31 March 2009) and the post crisis period (1 April 2009 - 30 June 2011).[17]

Comparison of the results of the panel regressions in Table 5 with those of the panel regressions of Table 4, which consider both bank CDS spreads and balance sheet variables at time t, reveals that bank CDS spreads did not react in advance to the crisis and required less than a three month lag to incorporate balance sheet information. The CDS market is thus an efficient market capable of reacting to information as it is made public. For this reason, it is correct to consider both bank CDS spreads and balance sheet variables at time t. The Adjusted R-squared values in Table 4 in all three time periods are higher than those obtained considering bank CDS spreads at time t+1. Moreover, in two of the three periods, the crisis period and the post crisis period, values are marginally higher even than those obtained considering bank CDS spreads at time t-1.

[Insert Table 5]

7. Conclusions

This paper investigates whether CDS spreads can be considered a good proxy for bank riskiness. Based on a sample of mid-tier to top-tier international banks with senior CDS spreads at 5 years, we analyse the relationship between bank CDS spreads and balance sheet variables relating to the quality of bank assets, capital, earning potential and liquidity. The analysis was conducted on the on the period 1 January 2005 – 30 June 2011. This was then subdivided into three sub-periods: the pre-crisis period (1 January 2005 - 30 June 2007); the crisis period (1 July 2007 - 31 March 2009) and the post crisis period (1 April 2009 - 30 June 2011).

Results indicate that bank CDS spreads in the pre-crisis period, but especially in the crisis and post crisis period, reflect the risk captured by balance sheet ratios. The lower explanatory power of the balance sheet indices in the pre-crisis period is mainly due to the fact that bank CDS spreads were relatively flat at that time. The crisis was a relevant event in the relationship between bank CDS

spreads and balance sheet data. As bank CDS spread grew, so did the explanatory power of the balance sheet variables. The relationship between bank CDS spreads and balance sheet ratios grew stronger during the crisis period, when a number of explanatory variables became significant. Furthermore, bank CDS spreads seem to be influenced by different variables in the pre-crisis and crisis period. This finding confirms similar results in studies for both bond and CDSs spreads and indicates that models which attempt to explain changes in bank CDS spreads must be re-estimated as macroeconomic conditions change in order to give the "right" information to regulators and policy makers. Our results also indicate that bank CDS spreads did not react in advance to the crisis and required less than a three month lag to incorporate the balance sheet information. The CDS market is thus an efficient market capable of reacting to information as it is made public. This cast doubts on the ability of CDS spreads to "predict" banks probability of default.

In terms of individual predictors, the ratio Loan Loss Reserve to Gross Loans is the only significant variable in all the three sub-periods considered. The probability of default is likely to increase principally for those banks with poor quality loan portfolios. Contrary to prior expectations, Leverage and the TIER 1 Ratio were not among the determinants of bank CDS spreads in any of the three sub-periods considered. What is more, the sample banks that ran into difficulty almost always had a TIER 1 Ratio well above the statutory minimum. Overall, doubts emerge in relation to the efficacy of the capital index TIER 1 Ratio as a safeguard against the risk of future default.

Finally, as expected, the bank CDS market in the pre-crisis period showed no interest in any of the liquidity indices considered. Only with the outbreak of the sub prime crisis liquidity indicators become significant and remained significant in the post-crisis period, possibly reflecting the increased attention paid by regulators to bank liquidity in the new Basle proposals.

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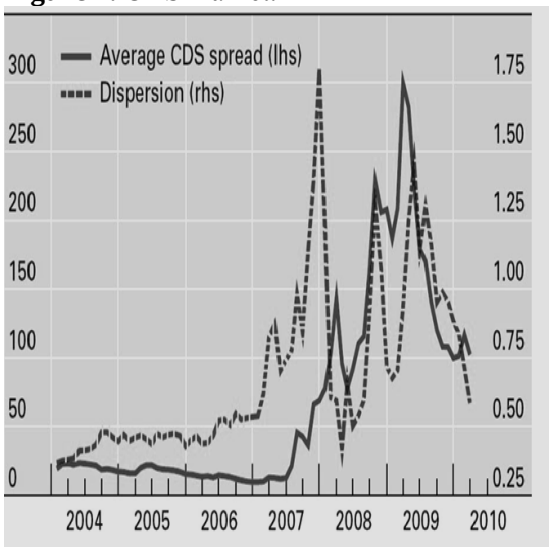
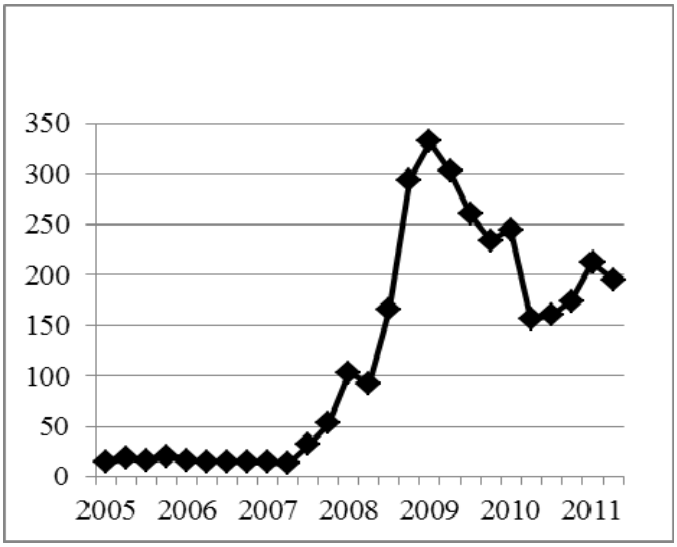
Tables and Figures

Figure 1. CDS market.





Notes: In the figure on the left, taken from the BIS Annual Report (2010), the CDS market is based on the CDS spreads of 34 large banks and 14 large insurance companies in Europe and North America. Average CDS spread (lhs) is in basis points. Dispersion (rhs) is the standard deviation of the cross section of CDS spreads, divided by the contemporaneous average.
The figure on the right show the trend of average CDS spread values for the 57 sample banks. Average values for bank CDS spreads are in basis points.
Source: Bank for International Settlements. 2010. *Annual Report*, Basel, June (for the figure on the left) and Datastream Database (for the figure on the right).

Table 1. Explanatory variables and predicted sign

Variable	Description	Predicted sign
Asset Quality		
qa1	Loan Loss Reserve/Gross Loans (%)	POSITIVE
qa2	Unreserved Impaired Loans/Equity (%)	POSITIVE
Capital		
pat1	TIER 1 Ratio (%)	NEGATIVE
pat2	Leverage: Equity/Total Assets (%)	NEGATIVE
Operations		
op1	ROA (%) = Net Income/Average Total Assets	NEGATIVE / POSITIVE
op2	ROE (%) = Net Income/Average Equity	NEGATIVE
Liquidity		
liq1	Net Loans/Deposits & Short Term Funding (%)	POSITIVE / NEGATIVE
liq2	Liquid Assets/Deposits & Short Term Funding (%)	NEGATIVE

Table 2. Summary statistics on eight balance sheet indicators for sample banks

Variable	Pre-crisis period*		During the crisis period*		Post crisis period*	
	Mean (Std. Dev.)	Min. – Max.	Mean (Std. Dev.)	Min. – Max.	Mean (Std. Dev.)	Min. – Max.
Asset Quality						
Qa1	0.014 (0.009)	0.000-0.041	0.016 (0.010)	0.001-0.051	0.025 (0.015)	0.001-0.078
Qa2	1.370 (9.505)	0.000-107.945	0.283 (1.951)	-7.866-36.044	0.257 (1.777)	-26.7530-4.569
Capital						
Pat1	0.078 (0.013)	0.047-0.139	0.081 (0.017)	0.051-0.179	0.105 (0.023)	0.043-0.182
Pat2	0.053 (0.021)	0.019-0.104	0.051 (0.042)	-0.036-0.386	0.058 (0.033)	-0.018-0.295
Operations						
Op1	0.008 (0.004)	-0.001-0.025	0.003 (0.011)	-0.091-0.044	0.001 (0.012)	-0.104-0.030
Op2	0.182 (0.060)	-0.071-0.562	0.041 (0.237)	-2.020-1.445	0.018 (0.177)	-1.489-0.422
Liquidity						
Liq1	0.820 (0.351)	0.139-2.031	0.805 (0.418)	0.014-2.488	0.875 (0.677)	0.015-12.948
Liq2	0.484 (0.276)	0.128-1.530	0.464 (0.277)	0.090-1.750	0.487 (0.295)	0.082-1.896

Notes: This table reports summary statistics on eight explanatory balance sheet variables for the sample banks for the pre-crisis period (1 January 2005 - 30 June 2007), the crisis period (1 July 2007 - 31 March 2009) and the post crisis period (1 April 2009 - 30 June 2011).
* The number of banks in the period preceding the crisis was 53, in the crisis period 55, and in the post crisis period 47.
The independent variables (qa1, qa2, pat1, pat2, op1, op2, liq1, and liq2) are defined in paragraphs 3.3.
Source Datastream Database and authors' calculations.

Table 3. Correlations pre-crisis and crisis period

	CDS spreads	
Variable	**Pre crisis period**	**During the crisis period**
Qa1	0.0107	0.1174*
Qa2	-0.0298	0.0133
Pat1	0.0031	0.1592*
Pat2	0.1372*	-0.0441
Op1	0.2041*	-0.3021*
Op2	0.1319*	-0.3214*
Liq1	-0.0146	0.1196*
Liq2	0.1339*	-0.1779*

Notes: The dependent variable (CDS spreads) and the independent variables (qa1, qa2, pat1, pat2, op1, op2, liq1, and liq2) are defined respectively in paragraphs 3.2 and 3.3.
The pre-crisis period spans from 1 January 2005 to 30 June 2007, while the crisis period extends from 1 July 2007 to 31 March 2009.
The variables with no * are independent.

Table 4. Panel Regressions

Variable	Whole period	Whole period and dummy crisis	Pre-crisis Period	During the crisis period	post crisis period
Qa1	3019.194***	3184.293***	339.959*	5841.518***	3578.455***
	(360.622)	(342.706)	(132.078)	(1054.481)	(823.578)
Qa2	-2.383***	-1.798***	-0.101	-1.018	28.410
	(0.394)	(0.377)	(0.069)	(1.747)	(24.794)
Pat1	809.870***	252.133	-38.498	2159.72***	978.256**
	(129.453)	(132.205)	(61.460)	(411.876)	(312.541)
Op1	-4.170.813***	-3396.34***	1626.445***	2154.717	-13173.09***
	(906.371)	(863.232)	(349.269)	(1409.976)	(3371.008)
Op2	-206.312***	-152.949***	-3.866	-301.503***	128.771
	(36.052)	(34.546)	(11.552)	(55.877)	(119.554)
Liq1	0.025	-29.542	2.017	-178.760***	-110.261*
	(17.081)	(16.422)	(4.160)	(41.685)	(47.502)
Liq2	-82.940***	-70.733***	-2.357	-26.342	-99.579*
	(19.160)	(18.223)	(4.069)	(40.455)	(48.683)
Dummy crisis		54.940***			
		(4.796)			
Number of observations	1256	1256	506	354	396
Number of sample banks	57	57	53	55	47
Adjusted R-squared	0.6386	0.6742	0.6141	0.6627	0.7329

Variable	Whole period	Whole period and dummy crisis	Pre-crisis Period	During the crisis period	post crisis period
Qa1	3897.548***	3376.869***	285.000*	5491.569***	4250.474***
	(390.638)	(364.000)	(128.170)	(1424.575)	(805.759)
Qa2	-2.273***	-1.520***	-0.036	-0.984	46.202
	(0.462)	(0.431)	(0.070)	(2.436)	(24.959)
Pat2	-312.295	-750.698*	-261.141***	-2493.139*	2141.462*
	(169.897)	(314.818)	(72.162)	(993.529)	(896.981)
Op1	-4731.896***	-4208.07***	1702.289***	-1284.64	-12093.8***
	(1049.319)	(973.519)	(327.702)	(1905.935)	(3354.918)
Op2	-196.451***	-110.0233**	-13.423	-162.507*	119.693
	(41.837)	(39.259)	(11.602)	(77.744)	(120.221)
Liq1	-9.279	-51.343**	4.712	-193.063**	-107.880*
	(20.067)	(18.836)	(4.100)	(41.803)	(47.871)
Liq2	-66.426**	-60.439**	-3.826	-6.090	-86.151
	(22.369)	(20.742)	(3.938)	(55.849)	(49.382)
Dummy crisis		71.185***			
		(4.996)			
Number of observations	1301	1301	525	372	404
Number of sample banks	58	58	56	56	49
Adjusted R-squared	0.5556	0.6180	0.6223	0.4911	0.7462

Notes: The dependent variable is CDS spreads which measure the probability of default. The explanatory variables are balance sheet ratios referring to asset quality (qa1 and qa2), capital (pat1, pat2), operations (op1 and op2), and liquidity (liq1 and liq2). The dummy crisis identifies the start of the crisis (1 July 2007).

The dependent variable and the independent variables are defined respectively in paragraphs 3.2 and 3.3.

'Whole period' denotes the period from 1 January 2005 to 31 March 2010 (latest data available).

'Pre-crisis period' denotes the period from 1 January 2005 to 30 June 2007.

'During the crisis period' denotes the period from 1 July 2007 to 31 March 2009.

' post crisis period' denotes the period from 1 April 2009 to 30 June 2011.

Due to multicollinearity problem between capital explanatory variables (pat1 and pat2), for each time periods considered, the panel regression was performed using alternately the two capital ratios.

Standard Errors of estimated coefficients are reported in parentheses. Adjusted R-squared derives from areg.

*** denotes coefficient statistically different from zero (1% level, two-tail test), ** 5% level, * 10% level.

Table 5. Panel Regressions (Robustness Test)

	CDS t-1			CDS t+1		
Variable	**Pre-crisis period**	**During the crisis period**	**post crisis period**	**Pre-crisis Period**	**During the crisis period**	**post crisis period**
Qa1	168.048	4310.54***	3683.421**	334.304	4310.54***	3683.421**
	(181.153)	(1041.466)	(1118.108)	(175.313)	(1041.466)	(1118.108)
Qa2	-0.050	73.594*	-13.973	-0.125	73.594*	-13.973
	(0.765)	(34.942)	(29.081)	(0.092)	(34.942)	(29.081)
Pat1	-117.531*	1128.544**	1270.552**	-32.450	1128.544**	1270.552**
	(58.977)	(1431.283)	(369.058)	(81.598)	(410.269)	(369.058)
Op1	-40.900	997.283	-15088.28**	3727.584***	997.283	-15088.28**
	(349.780)	(1431.283)	(4764.587)	(463.661)	(1431.283)	(4764.587)
Op2	3.715	-217.918***	312.260	-11.628	-217.918***	312.260
	(12.709)	(56.643)	(179.973)	(15.333)	(56.643)	(179.973)
Liq1	1.006	-116.235**	-105.724	3.037	-116.235**	-105.724
	(4.106)	(41.917)	(55.779)	(5.522)	(41.917)	(55.779)
Liq2	-0.524	12.827	-93.834	2.460	12.827	-93.834
	(4.165)	(40.616)	(61.226)	(5.402)	(40.616)	(61.226)
N.of observations	455	301	349	505	301	349
N. of sample banks	53	54	55	53	54	47
Adjusted R-squared	0.6460	0.6163	0.6448	0.6191	0.6163	0.6448

	CDS t-1			CDS t+1		
Variable	**Pre-crisis period**	**During the crisis period**	**post crisis period**	**Pre-crisis Period**	**During the crisis period**	**post crisis period**
Qa1	195.911	2949.261*	4829.115***	154.655	2949.261*	4829.115***
	(178.074)	(1194.255)	(1108.015)	(175.969)	(1194.255)	(1108.015)
Qa2	-0.024	229.261***	19.218	-0.020	229.261***	19.218
	(0.077)	(36.759)	(28.917)	(0.096)	(36.759)	(28.917)
Pat2	-185.803*	-1258.094	4227.542***	-350.036***	-1258.094	4227.542***
	(73.087)	(877.093)	(1107.999)	(99.072)	(877.093)	(1107.999)
Op1	285.546	-1201.006	-13743.28**	3170.933***	-1201.006	-13743.28**
	(337.272)	(1660.659)	(4699.187)	(449.939)	(1660.659)	(4669.187)
Op2	-1.759	-103.864	303.895	-24.423	-103.864	303.895
	(13.023)	(66.038)	(179.230)	(15.928)	(66.038)	(179.230)
Liq1	3.940	-109.317*	-108.554	6.525	-109.317**	-108.554
	(4.139)	(49.553)	(55.669)	(5.630)	(49.553)	(55.669)
Liq2	-2.625	57.716	-68.811	0.188	57.716	-68.811
	(4.060)	(48.108)	(61.665)	(5.407)	(48.108)	(61.665)
N.of observations	471	316	355	524	316	355
N. of sample banks	56	55	49	56	55	49
Adjusted R-squared	0.6463	0.5585	0.6730	0.5994	0.5585	0.6730

Notes: The dependent variable is CDS spreads which measure the probability of default. The explanatory variables are balance sheet ratios referring to asset quality (qa1 and qa2), capital (pat1, pat2), operations (op1 and op2), and liquidity (liq1 and liq2). The dependent variable and the independent variables are defined respectively in paragraphs 3.2 and 3.3.

'CDS t-1' denotes CDS spread values for the quarter preceding the quarter in progress; 'CDS t+1' denotes CDS spreads for the quarter following the quarter in progress.

The balance sheet data in both panel regressions are at time t (the quarter in progress).

'Pre-crisis period' denotes the period from 1 January 2005 to 30 June 2007.

'During the crisis period' denotes the period from 1 July 2007 to 31 March 2009.

' post crisis period' denotes the period from 1 April 2009 to 30 June 2011.

Due to multicollinearity problem between capital explanatory variables (pat1 and pat2), for each time periods considered, the panel regression was performed using alternately the two capital ratios.

Standard Errors of estimated coefficients are reported in parentheses. Adjusted R-squared derives from areg.

*** denotes coefficient statistically different from zero (1% level, two-tail test), ** 5% level, * 10% level.

Appendix

Table A. Summary statistics on CDS spreads for sample banks

	Pre-crisis period		During the crisis period		Post crisis period	
Banks (Country)	**Mean (Std. Dev.)**	**Min. – Max.**	**Mean (Std. Dev.)**	**Min. – Max.**	**Mean (Std. Dev.)**	**Min. – Max.**
Erste Group Bank AG (AT)	19.93 (13.47)	1 - 75.08	120.46 (103.78)	13.69 - 487.13	166.49 (46.30)	128.81 – 275.08
Raiffeisen International Bank Holding (AT)	37.19 (36.53)	1 - 224.97	171.28 (95.90)	70.90 - 535	189.28 (51.87)	136.97 - 306.05
Dexia SA (BE)	9.42 (1.66)	6.50 - 14	166.55 (122.76)	11.40 - 550	263.88 (54.99)	183.83 – 342.01
Fortis (BE)	16.50 (5.26)	8 - 31.62	74.83 (64.75)	10.80 - 666.70	86.44 (24.43)	60.99 - 111.77
KBC Groep NV (BE)	9.60 (1.72)	6.90 - 15.70	126.33 (76.65)	9.80 - 343.30	173.83 (54.49)	109.54 – 266.07
Danske Bank A/S (DK)	7.08 (3.11)	3.50 - 21	68.67 (61.87)	4.10 - 225	98.04 (27.70)	69.44 – 153.06
Banco Bilbao Vizcaya Argentaria (ES)	9.71 (1.36)	7.10 - 16.50	76.08 (36.76)	11.50 - 184.95	164.08 (67.34)	78.15 – 249.35
Banco de Sabadell SA (ES)	24.20 (0)	24.20 (0)	167.02 (97.92)	19.60 - 371.66	274.95 (83.21)	146.94 – 406.30
Banco Popular Espanol (ES)	11.27 (3.92)	7.97 - 31.54	116.50 (112.71)	14.78 - 340	278.19 (99.07)	139.02 - 439.06
Banco Santander SA (ES)	10.22 (1.67)	7 - 17.50	78.21 (37.61)	11.50 - 183.61	151.97 (60.17)	76.58 – 239.59
Caja de Ahorros de Valencia Castellon Y Alicante Bancaja (ES)	16.58 (4.06)	9.50 - 31.36	387.21 (299.71)	28.60 - 1,148	475.85 (112.84)	368.08 – 624.91
Caja de Madrid (ES)	21.45 (3.03)	14.80 - 27.05	284.59 (236.85)	23 - 750	464.98 (102.51)	345.95 – 612.50
Banque Federale des Banques (FR)	68.13 (55.44)	1 - 265.92	14.78 (0)	14.78	24.61 (19.66)	14.78 – 54.11
BNP Paribas (FR)	7.81 (1.97)	5 - 14.50	54.99 (25.49)	7.50 - 143.13	88.51 (21.01)	57.17 – 107.71
Crédit Agricole SA (FR)	8.06 (1.84)	5.50 - 13.50	70.69 (32.96)	8 - 165	119.46 (27.36)	83.66 – 148.67
Natixis (FR)	9.28 (1.79)	6.30 - 15	145.67 (93.63)	10.30 - 390.18	167.18 (48.94)	121.27 – 283.78
Société Générale (FR)	8.64 (2.30)	5.70 - 15.50	73.33 (35.83)	8.50 - 165	113.45 (23.73)	83.29 - 141.93
Deutsche Bank AG Registered (DE)	13.61 (2.99)	8.70 - 26.30	82.92 (38.69)	14.50 - 186.20	103.88 (16.65)	77.40 – 136.33

Deutsche Postbank AG (DE)	20.50 (3.17)	6.50 - 28.90	54.73 (23.50)	18.30 - 105.30	60.41 (12.78)	44.32 – 74.24
Allied Irish Banks PLC (IE)	8.81 (2.35)	5.70 - 17.50	151.09 (137.56)	10.40 - 646.72	637.44 (506.98)	223.69 – 1,544
Anglo Irish Bank Corporation LTD (IE)	20.20 (5.93)	3 - 41	279.13 (210.52)	14 - 950	460.165 (111.09)	340.19 – 590.63
Bank of Ireland (IE)	8.62 (1.79)	5 - 14.50	169.04 (147.37)	10.10 - 670.28	287.81 (73.76)	207.17 – 377.62
Banca Monte dei Paschi di Siena (IT)	13.70 (4.82)	6 - 25	75.40 (35.01)	9.50 - 171.68	151.33 (74.15)	65.80 – 275.06
Banco Popolare SCARL (IT)	21.98 (5.36)	11 - 37.79	18.07 (6.62)	14 - 28.39	227.30 (43.78)	170.72 - 287.81
Intesa SanPaolo (IT)	11.78 (3.78)	5.40 - 19.50	66.65 (39.51)	8.50 - 200	108.57 (42.22)	54.78 – 173.78
UBI Banca SCPA (IT)	17.63 (2.80)	10 – 25	70.48 (50.75)	13 - 190	135.89 (53.92)	67.72 – 199.23
Unicredit SPA (IT)	12.84 (2.76)	7 - 20.70	83.64 (50.70)	10 - 278.74	122.88 (27.96)	90.24 – 157.84
Rabobank (NL)	6.21 (2.01)	2.50 - 10	69.21 (50.96)	5 - 204.30	82.80 (28.95)	65.54 – 125.85
DNB NOR ASA (NO)	-	-	100.27 (45.30)	37.50 - 188.11	79.10 (21)	60.57 - 131.62
Banco Espirito Santo (PT)	13.33 (3.10)	8.20 - 22.70	91.32 (44.56)	12.50 - 230	370.90 (245.29)	118.99 - 700.95
Nordea Bank AB (SE)	11.05 (2.67)	5 - 19.31	61.43 (42.45)	14.78 - 165	77.55 (15.69)	58.63 – 114.04
Skandinaviska Enskilda Banken (SE)	15.59 (9.66)	6.68 - 31.54	79.72 (69.28)	8.33 - 281.50	110.91 (35.70)	80.80 - 189.84
Svenska Handelsbanken (SE)	12.06 (3.34)	5.41 - 19.31	51.11 (42.08)	14.78 - 163.40	67.15 (19.57)	51.01 – 114.41
Swedbank AB (SE)	25.39 (7.82)	10.94 - 35.24	89.95 (96.55)	14.78 - 362	131.38 (65.38)	84.57 – 266.09
Credit Suisse Group AG (SW)	14.90 (3.73)	9.20 - 25.50	98.42 (55.14)	17.50 - 262.88	95.13 (19.91)	71.05 – 130.07
Alliance & Leicester PLC (UK)	14.36 (12.42)	1 - 78.78	131.33 (88.15)	11.78 - 471	82.13 (21.15)	65.08 – 112.84
Barclays PLC (UK)	8.52 (1.94)	5.30 - 15.80	103.14 (59.44)	11 - 270	114.41 (28.23)	82.31 – 164.75
Bradford & Bingley PLC (UK)	25.04 (16.08)	1 - 84.56	320.93 (298.33)	31.67 - 1,591	439.34 (80.51)	325.40 - 610.20
HBOS PLC	8.44 (2.58)	4.90 - 16.50	118.43 (69.90)	11.40 - 500.80	161.76 (20.62)	123.86 - 183.62

(UK)						
HSBC Holdings PLC (UK)	8.46 (2.19)	4.90 - 15.50	70.89 (38.04)	10.40 - 170.59	78.29 (13.62)	56.66 - 101.19
Lloyds Banking Group PLC (UK)	6.97 (2.43)	3.50 - 15.50	75.60 (49.77)	6.50 - 221.05	168.27 (28.20)	120.64 - 198.72
Royal Bank of Scotland Group (UK)	7.84 (2.50)	3.50 - 15.50	98.92 (57.50)	9 - 299.60	169.83 (28.80)	126.14 - 206.66
Standard Chartered PLC (UK)	16.02 (1.91)	8.50 - 22.50	40.10 (23.77)	16.20 - 63.70	72.89 (13.92)	63.70 - 95.14
Bank of America Corporation (US)	13.59 (3.79)	7.80 - 23.80	108.99 (71.70)	13.50 - 400.68	160.30 (34.41)	115.26 – 233.36
JP Morgan Chase & Co. (US)	20.94 (6.97)	11 - 43.50	95.17 (44.50)	19.80 - 242.05	87.95 (21.16)	58.51 – 132.45
National City Corporation (US)	21.62 (4.80)	10.40 - 29.44	311.84 (560.67)	18.30 - 2,969	733 (0)	733
Suntrust (US)	20.03 (13063)	10.30 - 44.34	69.85 (51.94)	1 - 115.30	113 (0)	113
Wachovia Corporation (US)	13.69 (2.64)	8.20 - 21.30	162.16 (124.98)	14.60 - 1,560	248.80 (3.50)	245.47 - 253.75
Washington Mutual INC (US)	35.70 (10.51)	18.80 - 63.20	2,138 (2,580)	41.40 - 6,235	-	-
Wells Fargo & Co. (US)	11.93 (3.36)	6 - 19.20	98.95 (57.28)	11.40 - 307.85	108.07 (28.74)	85.49 - 182.49
Mitsubishi UFJ Financial Group (JP)	13.67 (5.44)	5.50 - 29	69.22 (38.50)	6.90 - 163.80	71.51 (10.25)	53.78 – 83.14
Mizuho Financial Group Inc. (JP)	28.85 (7.27)	12.21 - 34.91	37.74 (10.48)	13.50 - 48.50	62.81 (33.93)	43 - 135.67
Sumitomo Mitsui Financial Group (JP)	13.87 (5.46)	5.20 - 25.20	69.97 (39.89)	6.90 - 150	92.18 (34.90)	57.03 – 167.38
Aust and NZ Banking Group (AU)	8.31 (1.95)	4.40 - 13.50	85.10 (51.37)	5.50 - 228.27	98.59 (15.16)	70.31 – 113.89
Commonwealth Bank of Australia (AU)	8.54 (2.61)	4.40 - 19.10	82.15 (48.39)	5 - 218.30	97.19 (15.94)	67.46 – 112.36
National Australia Bank LTD (AU)	8.30 (2.01)	4.50 - 14	85.92 (51.40)	4.90 - 225	98.88 (15.29)	70.42 - 115.21
Westpac Banking	8.37 (1.93)	4.70 - 14.20	81.51 (48.52)	5.50 - 221.73	91.44 (16.69)	67.57 - 113.36

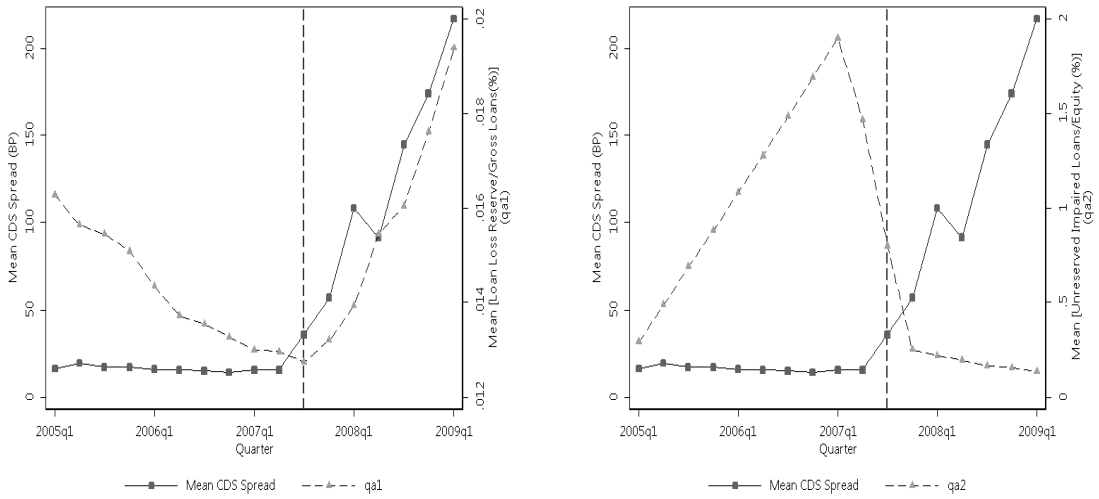
Corporation
(AU)

	Pre-crisis period		During the crisis period		Post crisis period	
Country Average	**Mean (Std. Dev.)**	**Min. – Max.**	**Mean (Std. Dev.)**	**Min. – Max.**	**Mean (Std. Dev.)**	**Min. – Max.**
Austria (2)	**28.56 (25)**	**1 - 150.02**	**145.87 (99.84)**	**42.29 - 511.06**	**177.89 (49.11)**	**128.81 – 306.05**
Belgium (3)	**11.84 (2.88)**	**7.13 - 20.44**	**122.57 (88.05)**	**10.66 - 520**	**185.75 (85.04)**	**60.99 – 342.01**
Denmark (1)	**7.08 (3.11)**	**3.50 - 21**	**68.67 (61.87)**	**4.10 - 225**	**98.04 (27.70)**	**69.44 – 153.06**
Espania (6)	**15.57 (2.34)**	**11.76 - 24.69**	**184.93 (136.92)**	**18.16 - 496.45**	**272.96 (147.85)**	**76.58 – 624.91**
France (5)	**20.38 (12.66)**	**4.70 - 64.88**	**71.89 (37.58)**	**9.81 - 175.61**	**112.40 (50.07)**	**14.78 – 283.78**
Germany (2)	**17.05 (3.08)**	**7.60 - 27.60**	**68.82 (31.09)**	**16.40 - 145.75**	**82.14 (14.71)**	**44.32 – 74.24**
Ireland (3)	**12.54 (3.35)**	**4.56 - 24.33**	**199.75 (165.15)**	**11.50 - 755.66**	**489.71 (377.49)**	**207.17 – 1,544**
Italy (5)	**15.58 (3.90)**	**7.88 - 25.59**	**62.84 (36.51)**	**11- 173.76**	**142.53 (61.55)**	**54.78 – 287.81**
Netherlands (1)	**6.21 (2.01)**	**2.50 - 10**	**69.21 (50.96)**	**5 - 204.30**	**82.80 (28.95)**	**65.54 – 125.85**
Norway (1)	**-**	**-**	**100.27 (45.30)**	**37.50 - 188.11**	**79.10 (21.00)**	**60.57 – 131.62**
Portugal (1)	**13.33 (3.10)**	**8.20 - 22.70**	**91.32 (44.56)**	**12.50 - 230**	**370.90 (245.29)**	**118.99 – 700.95**
Sweden (4)	**16.02 (5.87)**	**7 - 26.35**	**70.55 (62.59)**	**13.16 - 242.97**	**96.74 (45.74)**	**51.01 – 266.09**
Switzerland (1)	**14.90 (3.73)**	**9.20 - 25.50**	**98.42 (55.14)**	**17.50 - 262.88**	**95.13 (19.91)**	**71.08 – 130.07**
U K (8)	**11.95 (5.25)**	**4.07 - 33.08**	**119.91 (85.61)**	**13.49 - 448.46**	**124.80 (47.64)**	**56.66 – 206.66**
U S (7)	**19.56 (5.67)**	**10.33- 34.19**	**486.84 (569.96)**	**19.58 - 1,930**	**191.16 (17.56)**	**58.51 – 733**
Japan (3)	**18.79 (6.05)**	**7.63 - 29.70**	**58.97 (29.62)**	**9.10 - 120.76**	**75.5 (26.36)**	**43 – 167.38**
Australia (4)	**8.38 (2.12)**	**4.50 - 15.20**	**83.67 (49.92)**	**5.22 - 223.32**	**96.52 (15.40)**	**67.46 - 115.21**

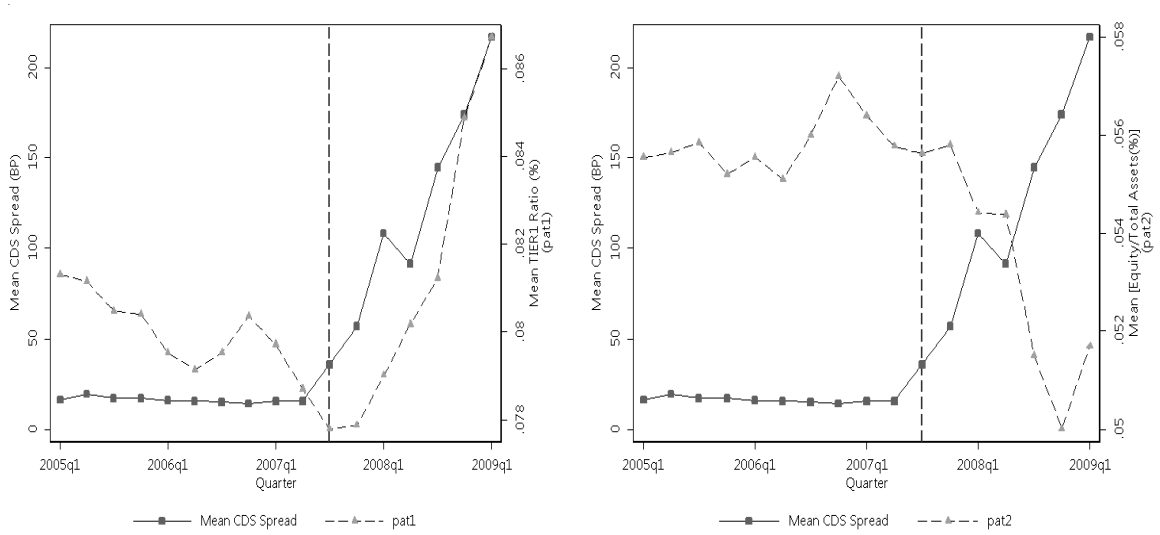
Notes: This table reports quarterly summary statistics on five year senior CDS spreads for the 57 sample banks per for the pre-crisis period (1 January 2005 - 30 June 2007), for the crisis period (1 July 2007 - 31 March 2009) and for the post crisis period (1 April 2009 – 30 June 2011).
Mean, Standard Deviation (Std. Dev.), Median, Minimum (Min.) and Maximum (Max.) are expressed in basis points.
AT: Austria; AU: Australia; BE: Belgium; DE: Germany; DK: Denmark; ES: Spain; FR: France; IE: Ireland; IT: Italy; NL: Netherlands; NO: Norway; PT: Portugal; SE: Sweden; SW: Switzerland; UK: United Kingdom; US: United States. JP: Japan.
With reference to the Country Average, the number of observations is indicated in brackets.
Source: Datastream Database, authors' calculations.

Figure A. Times-Series Graphs

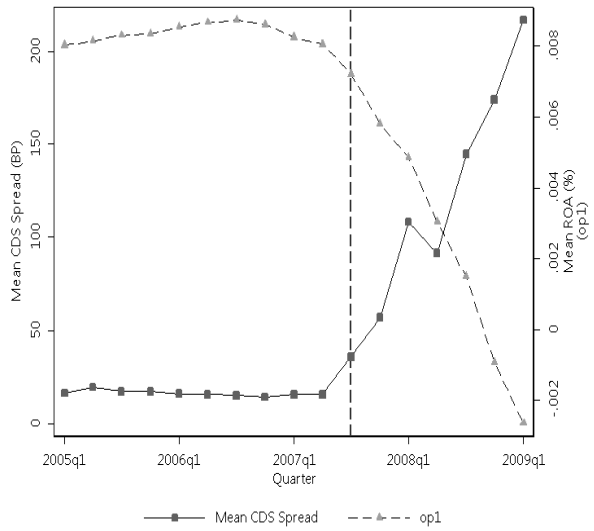
Panel A and B

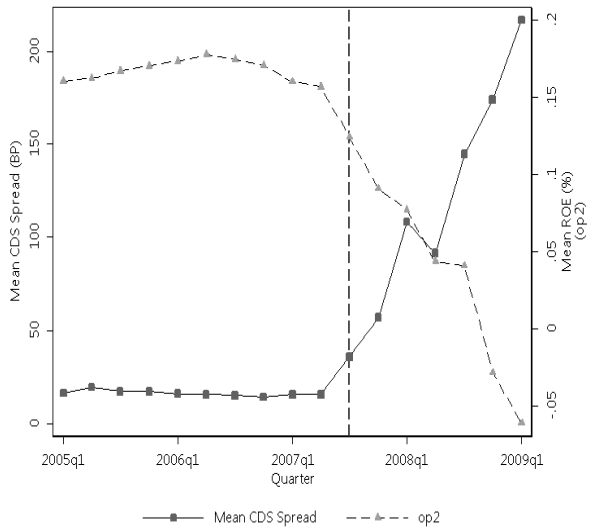


Panel C and D

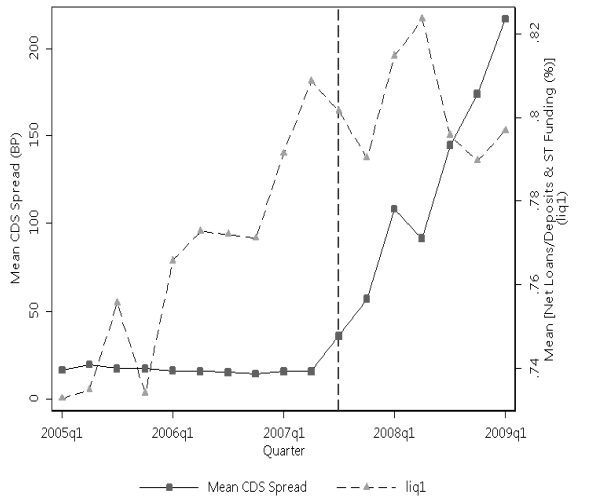


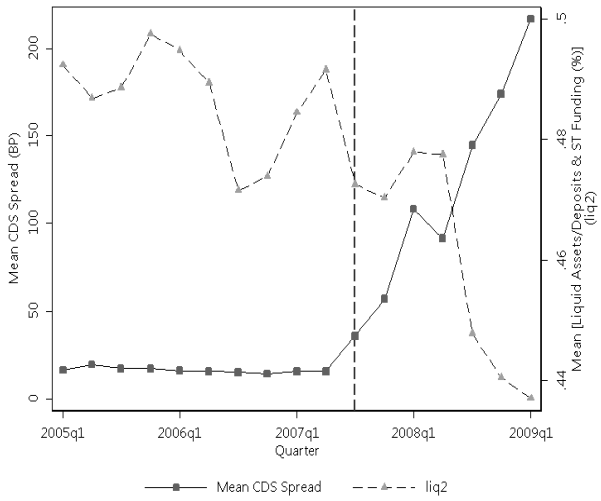
Panel E and F





Panel H and G





Notes: These figures show the relationship between mean CDS spreads of sample banks and the mean of each balance sheet ratio used (qa1, qa2, pat1, pat2, op1, op2, liq1 and liq2). The sample period is from 1 January 2005 to 31 March 2009. The dashed vertical line coinciding with the start of the third quarter 2007 (July 2007) indicates the outbreak of the crisis.

[1] Allen and Gale (2007a, 2007b), Goodhart (2008), International Monetary Fund (IMF, 2008), International Organization of Securities Commissions (IOSCO, 2008), Bank for International Settlements (BIS, 2008, 2009), and Brunnermeier (2009) offer a detailed analysis of the subprime crisis.

[2] The International Swap and Derivatives Association (ISDA) released sets of Credit Derivatives Definitions in 1999 (which were amended in 2001) and 2003. They are: Bankruptcy, Obbligation Acceleration, Obbligation Default, Failure to Pay, Repudiation/Moratorium, and Restructuring.

[3] See European Central Bank (2009a, pp.64-70).

[4] A limited number of recent studies focus exclusively on CDS spreads in the banking sector, though with different research aims: Kool (2006), Annaert *et al*. (2009) and Norden and Weber (2010), with a sample of the major European banks; Huang *et al*. (2009), Constantinos (2010) and Hart and Zingales (2010), with a sample of the major US banks; Eichengreen *et al*. (2009) and Calice and Ioannidis (2009), with a sample of the largest US and European Financial Institutes (LFIs). Almer *et al*. (2008), Volz and Wedow (2009) and Demirgüç-Kunt and Huizinga (2010) with a sample of banks from all over the world.

[5] In particular, the national outstanding of credit default swaps, which ISDA began to survey at midyear 2001, grew from $631.5 billion at midyear 2001 to $62 trillion in 2007, reaching a peak. In the two subsequent years the number of CDS diminished, to $38.5 trillion in 2008 and $30.4 trillion in 2009. Recent reduction of the number of CDS is principally due to trade cancellations (International Swaps and Derivatives Association, 2010).

[6] The quoting convention for CDSs is the annual premium payment as a percentage of the notional value of the reference obligation. Under certain conditions, this CDS premium should be approximately equal to the credit spread (yield minus risk-free rates) of the reference bond of the same maturity. See Bank for International Settlements (2003, p. 84).

[7] Initially the literature concentrated on the structural models' theoretical determinants of corporate bond credit spreads, rather than CDS spreads. See, for example, Collin-Dufresne *et al.* (2001), Campbell and Taksler (2003), Cremers *et al.* (2004) and, recently, Avramov *et al.* (2007).

[8] See Ashraf *et al.* (2007).

[9] See Bank for International Settlements (2011, pp. 8-9).

[10] 'TIER 1 Ratio' is shareholder funds plus perpetual non cumulative preference shares as a percentage of risk weighted assets and off balance sheet risks measured under the Basel rules.

[11] 'Liquid Assets' denotes the sum of Government Securities, Trading Securities, Cash and Due from Banks, and Due from Other Banks. 'Short Term Funding' denotes the sum of Customer Deposits, Banks Deposits and Total Money Market Funding.

[12] Since the results relative to the post crisis period do not differ significantly from the crisis period, to save space, these are not reported but are available upon the authors.

[13] A possible explanation for this outcome will be offered in the section dedicated to the analysis of regression results.

[14] Due to multicollinearity problem between capital explanatory variables (pat1 and pat2), for each time periods considered, the panel regressions were performed using alternately the two capital ratios.

[15] For more details see Basel Committee on Banking Supervision (2010a).

[16] For more details see Basel Committee on Banking Supervision (2010b).

[17] Due to multicollinearity problem between capital explanatory variables (pat1 and pat2), for each time periods considered, the panel regression was performed using alternately the two capital ratios.