Bachelor Thesis Finance

Financial crisis: from bank credit risks to sovereign credit risk

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Abstract

This thesis describes the evolvement of the late-2000s financial crisis into a sovereign debt crisis, starting with the U.S. subprime mortgage crisis. Thereby, it clarifies the rise in bank credit risks and how this eventually led to sovereign credit risk. Empirical analysis shows the relationship between bank credit risks and sovereign credit risk in the period 2007-2012, subdivided in a pre-bailout, bailout, post-bailout I and post-bailout II period, via a panel study on bank and sovereign credit default swaps (CDS) for eleven Euro area countries. There exists a weak positive relationship before the bailouts. However, during the bailouts a clear negative relationship exists. The post-bailout periods are both characterized by a strong positive relationship, but do not differ from each other. A weighted average method based on the size of total assets is used to calculate average bank CDS, which has a higher predictability and shows to be more accurate than the unweighted average method used in earlier research.

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1. Introduction

For sale: the Acropolis of Athens, buildings included (among them the Parthenon, ±2500 years old), about three hectares, listed on the European Cultural Heritage list of monuments, well maintained and available for a reasonable price. Reason for selling: large cash shortfalls of the Greek government. Would such a delusion become probable in the near future? According to Frank Schäffler and Marco Wanderwitz it would be a reasonable option for solving the Greek puzzle[1]. Although it sounds a bit ironical, this creative thinking represents a serious matter in our contemporary world.

The late-2000s financial crisis has had and still has a major impact on the state and stability of today's financial system. However, not only the financial system is dramatically affected by the default and financial distress of several financial institutions, which led to increased bank credit risks, the credit risks of countries are affected as well. The financial crisis involved the solvency of sovereigns, in particular some Euro area countries, thereby has led to a sovereign debt crisis. Questions that arise are; why did this happen, why did it come so far, how did it evolve and what is the relation between bank credit risks and sovereign credit risk? These questions will be the outline of this thesis. The central research question of this thesis will be: *Why did the late-2000s financial crisis turn into a sovereign debt crisis and how did it evolve?* Empirical research will in particular answer the question: *What is the relationship between bank credit risks and sovereign credit risk during the late-2000s financial crisis and sovereign debt crisis?*

Out of these two main research questions, the following sub questions emerged:

Introduction question: *Where and why did the late-2000s financial crisis start?*

Sub question 1: *Which factors have caused an increase in the bank credit risks during the financial crisis and how do we measure bank credit risk?*

Sub question 2: *Why has an increase in bank credit risks led to a sovereign debt crisis and which factors are the main causes of this event?*

Sub question 3: *How did the bank credit risks and sovereign credit risk evolve during the late-2000s financial crisis and sovereign debt crisis in the Eurozone and what is their relationship during these periods?*

The actuality and importance of the late-2000s financial crisis and the sovereign debt crisis makes it interesting and relevant to write about this topic. Unawareness of the public about the precise evolvement of the crisis provides further relevance for this thesis. Because bank credit risks and sovereign credit risk play such an important role in this event, it is of

[1] 'We give you cash, you give us Corfu!' German MPs suggest Greece sell its islands (and the Acropolis) to pay off its debt. (2010, March 5). *Daily mail co UK.*

added value to current research on credit risk to examine the relationship between these two factors during the late-2000s financial crisis and the sovereign debt crisis. Although this topic has the disadvantage of a small amount of recent and relevant literature, it provides an opportunity to present a whole overview about the evolvement of the crisis and its credit risks.

The purpose of this thesis is therefore to present a simplistic, although still profound understanding to the public why the late-2000s financial crisis has led to a sovereign debt crisis. Therefore, the literature review focuses on generating and presenting an overview of what relevant, mainly recent, literature tells about the development from a financial crisis to a sovereign debt crisis. It starts with financial innovation and the subprime mortgage crisis, leading to a liquidity crash in financial markets which caused bank credit risks to increase. Then it proceeds with explaining the risk transfer between bank credit risks and sovereign credit risk, via the bank bailouts in September and October 2008 after the fall of Lehman Brothers, and concludes with the origination of a sovereign debt crisis.

In addition to this, a panel study will examine the direct relationship between bank credit risks and sovereign credit risk for eleven Euro area countries over the past five years in four separate periods; pre-bailout, bailout, post-bailout I and post-bailout II. Data on credit default swaps (CDSs[2]) is used as a measurement of credit risk, the reasoning of which is captured in the literature review. Average bank CDS is calculated via a weighted average method, based on the size of total assets a bank has. Results show that the direct relationship between bank credit risks and sovereign credit risk has changed during the progression of the late-2000s financial crisis and sovereign debt crisis. The pre-bailout period is characterized by a weak positive relationship between bank credit risks and sovereign credit risk. However, during the bailouts a clear negative relationship exists, which evidences a risk transfer between bank and sovereign credit risk. The post-bailout periods are both characterized by a strong positive relationship, but beta and correlation comparison cannot show that the relationships in these two periods differ. An extended model uses control variables; international risk aversion, local stock market index and a CDS market index; country dummies and interaction terms to improve the predictability of the model.

The further structure of this thesis is organized as follows. Chapter 2 will cover the literature review, which incorporates the answers to the introduction question and sub questions 1 and 2. Chapter 3 will be the empirical analysis, which starts with the methodology for research and the formulation of hypotheses derived from the literature review, proceed by a data description and completed by the testing of the hypotheses to answer sub question 3. Chapter 4 will present the conclusions, implications and recommendations for future research.

[2] An overview of the abbreviations can be found in Appendix A.

2. Literature review

In this chapter, recent and other relevant literature will be investigated to form an answer to the introduction question and sub questions 1 and 2. In addition to the sub questions, relevant measurements for the empirical analysis will be described. This chapter will conclude with a conceptual model for empirical research.

2.1 Financial innovation and the subprime mortgage crisis

Before diving into the depths of bank credit risk and sovereign credit risk, it is important to understand where the late-2000s financial crisis started and why it happened. This section will give an answer to the introduction question; *where and why did the late-2000s financial crisis start?* Thereby, it will present a general overview of the start of the subprime mortgage crisis, which eventually led to the late-2000s financial crisis.

According to Ackermann (2008) the boom in U.S. real estate markets and the high liquidity in the global financial markets were the main drivers of the U.S. subprime mortgage crisis. High liquidity in global financial markets was provided by the quantitative easing policy of the Federal Reserve System (FED), in order to stimulate the economy after the dot-com bubble and the terrorist attacks of September 11 in 2001. Quantitative easing urged the need for financial innovation to develop more profitable investments, because investors could only earn a relatively low return on Treasury Bills. Increased financial innovation led to the concept of securitization, with new financial instruments as mortgage-backed securities (MBSs), part of asset-backed securities (ABSs) and collateralized debt obligations (CDOs). These instruments facilitated rising mortgage lending, especially to sub-primers (less wealthy people, who face a higher probability on having difficulties with the repayment of their mortgage), which led to a boom in the US real estate markets (Reinhart and Rogoff, 2008).

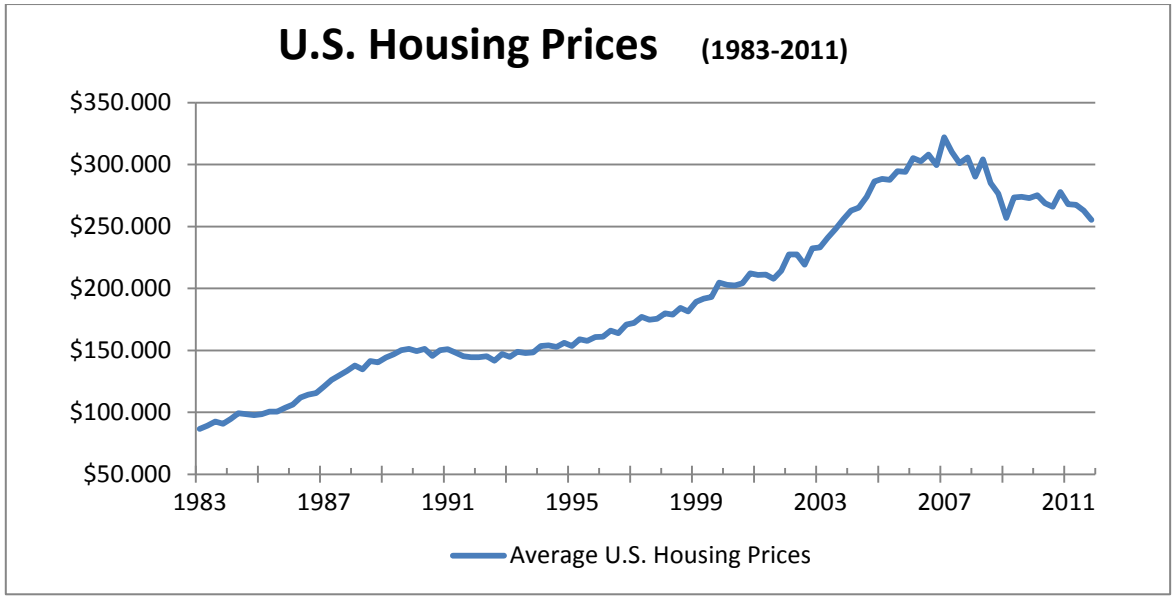
The subprime mortgage market was based on an originate-to-distribute business model; meaning that the mortgage broker eventually does not bear the risk because he or she distributes the mortgages to investors, including their risks (Fratianni and Marchionne, 2010). Thereby, mortgage brokers had the incentive to sell as many mortgages as possible, even though they knew that the borrower was unable to afford it. According to Brunnermeier (2008), the originate-to-distribute and securitization were eventually the main drivers in the downturn of the financial markets. The principles of the agency problem (Jensen and Meckling, 1976) arose in mortgage lending. Since mortgage brokers did not care much about the credit risk the borrower bears, adverse selection/lemons problem (Akerlof, 1970) severely extended. Mishkin (1991) describes this process as a characteristic of a financial crisis. This

implicates that especially less creditworthy borrowers who are more willing to take risks, obtained loans to finance their houses. Because risk was constantly sold to other investors, mortgage brokers and even investment banks (underwriters of MBSs and CDOs) had weak incentives to assess the credit risk of borrowers. The complexity of new financial instruments and lacking regulation worsened the asymmetric information in the financial system (Mishkin, 2009). As a consequence the ownership and future cash flows were hard to predict. Keys, Mukherjee, Seru and Vig (2010) evidenced that securitization indeed decreased the quality of credit.

Deterioration in mortgage lending increased further by the introduction of teaser rates, stated income loans and NINJA (No Income No Job or Assets) loans. Increased housing prices caused the value of collateral to increase which lowered the cost of a potential defaulting borrower for the lender (Ackermann, 2008). This led to an even higher demand for houses, stimulating a boom in housing prices (Mishkin, 2009). The housing boom created an attractive investment opportunity for investors, especially because stock markets plunged and seemed to be more volatile than before (The Economist, 2005). Speculative investments increased and a housing price bubble developed. A prominent role in the boom of subprime mortgage lending was played by two Government Sponsored Entities (GSEs), Fannie Mae and Freddie Mac. They initiated the development of new financial instruments such as MBSs in the mortgage market. The fact that they provided guarantees on the MBSs, led many investors believe that although Fannie Mae and Freddie Mac were privatized, they still in one way or the other, were backed by the U.S. Government (Lucas and McDonald, 2006; Hellwig, 2009). In combination with the complexity of the new financial instruments, portfolios were not diversified enough as was normally necessary (Hellwig, 2009)

So far, it seemed to be a good deal for everyone, but as it is with all bubbles the U.S. housing price bubble burst at a certain moment when the price was too far above its fundamental value (Cukierman, 2011). The end of the bubble was preceded by a gradual rise in interest rates by the FED to prevent high inflation, which affected the disposable income of adjustable rate mortgage holders (Ackermann, 2008). When the bubble burst in mid-2006 the U.S. housing prices fell (see figure 2.1), leading to higher default levels in particular among the sub-primers (Reinhart and Rogoff, 2008). Falling house prices caused people to default on their mortgage, as a consequence the lender has to put the house up for sale to get his money back, this increased the supply of houses, which eventually led to a further decrease in housing prices. Note that the problems concerning the riskiness of the subprime mortgages were already present before 2006, but were masked by the increasing housing prices (Demyanyk and van Hemert, 2011).

Figure 2.1: U.S. Housing Prices



** Note: housing prices are computed as the average sales price of houses sold in the U.S. The average price of new houses sold in the U.S. is more or less the same and shows a similar path. Data are from FRED databases.*

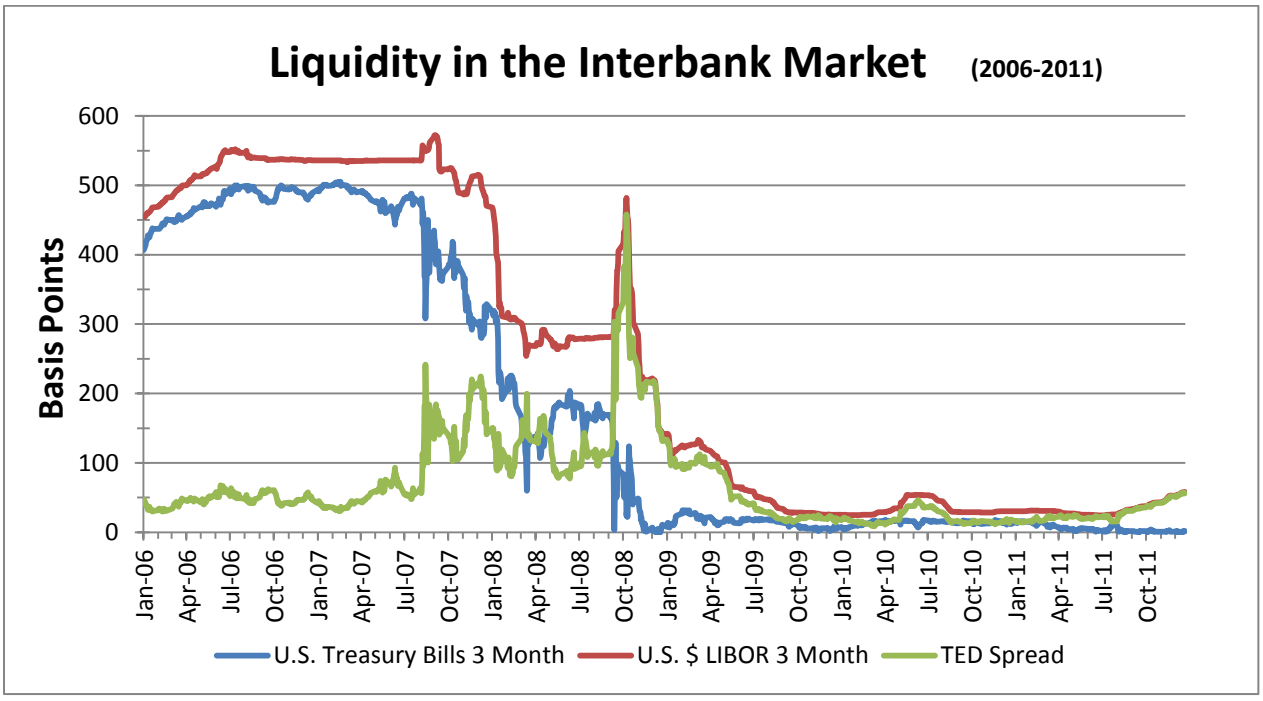
A consequence of the large amount of defaults on subprime mortgages, were massive declines on the market values of large portfolios that consist of MBSs and other ABSs, held by many financial institutions (Longstaff, 2010). The spread around the world was mainly caused by the concepts of securitization and globalization, which were actually used to diversify and distribute the risk, but eventually spread the impact of the crisis (Ackermann, 2008). As Nobel laureate Dr. A. Michael Spence wrote: *'Financial innovation, intended to redistribute and reduce risk, appears mainly to have hidden it from view. An important challenge going forward is to better understand these dynamics as the analytical underpinning of an early warning system with respect to financial instability.'* Many financial institutions around the world started to incur losses, sometimes at unexpected places. Asymmetric information caused a co-movement, especially of credit markets, the granting of credit decreased; uncertainty about further potential losses increased, which ultimately led to a crisis of confidence. Distrust made financial institutions unwilling or extremely cautious about lending their money, even to other financial institutions. The liquidity in financial markets severely declined and the interbank market dried up (Ackermann, 2008). As Mishkin (1991) states: *a financial crisis is a disruption to financial markets in which adverse selection and moral hazard problems become much worse, so that financial markets are unable to efficiently channel funds to those who have the most productive investment opportunities.* A global financial crisis was born.

2.2 *Liquidity crash*

The previous section ended mentioning declined liquidity in the financial markets as a consequence of confidence loss. The subprime mortgage crisis turned into a liquidity crisis in which banks were unwilling or extremely cautious about lending their money, in particular to other banks. This was mostly to ensure access to funds, due to concerns about the solvency and liquidity of financial markets (Ivashina and Scharfstein, 2010). How did it come so far?

In the last decade, banks increasingly financed their asset holding with short-term instruments, which increased their exposure to a dry-up in the funding of liquidity (Brunnermeier, 2008). Banks normally make unsecured short-term loans to each other in the interbank market against an individually interest rate agreed upon. The London Interbank Offered Rate (LIBOR) is an average quote of these interest rates. Liquidity in the interbank market can be measured by the TED spread, which is the difference between the interest rates on 3-month LIBOR and 3-month Treasury Bills (Eichengreen, Mody, Nedeljkovic and Sarno, 2009). The evolvement of 3-month LIBOR, 3-month Treasury Bills and the TED-spread from 2006 to 2011 is presented in figure 2.2.

Figure 2.2: Liquidity in the Interbank Market – TED spread



** Note: LIBOR 3 Month is computed as a U.S. Dollar rate. Data are from FRED databases.*

In August 2007 an increase in perceived default and liquidity risk of banks widened the TED spread and the first illiquidity wave occurred (Brunnermeier, 2008). Preceding downgrades by Standard & Poor's, Moody's and Fitch on MBSs and CDOs caused turmoil in the financial markets (Mishkin, 2009). As a reaction the FED and the European Central Bank (ECB) injected billions to the interbank market, additionally the FED lowered its federal fund

and discount rate. Although the injections appeared to be temporary effective, the lowered discount rate (the rate at which banks can directly borrow from the FED) did not work at all, due to its stigma. Banks are reticent, sometimes even reluctant to borrow from the FED because they fear that it might signal a lack of creditworthiness to the market (Peristiani, 1998). To solve this stigma, the FED created the Term Auction Facility (TAF), by which banks could directly and anonymously bid for funds by the FED (Taylor, 2009). This could alleviate the turmoil for a while. However, the underlying problem of information asymmetry, especially adverse selection, remained unsolved because investors were unable to separate liquidity from credit concerns (Fratianni and Marchionne, 2010). Although these terms are distinguishable in theory, they are intertwined in practice, especially during periods of uncertainty (IMF, 2008).

Further write-downs on MBSs and CDOs in December 2007, caused potential downgrading for exposed Monoline insurers (insurance companies, who focus on insuring only one specific product, mostly municipal bonds), due to increased default risk (premium) (Brunnermeier, 2008). This caused a second peak in the TED spread.

An accelerating decline in U.S. housing prices caused even more defaults on mortgages, thus a collapse of the MBSs and CDOs systems (Mishkin, 2009). Write-downs on the balance sheet started to hit larger investment banks such as Bear Stearns, causing a third peak in the TED spread during March 2008. The financial stability of Bear Stearns was at stake and since it was considered to be ‘too interconnected to fail’, Bear Stearns needed to be bailed out by J.P. Morgan guaranteed by the U.S. Government (Brunnermeier, 2008).

Events rapidly evolved; Lehman Brothers had to file for bankruptcy since Treasury and FED officials decided not to offer guarantees funded by taxpayers, since Lehman had ample time to prepare for a liquidity shortage (Brunnermeier, 2008). This bankruptcy happened just a day before Merrill Lynch sold itself to the Bank of America, after suffering larges losses from MBSs (Mishkin, 2009). A couple of days later AIG needed to be bailed out, since its interconnectedness in the credit derivatives markets and active trading in credit default swaps, made a failure unavoidable (Brunnermeier, 2008). These events, especially the failure of Lehman Brothers, caused a crash in liquidity on the interbank market (figure 2.2). Banks were unwilling to lend their money to each other, only at high interest rates and cautiously. Uncertainty about the credit risk of counterparties increased the LIBOR severely. The other way around, banks want the best collateral which increased the demand for attractive Treasury Bills, thereby decreased the rate on Treasury Bills (Brunnermeier, 2008).

This explains the large TED spread in October 2008[3]. Distrust was clearly present, therefore many banks bought CDSs to protect themselves against counterparty risk (default of other banks), which increased the price of CDSs (Brunnermeier, 2008). But the effects extended beyond the scope of the financial sector. A flight to quality as Bernanke, Gertler and Gilchrist (1994) describe it took place, as investors were seeking for trustworthy and especially creditworthy investments. But a flight to quality contaminates other markets as well, through a downward liquidity spiral (Brunnermeier and Pedersen, 2009). Several commodities and most asset classes fell vigorously in prices (Ivashina and Scharfstein, 2010). Costs of borrowing money increased substantially and companies had to utilize their (excess) cash holdings for funding (Duchin, Ozbas and Sensoy, 2010). The global economy got infected, but that was just the start.

2.3 Increased bank credit risk and its measurement

After having formulated an in depth background on the start of the late-2000s financial crisis, I come to the main point of this thesis; bank credit risk and sovereign credit risk. This section will give an answer to sub question 1; *which factors have caused an increase in the bank credit risks during the financial crisis and how do we measure bank credit risk?*

Credit risk implicates the risk that a borrower is not able to pay back the money to the lender, thereby will default on his obligation to pay (Grinblatt and Titman, 2002; Berk and DeMarzo, 2007). As credit risk deals with a possible default of the counterparty, it can also be expressed as counterparty risk or default risk. The extent to which a company is able to meet its debt obligations is called creditworthiness. Credit rating agencies, such as Standard & Poor's, Fitch and Moody's, evaluate the creditworthiness of corporations to rate their likelihood of a default in order to diminish information asymmetries in financial markets (Stiglitz and Weiss, 1981). Bank credit risk is nothing less than the risk that the clients of the bank will not be able to pay back their borrowings to the bank.

Although the measurement of credit risk has received a lot of attention from academic research in the last decades (Artzner, Delbaen, Eber and Heath, 1999; Crouhy, Galai and Mark, 2000; Duffie and Singleton, 2003), it still failed to provide a clear path due to its complexity. Altman and Saunders (1998) provide an overview of credit risk measurements in the 80's and 90's. Starting with subjective analysis, e.g., 'the 4 C's of credit' (character, capital, capacity and collateral) to accounting based credit-scoring systems, e.g., multivariate accounting based credit-scoring models that use linear probability models, Logit models,

[3] Note: according to Brunnermeier (2008) the spread is a bit misleading, since LIBOR rose partly because of an increase in collateralized borrowing by central banks.

Probit models or discriminant analysis. Although these methods were quite solid measurements, financial innovation increased its dynamical feature, thereby its complexity. Most recent methods that measure credit risk are based on bond yield spreads or CDS spreads (Aunon-Nerin, Cossin, Hricko and Huang, 2002). A theoretical relationship between these two measurements is evidenced by Hull, Predescu and White (2004); Blanco, Brennan and Marsh (2005). But Longstaff, Mithal and Neis (2003) find significant differences between the measurements of bond yield spreads and CDS spreads. Zhu (2006) evidenced that the theoretical relationship holds in the long run, but substantial deviations are possible in the short run. Manganelli and Wolswijk (2009) for example show that bond yield spreads are significantly related to market liquidity in the short run. While CDS spreads tend to be less sensitive to liquidity issues than bond yield spreads (Ejsing and Lemke, 2011). Bongaerts, de Jong and Driessen (2011) show that market liquidity is still a significant factor in CDS spreads, although it is economically small. Recent literature on bank bailouts during the late-2000s financial crisis, considers CDS spreads to be a particular accurate variable to measure bank credit risk (Eichengreen et al, 2009; Sgherri and Zoli, 2009; Attinansi, Checherita and Nickel, 2010; Dermirguc-Kunt and Huizinga, 2010; Acharya, Dreschler and Schnabl, 2011; Ejsing and Lemke, 2011). Because of this and the allowance of CDS spreads for a direct analysis of credit risk (Aunon-Nerin et al, 2002); bank credit risks for the empirical analysis will be measured via CDS spreads.

As explained before, credit risk implicates the risk that a borrower is not able to pay back the money to the lender. But which factors then actually determine credit risk? Several studies have investigated the determinants of credit risk (Collin-Dufresne, Goldstein and Martin, 2001; Aunon-Nerin et al., 2002; Alexander and Kaeck, 2008; Ericsson, Jacobs and Oviedo, 2009). Altogether, aggregate (common) factors such as the yield curve (cost of borrowing over time), market return and implied volatility seem to be more important than firm-specific factors such as firm leverage and stock returns in determining credit risk. Eichengreen et al. (2009) show that aggregate factors became even more significant during the subprime crisis up to the failure of Lehman Brothers and remained elevated afterwards. Within aggregate factors the importance shifted from macroeconomic impact to funding risk and real economy after the failure of Lehman Brothers, meaning that investors were initially concerned about their own investments rather than the prospects of a global recession. Furthermore the sensitivity of a wide range of economic and financial factors (interest rates, stock returns) heightened after the failure of Lehman Brothers (Eichengreen et al, 2009). Di Cesare and Guazzarotti (2010) evidenced an increased importance of the leverage ratio for U.S. non-financial firms. At last, something not specifically found in empirical literature but

likely for added value, is the size of financial institutions, since larger financial institutions are more likely to be rescued than smaller ones; referring to concept of 'too big to fail'.

Bank credit risk obviously increased during the late-2000s financial crisis due to the large write-downs on MBSs and CDOs, which affected bank capital, thereby its solvency. The complexity of these instruments caused severe uncertainty about their values and actual ownership, something that Mishkin (2009) states as increased information asymmetry. The failure of Lehman Brothers instigated turmoil in the financial markets as the risk that a counterparty defaults increased, banks started to buy CDSs as a protection (Brunnermeier, 2008).

2.4 How increased bank credit risks have led to a sovereign debt crisis

After it has been made clear that bank credit risks increased during the financial crisis, the shift towards sovereign credit risk will be investigated. This section will answer sub question 2; w*hy has an increase in bank credit risks led to a sovereign debt crisis and which factors are the main causes of this event?*

As stated in the previous section, uncertainty in the financial markets after the fail of Lehman Brothers increased turmoil. Turmoil caused investors to be more risk averse compared to the period before the crisis, implicating that the crisis was contaminated by deterioration in banks' balance sheets, but propped by risk aversion (Fratianni and Marchionne, 2010). As bank credit risk significantly increased, many governments of developed countries had to secure their financial institutions via capital injections (emergency funding) or even rescue them via a bailout (Sgherri and Zoli, 2009). Many financial institutions became backed or guaranteed via financial support programs of the government.

Why did governments do so? As banks' balance sheets deteriorated via write-downs on MBSs and CDOs, undercapitalization revealed. Fratianni and Marchionne (2009) evidenced undercapitalization via the ratio of Tier 1 (core capital) to risk-weighted assets. Undercapitalization has been the biggest obstacle to solve the financial crisis, as confirmed by strengthened bank capital requirements in Basel III accord. To solve undercapitalization banks need to deleverage, which can be done via recapitalization (rearrange debt and equity) or selling assets (shrinking) (Dahl and Spivey, 1995; Mishkin, 2009). Since distrust among banks caused a dry up on the interbank market, which instigated a liquidity crash in financial markets, recapitalizing was nearly impossible and selling assets in illiquid markets extremely expensive (Fratianni and Marchionne, 2010). This implicates that deleveraging distressed sales and reduced asset values even further (Adrian and Shin, 2010). Concerns about further financial contagion and a total collapse of the financial market (increased systemic risk) left

no other choice for governments and central banks than to play as a 'lender of last resort' (Mishkin, 2009). Supportive reasoning for bailouts considers the principles of 'too big to fail' (O'Hara and Shaw, 1990) and 'too interconnected to fail' (e.g. the interconnectedness of AIG in the CDS market) (Markose, Giansante, Gatkowski and Shaghaghi, 2010). The limitations of these principles regarding risk incentives (Rochet and Tirole, 1996; Fischer, 1999; Cukierman, 2011) are beyond the scope of this thesis.

As financial support programs popped up during October 2008 to deleverage the financial system, funding did not only take place via capital injections in equity shares or loans but also via the sales of illiquid overvalued 'toxic' assets (Fratianni and Marchionne, 2010). In the U.S. the Troubled Asset Relief Program (TARP) and the Term Asset-backed securities Loan Facility (TALF) were established to purchase troubled ('toxic') assets (Nguyen and Enomoto, 2009). Some sovereigns and central banks in Europe acted similarly (Sgherri and Zoli, 2009). The implication of this is that the taxpayers are ultimately punished, because they turn up for the financing of these programs. The old and famous lesson form Bagehot (1873) was disregarded; *'In a crisis, the lender of last resort should lend freely, at a penalty rate, on the basis of collateral that is marketable in the ordinary course of business when there is no panic.'* Nevertheless the capital injections fulfilled to transfer risk from banks to sovereigns to lower bank credit risk, as is evidenced by Attinasi, Checherita and Nickel (2009); Ejsing and Lemke (2009); Sgherri and Zoli (2009); Acharya, Drechsler and Schnabl (2011). October 2008 was characterized by decreased bank credit risk and increased sovereign credit risk (Ejsing and Lemke, 2009).

So far, so good, but as Reinhart and Rogoff (2010) show; '*Banking crises most often either precede or coincide with sovereign debt crisis*.' Manasse, Roubini and Schimmelpfenning (2003) provide some determinants of a sovereign debt crisis. One of the main macroeconomic factors is a relative high level of foreign debt to GDP. Important note here is that many Euro area countries did not consolidate their financial position during good economic conditions, meaning that they have no 'buffer' when it gets into an economic downturn (Attinasi, Checherita and Nickel, 2009). Therefore, a lot of Euro area countries entered the financial crisis with high fiscal deficits and debt ratios. While capital injections were definitely necessary to strengthen financial institutions, the fiscal budget positions of many Euro area countries significantly deteriorated, leading to even higher government debt levels (Sgherri and Zoli, 209). Subordinate lower tax revenues because of decreased economic activity provided an additional problem for the funding of capital injections (Sgherri and Zoli, 2009). As Fratianni and Marchionne (2010) state it: *'it is now time to ask the question of when too-big-to-fail institutions become too big to be saved.'*

Although empirical analysis has shown that bailouts have caused a transfer from bank credit risk to sovereign credit risk, it seemed to be only a temporary effect. The bailouts eventually contaminated bank credit risks as well as sovereign credit risk which led to a further rise in both credit risk levels (Acharya, Drechsler and Schnabl, 2011; Ejsing and Lemke, 2011). Although bailouts benefit the economy, by revoking the under-investment problem during financial crises, funding such bailouts can rather be problematical. Funding bailouts by higher taxation is inefficient, especially in downturn times of the economy, because it weakens the incentives to invest, thereby decreases economic growth (Acharya, Drechsler and Schnabl, 2011). Another way of funding bailouts in the short run is the issuance of government bonds. This however dilutes existing bondholders and results in an aggravation of a sovereign's creditworthiness. Acharya, Drechsler and Schnabl (2011) show that such a way of funding has a two-way feedback between bank credit risk and sovereign credit risk. The financial system depends on its own direct government bond holdings, but also on the implicit safety net of the government. Therefore, the additional cost of bailouts is the emergence of a noticeable sovereign credit risk, which suggests a pyrrhic victory for the financial system. Investors started to worry about the creditworthiness of sovereigns, in particular, about some Euro area countries. The financial crisis that covered the financial system has now turned into a sovereign debt crisis, putting at stake the solvency of sovereigns.

2.5 Measuring sovereign credit risk

The measurement of credit risk has already been explained in section 2.3 and it has been concluded that CDS spreads tend to be an accurate measurement for bank credit risk, and thus the same goes for sovereign credit risk. Acharya, Drechsler and Schnabl (2011) and Ejsing and Lemke (2011) use CDS spreads to measure sovereign credit risk as well.

However, considering the determinants of CDS spreads for sovereigns, some other factors seem to be important and have changed in the late-2000s financial crisis. Sgherri and Zoli (2009) argue that projected debt changes have become increasingly significant in recent years. Acharya, Drechsler and Schnabl (2011) show that the debt-to-GDP is indeed an important determinant of sovereign credit risk. Additionally they show that the changes in the CDS Market Index, e.g. iTraxx Europe, have a high positive correlation with changes in sovereign credit risk. Longstaff, Pan, Pedersen and Singleton (2007) show that the state of the local economy has significant effects on sovereign credit risk; which they measure by the local stock market index. Furthermore, the weakness of the financial sector seemed not to be an important determinant prior to the financial crisis, but became increasingly significant

when it progressed (Mody, 2009). Additionally, the same goes for risk averseness (Attinasi, Checherita and Nickel, 2009), measured as the spread between the yield on 10-year U.S. Corporate AAA bonds and the yield on the 10-year U.S. government bonds. At last, liquidity remains to be an important determinant for sovereign credit risk; high liquid government bond markets tend to have a lower CDS spread (Attinasi, Checherita and Nickel, 2009).

Since my focus is on investigating the direct relationship between bank credit risks and sovereign credit risk, not all factors mentioned above will be incorporated in the empirical research. However, many of these variables can explain variation in sovereign credit risk; therefore some of them will be used as control variables. Additionally, since bank CDS and sovereign CDS will be measured on a daily basis, using a variable e.g. debt-to-GDP is a bit inconvenient. Therefore, the controls have been chosen based on their daily availability.

2.6 Conceptual model for empirical research

The previous sections explained the shift from a financial crisis, with high bank credit risks, to a sovereign debt crisis, with high sovereign credit risk. The next chapter will empirically investigate the relationship between these two factors for the Euro area countries during the late-2000s financial crisis. As a general overview figure 2.3 presents the conceptual model for empirical research. The effect of bank credit risks on sovereign credit risk will be investigated based on the respective CDSs. The control variables which will be used as a support to explain variation in sovereign credit risk are presented in figure 2.4.

Figure 2.3: Conceptual model for empirical research

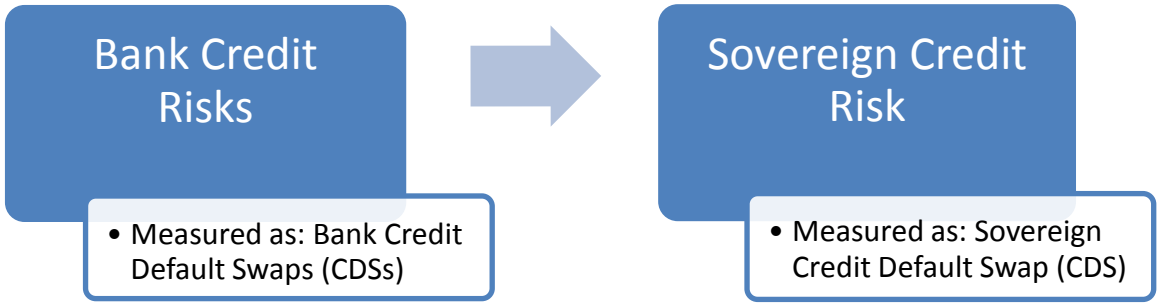


Figure 2.4: Control variables for empirical research

3. Empirical analysis

In this chapter, empirical research will examine how bank credit risks and sovereign credit risk have evolved during the late-2000s financial crisis and the sovereign debt crisis in the Eurozone and what their relationship is during this period; thereby sub question 3 will be answered. First of all, the research methodology will be described, including a formulation of the hypotheses. Secondly, a description of the data will show the evolvement of bank credit risks and sovereign credit risk. At last, the hypotheses will be tested to examine the relation between bank credit risks and sovereign credit risk.

3.1 Methodology and hypotheses

Since I am specifically interested in the direct relationship between bank credit risks and sovereign credit risk during the late-2000s financial crisis and sovereign debt crisis in the Euro area countries, I will firstly test this relationship without the control variables mentioned in section 2.6. The model which is going to be used to test this relationship is as follows:

$$\Delta\, LOG(Sovereign\ CDS_{(j,t)}) = \alpha + \beta\, \Delta\, LOG(Bank\ CDS_{(j,t)}) + \varepsilon_{(j,t)}$$

Where $Sovereign\ CDS_{(j,t)}$ is measured as the respective 5-year senior sovereign CDS in basis points (bps) of country *j* at time *t*. $Bank\ CDS_{(j,t)}$ is measured as the weighted average of 5-year senior bank CDS in bps for all banks with traded CDS headquartered in country *j* at time *t*. Lastly, $\varepsilon_{(j,t)}$ represents the random error term in country *j* at time *t*. The LOG change is used since I am dealing with a possibly non-stationary variable. The LOG makes it easier to analyze the countries separately and interpret the beta of the regression. Subsequently, the Δ (change) is used since I am interested in the relationship between the changes of both variables; thereby a decrease or an increase in the variables is important to detect in order to be able to show a potential negative relationship. The LOG change in a variable is considered to be equal to the relative change in that variable (Törnqvist, Vartia and Vartia, 1985)

The weighted average bank CDS is calculated based on the size of total assets the respective banks have. These in contrast to Acharya et al (2011) which have used the 'unweighted' average to calculate bank CDS in a respective country. I differ from this 'regular' method since I expect that the respective size of a bank is an important component of its effect on sovereign CDS. Referring to the terms of 'too interconnected to fail' and 'too big to fail', larger banks are considered to be more important than smaller banks. Thereby, the effect of a change in the CDS of a large bank on sovereign CDS is expected to be larger. Additionally, it would be unreasonable for example to put the same weights for the French banks Le Crédit Lyonnais and BNP Paribas, since Le Crédit Lyonnais deals with about 100

billion assets opposed to about 2000 billion assets of BNP Paribas. Therefore, I will use the weighted average method as a measurement for average bank CDS in a respective country, but as a comparison with the unweighted average method the results of both will be presented.

Since CDSs are traded on a daily basis, they will be smoothed to sharp irregular movements on days, following Eichengreen et al (2009). By smoothing the daily data, I attempt to capture important patterns in the periods, while eliminating 'noisy' data. For smoothing I have used a 5-day linearly weighted moving average (LWMA), a technique that assigns more value to current observations and less to earlier observations on a linear basis. I found this technique appropriate because it sharps and reduces the irregular movements of days, but is still more responsive to the present observations (as opposed to a regular moving average). Using more days in the LWMA is inappropriate since the bailout period is a rather short period, meaning that the data from that particular period would be too smoothed for testing hypothesis 2.

The objective of this empirical research is to examine the relationship between bank credit risks and sovereign credit risk during the late-2000s financial crisis and the sovereign debt crisis in the Eurozone. Therefore data will be collected from the start (1st of July 2007) up to now (20th of April 2012). The previous chapter has described the evolvement from the start of the late-2000s financial crisis up to the transition to a sovereign debt crisis. From that perspective on, the data are divided among four periods: pre-bailout, bailout, post-bailout I and post-bailout II, for which the model will be tested separately. An overview of the data division for each period is presented in table 3.1.

Table 3.1: Data division among periods

Period	**Start date**	**Ending date**
Period 1: Pre-bailout	1st of July 2007	25th of September 2008
Period 2: Bailout	26th of September 2008	13th of October 2008
Period 3: Post-Bailout I	14th of October 2008	22nd of July 2010
Period 4: Post Bailout II	23rd of July 2010	20th of April 2012

The pre-bailout period captures the start of the late-2000s financial crisis, since in July 2007 housing price started to fall dramatically and turmoil started to hit the interbank market, until 25th of September 2008, almost one and a half week after the fall of Lehman brothers. This date is specifically chosen since it is just before the bailout announcement for many banks, but still incorporates the immediate effect of the bankruptcy of Lehman Brothers. From the previous chapter, I know that bank credit risks increased significantly during this period, but sovereign credit risk remained more or less the same. This implies that a weak relationship between bank credit risks and sovereign credit risk can be expected. Thereby,

hypothesis 1 will be: *There is no significant relationship between bank credit risks and sovereign credit risk in the pre-bailout period.*

The bailout period lasts from the 26th of September 2008 until the 13th of October 2008. This period incorporates the first bank bailout announcements by sovereigns. Note that some of them were announced later on, but were more or less expected since sovereigns' partly reacted on other sovereigns' announcements (Acharya et al, 2011). Additionally, after the first bailout announcement investors may have speculated on the bailouts by other countries. From the previous chapter on we know that the intention of these bailouts was to decrease bank credit risks, but in the meantime the high costs of these large bailouts increased sovereign credit risk. Therefore **hypothesis 2** will be: *There is a significant negative relationship between bank credit risks and sovereign credit risk in the bailout period.*

The post-bailout period is split up in two periods in order to examine whether the relationship between bank credit risks and sovereign credit risk has changed over the years of a worsening sovereign debt crisis. The first post-bailout period starts with the end of most bank bailouts, 14th of October 2008, and lasts until the 22nd of July 2010, just before the results of the second European-wide bank stress test were presented and published[4]. The second post-bailout period therefore captures these results and the period lasts until the last date for observed data of CDSs (20th of April 2012). This split up has been chosen because the results of the second European-wide bank stress test were widely published which contained important information about the financial strength of many European Banks. Furthermore the months before were characterized by the downgrading's of Spain, Greece and Portugal; a worsening sovereign debt crisis. From the previous chapter, I know from Sgherri and Zoli (2011); Acharya et al (2011) that risk transferring eventually contaminated both sovereign credit risk and bank credit risks, arguing that there is a positive co-movement in the post-bailout period. Therefore **hypothesis 3** will be: *There is a significant positive relationship between bank credit risks and sovereign credit risk in the first post-bailout period.* Intuitively the same applies to the second post-bailout period. Therefore **hypothesis 4** will be: *There is a significant positive relationship between bank credit risks and sovereign credit risk in the second post-bailout period.* At last the results from the first and second post-bailout period will be compared and examined. Therefore **hypothesis 5** will be: *There is a significant difference between the relationship of bank credit risks and sovereign credit risk in the first and second post-bailout period.*

After the hypotheses are tested for the direct relationship between bank credit risks and sovereign credit risk, the model will be extended by adding the control variables mentioned in

[4] Europe's bank stress tests – partial stress relief. (2010, July 23). *The Economist.*

section 2.6; international risk aversion, local stock market index and the CDS market index. Note that the constant will be omitted in this extended model, since I expect that the control variables will explain a large part of the variation that was previously explained by the constant[5]. Firstly, international risk aversion will be measured as the spread between the yield on 10-year U.S. Corporate AAA bonds and the yield on the 10-year U.S. government bonds. Note that it is really the state of this difference that matters (Attinasi, Checherita and Christiane, 2010), therefore I will incorporate the specific difference and not the relative change. Secondly, local stock market index is measured as the most important stock market index in a particular country, e.g. the AEX-index for the Netherlands. Since the relative change per day is the factor that matters here, the relative change in the local stock market index will be used as a control. At last, CDS market index is measured as iTraxx Europe, a benchmark index from Markit comprised of 125 equally-weighted European names. Since the index is comparable to bank and sovereign CDS, the CDS market index will be calculated as the Δ LOG (CDS market index). Because bank and sovereign CDS are smoothed by a 5-day LWMA, so will be the control variables, to establish an accurate match between the variables in the model.

After the control variables have been used in the extended model to provide additional explanation in the variation of sovereign credit risk, I will incorporate country dummies and the interaction terms between Δ LOG (Banks CDS) and the country dummies to take into account the possible differences between the countries in the panel.

3.2 Data description and summary statistics

To examine the relationship between banks CDSs and sovereign CDS, I firstly determine the countries for examination. I select the Euro area countries with a GDP above 200 billion Euros according to the World Bank 2010; since smaller countries do not tend to be that important either do have banks with traded CDS. The Euro area countries for examination will therefore be: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal and Spain.

Secondly, I search for banks with traded CDS headquartered in these specific countries, for that I use Bankscope to check which banks are present in those countries. The country in which the headquarters of a particular bank is established determines to which country a bank belongs. Since not all banks will have traded CDS, I will only incorporate banks with more than 50 billion euros of total assets on the 31st of December 2010 in the

[5] Because of this, the number of observations differ between the models

dataset. Exceptions are made if the bank is listed on the stock exchange or recapitalized/ guaranteed during the late-2000s financial crisis and is still reasonable sized.

Subsequently, I then use Bankscope to check for bank characteristics (incl. listed or not) and total assets on the 31st of December 2010. I detect that the data for total assets from Bankscope are not always accurate; therefore I check the annual reports of the banks incorporated in the dataset for their accurate size of total assets. Accuracy is particular important since the size of total assets will be used to calculate the weighted average bank CDS. Note that the size of total assets is set at one specific point in time, namely the 31st of December 2010, thereby equal for all the periods that will be tested. Furthermore to prevent estimated double counting of specific credit risks, I check if the respective banks are subsidiaries of another bank or not, if so, the respective bank is omitted. To check whether a bank was recapitalized or guaranteed during the late-2000s financial crisis I use Petrovic and Tutsch (2009) and some insignificant sources for verification.

I then check for the presence of 5-year senior traded CDS for all these banks in Datastream. The tables in Appendix B present a survey of these results for each country separately. Additionally, I also retrieve the data for sovereign CDS from Datastream. Datastream has two databases for traded CDS; CMA Datavision (CMA) and Thomson Reuters (TR). CMA mostly covers the earlier years and the TR covers mostly the latest years. A brief description of merging the data from these databases and a table for merging dates can be found in Appendix C.

Finally, I retrieve data for the control variables from Datastream. For international risk aversion I use the difference between the yield on 10-year U.S. Corporate AAA bonds and the yield on the 10-year U.S. government bonds. I measure the CDS Market Index as a 5-year senior iTraxx Europe. Lastly, I measure the local stock market index as the most important stock market index in a particular country, a list of these indices can be found in table C3 of Appendix C.

Additionally, to avoid stale data I omit zero changes in bank CDS or sovereign CDS as in Acharya et al (2011). Stale data arises when e.g. average bank CDS changes but sovereign CDS is not updated (thereby remains the same). Because of the smoothing method described in section 3.1, some zero changes are incorporated in the dataset. However, the data retrieved from those normally zero changes are almost equal to zero (below 1.000E-04). Therefore changes with an absolute value less than (1.000E-04) are omitted. This change is effective since the results for all periods described in the next section improve.

I find proper CDS data for 58 banks established in the eleven countries. After smoothing this daily data by the LWMA technique, I calculate the weighted average banks

CDS for each country based on the size of total assets on the 31st of December 2010. The tables of Appendix D present the summary statistics for the total model and all periods separately. The average size of total assets for banks at the 31st of December 2010 with traded CDS is 356.71 bps. About 70% of these banks were recapitalized or guaranteed[6].

In the pre-bailout period, the weighted average bank CDS is 83.19 bps, opposed by an unweighted average bank CDS of 91.03 bps. The average sovereign CDS is 16.44 bps. The figures E1 and E2 in Appendix E present the evolvement of bank and sovereign CDS for respectively Germany and Portugal. These figures show that the sovereign CDS for Germany and Portugal remain quite stable over this period, the same goes for the other countries. Additionally, figure E3 shows the changes in bank and sovereign CDS over the pre-bailout period. Thereby, bank CDS increased significantly and sovereign CDS did not change that much in the pre-bailout period; this implicates that the bank bailouts were unanticipated before September 2008. The large increase in bank CDSs is devoted to worsening creditworthiness of many banks due to the write-downs on MBSs and CDOs, described in the previous chapter.

The bailout period is characterized by decreasing bank CDS and increasing sovereign CDS, which is illustrated in the side-figures of the figures D8 and D9. Figure E4 shows the changes in bank and sovereign CDS over the bailout period for all countries. Only Finland, Greece and Netherlands experienced an increase in bank CDS during this period. The weighted and unweighted average bank CDS during the bailout period are respectively; 178.60 and 197.95 bps. The average sovereign CDS is 40.44 bps.

In the first post-bailout period the weighted average bank CDS increases to 201.12 bps, opposed to an unweighted average bank CDS of 219.16 bps. Sovereign CDS increases sharply to an average of 101.74 bps. As figure E1 shows, German bank and sovereign CDS were quite volatile in this period, but remain more or less the same. The same goes for most of the other countries, except for Greece, Ireland and Portugal (figure E2) which encountered a large increase in bank and sovereign CDS. Ireland suffered a bank crisis, while Greece and Portugal were downgraded by rating agencies. Figure E5 presents the changes in bank and sovereign CDS during this period for all countries. Remarkable is that the average bank CDS in Finland and the Netherlands decreased.

Lastly, the second post-bailout period is characterized by a large increase in the volatility of bank and sovereign CDS. The weighted average bank CDS increases to 493.49 bps, while the unweighted average bank CDS increases to 519.47 bps. Sovereign CDS

[6] Note that the Spanish and Italian banks are excluded since I could not find reliable information to verify bailouts in these countries.

explodes, mainly because of Greece (see figure E7), up to 570.65 bps. Even more remarkable is the change in volatility, 103.99 bps in the first post-bailout period, increased to 1759.18 bps in the second post-bailout period. Volatility in bank CDS increased as well, from 174.12 bps (158.05 bps) to 531.73 bps (538.08) in the second post-bailout period. Figure E6 shows the changes in bank and sovereign CDS for all countries.

3.3 Testing hypotheses

Based on the data from the previous section, the direct relationship between bank and sovereign CDS will be investigated for the four periods mentioned in section 3.1; thereby the hypotheses formulated in that section will be tested. Further, the end of each subsection will briefly present the results of the extended model. Since that model will have multiple variables, the VIF-values will be analyzed to check for multicollinearity.

3.3.1 Total model (2/7/2007 - 20/4/2012)

Before running into the separate periods, the whole model will be tested. Based on the results of this model I will decide whether to use the weighted or the unweighted method to calculate average bank CDS. The model starts on the 2th of July 2007 with falling housing prices and financial turmoil starting to hit the interbank market, causing the first illiquidity waves in the financial market. The model ends at the 20th of April 2012 in the current financial situation, a sovereign debt crisis for many Euro area countries.

Table F1 in Appendix F presents the correlation matrix for this model. Note that the correlation between the weighted and unweighted average is included in this matrix to see their co-movement in the model. There is a strong and significant overall correlation between bank CDS and sovereign CDS. The weighted and unweighted method to calculate average bank CDS are logically highly correlated.

The results for the whole model are presented in table F2; in which column (a) presents the weighted average method and column (b) the unweighted average method. Based on these results I conclude that the weighted average method does a better overall job in predicting sovereign CDS, then the unweighted average method since its R-squared is clearly higher. The R-squared of the weighted average method is 0.162 opposed by an R-squared of 0.144 for the unweighted average method. Therefore I will use the weighted average (WA) method as a calculation of average bank CDS for the separate periods and extended model, even though the results for the unweighted average (UA) method are shown for comparison when testing the direct relationship.

3.3.2 Pre-bailout period (2/7/2007 – 25/9/2012)

The pre-bailout period was characterized by increasing bank CDSs and stable sovereign CDS. This indicates that there is no or at the most a weak relationship between bank credit risks and sovereign credit risk. Thereby, hypothesis 1: *There is no significant relationship between bank credit risks and sovereign credit risk in the pre-bailout period* will be tested for this period.

The results of regressing the LOG change in sovereign CDS on the LOG change in average bank CDS during the pre-bailout period is presented in column (a) of table F3. Although a non-relationship was more or less expected, the results show that there is a positive significant relationship between bank credit risk and sovereign credit risk. The beta of 0.287 (significant at $\alpha = 0.01$) implicates that a 10% increase in average bank CDS leads to an increase in sovereign CDS of 2.87%. However, the R-squared is only 0.063, implying that average bank CDS predicts only 6.3% of the variation in sovereign CDS.

Extending the model in this period with the control variables improves the R-squared up to 0.105, implying that 10.5% of the variation in sovereign CDS can be explained by average bank CDS and its control variables. The results for this model are shown in column (b) of table F4. The relationship between average bank CDS and sovereign CDS remains positive and weak, beta of 0.197 (significant at $\alpha = 0.01$). The control variables stock market index and international risk aversion are significant at ($\alpha = 0.01$). Note that the relationship between stock market index and sovereign credit risk is negative, since a good state of the economy decreases the credit risk level of a sovereign. The control variable CDS Market index is insignificant in this period.

When I add dummies for countries and interaction terms between the country dummies and the LOG change in average bank CDS, the model improves only slightly (see column (b) in table F5). This implicates that the relationship between bank credit risks and sovereign credit risk does not differ greatly from country to country. Note that nothing special needs to be said about the VIF-values in this period.

Overall conclusion for the pre-bailout period is that there is a positive relationship between bank credit risks and sovereign credit risk, but that this relationship is rather weak. The predictability of the model is relatively poor.

3.3.3 Bailout period (26/9/2008 – 13/10/2008)

As figure E4 shows, the bailout period was characterized by decreasing bank CDS and increasing sovereign CDS, suggesting that a risk transfer in this period exist. To verify

whether that is indeed the case, hypothesis 2: *There is a significant negative relationship between bank credit risks and sovereign credit risk in the bailout period* will be tested.

Regressing the LOG change in sovereign CDS on the LOG change in average bank CDS during the bailout period leads to the results presented in column (c) of table F3. These results confirm that a risk transfer between bank credit risks and sovereign credit risk indeed occurred during the bailout period. The beta of -0.275(significant at $\alpha = 0.01$) implicates that a decrease in average bank CDS of 10% leads to an increase in sovereign CDS of 2.75%. Although a negative relationship is evidenced, the predictability is rather poor. The R-squared indicates that only 6.6% of the variation of sovereign CDS is predicted by the average bank CDS.

However, if you shorten the end date of the bailout period the predictability of average bank CDS increases severely. Column (e) of table F3 shows the results of a shortened bailout period that lasts from 26/9/2008 to 3/10/2008. The results are striking; the beta of -0.598 (significant at $\alpha = 0.01$) implicates that a decrease of 10% in average bank CDS leads to a 5.98% increase in sovereign CDS and the R-squared indicates that average bank CDS explains 28.2% of the variation in sovereign CDS.

If I extend the normal bailout model with the controls, the R-squared increase drastically to 0.638; implying that 63.8% of the variation in sovereign CDS can be explained by average bank CDS and its control variables. The results for the extended model in the bailout period are presented in column (d) of table F4. The beta (significant at $\alpha = 0.01$) between average bank CDS and sovereign CDS becomes even more negative (-0.348), implicating that a 10% decrease in average bank CDS leads to an increase of 3.48% in sovereign CDS. Further, all control variables are significant (at $\alpha = 0.01$). Note that the beta of stock market index is significant positive, which implicates that a good day at the stock exchange (increasing stock prices) associates with an increase in sovereign CDS. This can be explained via the risk transfer of bank and sovereign CDS; since the risk of banks decreased at the costs of sovereigns, the future prospects improved which stimulated the stock price to increase.

Extending this model with dummies for countries and interaction terms between the country dummies and the LOG change in average bank CDS, improves the R-squared even further, to 0.741 (see column (d) in table F5). This implicates that 74.1% of the variation in sovereign CDS during the bailout period van be explained by this model. Intuitively, since the R-squared improved quite a lot with this addition, I can conclude that the relationship between average bank CDS and sovereign CDS differs considerably from country to country. Note that nothing special needs to be said about the VIF-values in this period.

At last, the overall conclusion is that a risk transfer between bank credit risks and sovereign credit risk indeed occurred; there is a clear negative relationship between bank credit risks and sovereign credit risk. The essence of this risk transferring is settled in the beginning of the bailout period and differs considerably from country to country.

3.3.4 Post-bailout period I (14/10/2008 - 22/7/2010)

Although a risk transfer between bank credit risks and sovereign credit risk succeeded via many bailouts, the literature review suggests an eventual contaminating effect between both risks. This indicates a positive relationship between bank credit risks and sovereign credit risk. Therefore hypothesis 3: *There is a significant positive relationship between bank credit risks and sovereign credit risk in the first post-bailout period* will be tested.

The results of the regressing the LOG change in sovereign CDS on the LOG change in average bank CDS in the first post-bailout period are presented in column (g) of table F3. The results indeed confirm that there is a clear and significant positive relationship between average bank CDS and sovereign CDS in the first post-bailout period. The beta of 0.947 (significant at $\alpha = 0.01$) implicates that a 10% increase in average bank CDS leads to a 9.47% increase in sovereign CDS. The R-squared shows that 37.3% of the variation in sovereign CDS is explained by average bank CDS.

Extending the direct model with the control variables, improves the model to an R-squared of 0.465 (see column (f) of table F4); implicating that 46.5% of the variation in sovereign CDS is explained by this model. Although the beta of average bang CDS decreased, it is still significantly positive (at $\alpha = 0.01$); meaning that the positive relationship between average bank CDS and sovereign CDS, which I evidenced before, still holds. All control variables are significant (at $\alpha = 0.01$) and the beta of the stock market index is again negative, as it was in the pre-bailout period.

When I add the dummies for countries and interaction terms between the country dummies and the LOG change in average bank CDS, the model improves only slightly (see column (b) in table F6). As explained before in the pre-bailout period; this implicates that the relationship between average bank CDS and sovereign CDS does not differ considerably from country to country. Note that nothing special needs to be said about the VIF-values in this period.

Concluding this subsection, states that there is a strong positive relationship between bank credit risks and sovereign credit risk during the first post-bailout period.

3.3.5 Post-bailout period II (23/7/2010 – 20/4/2012)

The second post-bailout period was characterized by a worsening sovereign debt crisis. In the months before this period, the first downgrading's on countries took place. Furthermore, the second post-bailout period itself incorporates the publication of the results from the second European-wide bank stress test, an important event since this test contained important about the financial strength of many European banks. Figure E6 shows that average bank CDS and sovereign CDS exploded in some of the countries, implying a positive relationship during this period. Therefore hypothesis 4: *There is a significant positive relationship between bank credit risks and sovereign credit risk in the second post-bailout period* will be tested.

Column (i) of Table F3 shows the results of regressing the LOG change in sovereign CDS on the LOG change in average bank CDS during the second post-bailout period. The results appear to be quite similar to the first post-bailout period; the beta of 0.917 (significant at $\alpha = 0.01$) is high and implicates that a 10% increase in average bank CDS leads to an increase of 9.17% in sovereign CDS and the explanatory variation of average bank CDS on sovereign CDS described by the R-squared is 34.4%.

Extending this model with the control variables improves the model to an R-squared of 0.436 (see column (h) of table F4), implicating that 43.6% of the variation in sovereign CDS in the second post-bailout period can be explained by average bank CDS and its control variables. The beta (significant at $\alpha = 0.01$) has the same pattern as in the first post-bailout period; it decreased but still indicates a strong and significant positive relationship between average bank and sovereign CDS. The control variables are all significant, but note that the significance level of stock market index decreased form a 1% level to a 5% level, compared with the first post-bailout period. Additionally, the beta of stock market index is positive, as it also was during the bailout period. Although this might be a bit remarkable since that implicates that increased stock prices associate with an increase in sovereign CDS but a risk transfer did not occur, the beta is rather weak (0.055).

Adding the dummies for countries and interaction terms between the country dummies and the LOG change in average bank CDS, improves the model only slightly (see column (d) of table F6). As it was the case in the pre-bailout and first post-bailout period; this implicates that the relationship between average bank CDS and sovereign CDS does not differ considerably from country to country. However, until this period and addition of dummies, no VIF-value of the variables in the model asked for immediate attention, but here the significance of the control variable international risk aversion is influenced and has become insignificant due to a high VIF-value. Since this is only a control variable, its goal is simply to

provide additional predictability of the variation in sovereign CDS. Therefore the multicollinearity in this model is not an issue, since the predictions (R-squared) will still be accurate

Overall conclusion is that there still is a strong positive relationship between bank credit risks and sovereign credit risk nowadays.

3.3.6 Comparison between first and second post-bailout period

Because the time period after the bailouts is rather large, it has been split up in a first and second post-bailout period. Now that the direct relationship between bank credit risks and sovereign credit risk in these periods are known, it is interesting to examine whether this relationship has changed over the time period after the bank bailouts. Therefore, hypothesis 5: *There is a significant difference between the relationship of bank credit risks and sovereign credit risk in the first and second post-bailout period* will be tested. This test will be done for the weighted average method, as well as the unweighted average method. Note that this test will only be done for the betas from the model that explains the direct relationship, so without the control variables, dummies and interaction terms.

In order to examine whether the relationship between bank credit risks and sovereign credit risk is different in the two periods, I have to test whether the betas of the respective periods are unequal. For this, I use a Student's t-test, but before doing so, the variances of the respective beta's need to be tested on equality via an F-test (Nieuwenhuis, 2009). The procedures and results for these tests are presented in Appendix G.

Weighted average method

The F-test cannot conclude that the variances for both periods are unequal; therefore an equal variance t-test will be used to test the betas. Then, the results of this t-test cannot show that the betas, thereby the relationship between bank credit risks and sovereign credit risk in the first and second post-bailout period, are statistically different from each other. Note that the betas of two samples can be equal, while their correlations are unequal, or the other way around. Therefore, I additionally tested whether the correlations of both periods are unequal, based on the procedures of Fisher (1921). The z-test cannot show that the correlations of both periods are statistically different.

Concluding from this; the tests for equality of the betas and correlations from the first and second post-bailout period cannot show that the relationship between bank credit risks and sovereign credit risk is statistically different. Thereby, it cannot be shown that the

relationship between bank credit risks and sovereign credit risk has changed over the time of the post-bailout periods.

Unweighted average method

Doing the same for the unweighted average method gives remarkably the opposite results. The variances are unequal, which is not really an issue. But the correlations and betas for the two periods are also unequal according to the results. Via this, the conclusion would be that the relationship between bank credit risks and sovereign credit risk has changed over the time of the post-bailout periods.

There can only be one reason why these results don't match: the method used to calculate average bank CDS. As explained in the methodology section, the weighted average method is used since larger banks are bigger than smaller ones and therefore are expected to be more important to sovereign CDS, simply because more assets are at stake. The unweighted average method is biased on this, since it demarcates the same weights to all banks in a country, thereby ignores the size of banks. As a consequence the unweighted average method, underestimates the relative changes in bank CDS of larger banks and overestimates the relative changes in bank CDS of smaller banks.

The reason for the difference in results is that in general (over the whole panel) the relative changes in bank CDS of smaller banks have decreased more than the relative changes in bank CDS of larger banks have decreased in the second post-bailout period. This explains that the beta of the second post-bailout period for the unweighted average method decreased more than for the weighted average method, because it overestimates smaller banks and underestimates larger banks.

4. Conclusions, implications and recommendations

This thesis gives a profound overview of the development from a financial crisis to a sovereign debt crisis. Quantitative easing of the FED after the dot-com bubble and the terrorist attacks of September 2001 caused high liquidity in financial markets, urging the need for financial innovation, which led to the concept of securitization with new financial instruments as MBSs and CDOs. Based on an originate-to-distribute business model, these instruments facilitated a rise in mortgage lending that stimulated a boom in the U.S. real estate market, worsening the quality of credit and masked by increasing housing prices, resulting in the subprime mortgage crisis. Then the burst of the housing bubble caused large write-downs on MBSs and CDOs, leading to a crisis of confidence, as a result, liquidity in financial markets dried up. Globalization and mainly the concept of securitization have spread the crisis globally. The combination of illiquid financial markets and write-downs affected bank capital, thereby its solvency, causing bank credit risks to increase.

As a consequence of undercapitalization banks needed to deleverage, which is rather expensive in an illiquid market, combined with the principles of 'too big to fail' and too interconnected to fail', governments had no other choice than to play as a 'lender of last resort'. A risk transfer occurred; many banks got bailed out or guaranteed by sovereigns, funded by the new issuance of government bonds. However, the funding was problematical since many Euro area sovereigns entered the financial crisis with large budget deficits and debt-to-GDP ratios. This implied that the sovereign's creditworthiness got affected; as a result the risk transfer contaminated both banks and sovereigns, since banks have large stakes in government bonds. Sovereign credit risk increased severely, leading to a sovereign debt crisis. Nowadays, with the rescue packages, restricted default of Greece and the promises of countries to reduce budget deficits, a plan for recovery has set up; coming years will be the litmus test for many Euro area countries, especially in the south.

The empirical analysis in this thesis shows a changing relationship between average bank credit risk and sovereign credit risk, via a panel study on bank and sovereign CDS for eleven Euro area countries in the period 2007-2012. In the period before the bailouts the relationship is positive but rather weak. The bailout period has a clear negative relationship, thereby evidencing a risk transfer between bank credit risks and sovereign credit risk. The period after the bailouts is split into two periods, because of a worsening sovereign debt crisis. Both periods are characterized by a strong positive relationship, but there is no significant difference between the betas and correlations in these periods.

Additionally, international risk aversion, local stock market index and CDS market index are important control variables for testing this relationship. Including dummies and

interaction terms of the dummies and average bank CDS in the panel study, shows that the relationship between average bank credit risk and sovereign credit risk does not differ considerably from country to country, except for the bailout period which shows to be quite diverse for the Euro area countries.

Average bank CDS is calculated on a weighted average bases, determined by the size of total assets. Empirical analysis shows that the weighted average method does a better overall job in predicting sovereign credit risk than the unweighted average method does, used in earlier research. Even further, the unweighted average method underestimates the relative changes in bank credit risk of larger banks and overestimates the relative changes in bank credit risk of smaller banks, leading to biased results and interpretations.

Future research could focus on extending the model of bank credit risks and sovereign credit risk, based on the weighted average method, since a sizeable part of the variability in sovereign credit risk remains unexplained, especially in the pre-bailout period. The unweighted method to calculate average bank CDS should be avoided since it leads to biased results and interpretations. Country specific macroeconomic factors as (expected) fiscal budget deficit/surplus as percentage of GDP and (expected) debt-to-GDP ratio have a special interest for future research, since they play an important role in the current situation of sovereigns and their plans for recovery. Limitations for these factors are accessibility and availability on a regular time span. Additionally, it would be interesting to see whether the relationship of these factors with sovereign credit risk has changed over the progression of the crisis. New panel research could specifically focus on the period prior to the bank bailouts, to reveal which important factors are missing in that specific period. Furthermore, at country level, research could investigate which factors become (more) important when a country approaches a sovereign default, such as for Greece.

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Appendix A: Abbreviations

ABS	=	Asset-Backed Security
Bps	=	Basis points
CDO	=	Collateralized Debt Obligation
CDS	=	Credit Default Swap
CMA	=	CMA Datavision
ECB	=	European Central Bank
FED	=	Federal Reserve System
GDP	=	Gross Domestic Product
GSE	=	Government Sponsored Entity
GT	=	Guaranteed
LIBOR	=	London Interbank Offered Rate
LWMA	=	Linearly Weighted Moving Average
MBSS	=	Mortgage Backed Security
MM	=	Modified-Modified restructuring
NINJA	=	No Income No Job or Assets
RC	=	Recapitalized
TAF	=	Term Auction Facility
TALF	=	Term Asset-backed securities Loan Facility
TARP	=	Troubled Asset Relief Program
TED	=	Treasury-bill Eurodollar
TR	=	Thomson Reuters
UA	=	Unweighted Average
WA	=	Weighted Average

Appendix B: Banks in the dataset

This appendix will show which banks in the eleven countries of the dataset have traded CDS and which do not. Selection for seeking is based on firms that are listed, bailed out/recapitalized (RC)/guaranteed (GT) during the late-2000s financial crisis and/or size of total assets. The norm for size of total assets was 50 billion. A general note to all the tables below: The amounts of total assets are in billions of euros at 31st of December 2010. Additionally, when it is said that a bank is not incorporated in the dataset, it does not necessarily imply that it has traded CDS and is omitted, but that it is omitted for the selection for the seeking of banks with traded CDS. Thereby, it is not searched for whether such a bank has traded CDS since it is omitted because of a certain reason (e.g. size or subsidiary).

Table B1: Austria

Name	Listed	RC/GT	Large	Total Assets	Present
Erste Group Bank AG	✓	✓	✓	205.77	✓
Raiffeisen Zentralbank Österreich AG	✓*	✓	✓	136.50	✓
Volksbanken Verbund AG	-	-	✓	65.17	-
Österreichische Volksbanken AG	✓	✓	-	46.47	-
Hypo Group Alpe Adria AG	-	✓	-	38.75	-
Kommunalkredit AG	-	✓	-	16.27	-

* Only Raiffeisen International Bank AG which is part of Raiffeisen Zentralbank AG is listed.

¬ Note: Constantia was also recapitalized by the Austrian government, but its size is too small to incorporate it in the dataset. Additionally, UniCredit Bank Austria is large enough but is a division of UniCredito Bank which is established in Italy; therefore it is not included in the dataset. Proceeding with the other countries, bank divisions of this type will not be mentioned anymore, thereby excluded from the dataset.

Table B2: Belgium

Name	Listed	RC/GT	Large	Total Assets	Present
Dexia NV	✓	✓	✓	566.74	✓
Fortis Bank SA/NV*	-	✓	✓	347.97	✓
KBC Bank NV	✓	✓	✓	320.82	✓

* Fortis Bank SA/NV was acquired by the Belgium for 99.93% but resold to BNP Paribas on the 12th of May 2009. Fortis Bank Nederland was recapitalized by the Dutch government. Since this all happened during the late-2000s financial crisis, it is important to include Fortis Bank SA/NV in the dataset.

¬ Note: Banque Transatlantique Belgium is large enough but is part of Banque Transatlantique which is stated in France and belongs to the Credit Mutuel – CIC Group. Therefore it is completely left out of the dataset. Additionally, Ethias Group was recapitalized by the Belgium government but its size is reasonable small and therefore it is also left out of the dataset.

Table B3: Finland

Name	Listed	RC/GT	Large	Total Assets	Present
Nordea Bank Finland Plc*	-	-	✓	286.09	✓
OP-Pohjola Group	✓**	-	✓	83.97	-
Sampo Group Plc	✓	-	-	29.85	✓

* Nordea Bank is a Swedish bank but has important stakes in Finland. Since Sweden does not belong to the dataset, Nordea Bank Finland Plc is incorporated to the dataset of Finland. However, the Nordea Bank Finland Plc does not have its own traded CDS, therefore the traded CDS of Nordea Bank is used.

** Only Pohjola Bank plc which is part of the OP-Pohjola Group is listed.

¬ Note: Iceland's Kaupthing Bank was partly guaranteed by the Finish government, but its size is too small to incorporate the bank in the dataset.

Table B4: France

Name	Listed	RC/GT	Large	Total Assets	Present
BNP Paribas	✓	✓	✓	1998.16	✓
Crédit Agricole Group	✓	✓	✓	1730.85	✓
Société Générale	✓	✓	✓	1181.40	✓
BPCE Group*	-	✓	✓	1048.40	-
Natixis**	✓	-	✓	458.01	✓
Banque Fédérative du Crédit Mutuel	✓***	✓	✓	434.26	✓+
Caisse des dépôts et consignations	-	-	✓	269.52	-
Banque Centrale de Compensation SA	-	-	✓	246.26	-
La Banque Postale	-	-	✓	173.02	-
Le Crédit Lyonnais (LCL)++	-	-	✓	108.89	✓
Groupama Banque SA	-	-	✓	93.07	-

* BPCE Group consists of a merger between Banque fédérale des banques populaires and Caisse nationale des caisses d'Epargne, established in 2009.

** Natixis is part of the BPCE group, but since there is no traded CDS for this group nor the parent companies Banque fédérale des banques populaires and Caisse nationale des caisses d'Epargne, Natixis is incorporated in the dataset since it has traded CDS.

*** Some parts BCM are listed (Credit Mutuel Arkea and Crédit Industriel et Commercial)

+ FDCM has traded CDS, but the data has quite some zero changes and is therefore left out of the dataset to prevent stale data.

++ LCL was acquired in 2003 by Crédit Agricole, but because these banks compete extensively with each other, LCL is separately included in the dataset.

¬ Note: Crédit Foncier de France is large enough but belongs to Groupe Caisse d'Epargne (BPCE Group), even as Compagnie de Financement Foncier. Newedge Group is also large enough but is jointly owned in a 50/50 split between Crédit Agricole and Société Générale. Therefore, these banks are not incorporated in the dataset.

Table B5: Germany

Name	Listed	RC/GT	Large	Total Assets	Present
Deutsche Bank AG	✓	-	✓	1905.63	✓
Commerzbank AG	✓	✓	✓	754.30	✓
KfW Bankengruppe-KfW Group*	-	-	✓	441.80	-
DZ Bank AG	-	-	✓	383.46	✓**
LB Baden-Wuerttemberg	-	-	✓	374.41	✓
FMS Wertmanagement AöR	-	-	✓	357.75	-
Hypo Real Estate Group	-	✓	✓	328.12	-
Bayerische Landesbank	-	✓	✓	316.35	✓
Norddeutsche LB Girozentrale	-	-	✓	228.59	✓
Deutsche Postbank AG	✓	-	✓	214.68	-
WestLB AG	-	✓	✓	191.52	✓
LB Hessen-Thueringen	-	-	✓	152.56	✓
NRW Bank	-	-	✓	156.84	-
HSH Nordbank AG	-	✓	✓	150.93	✓
Landesbank Berlin Holding	✓	-	✓	131.48	✓***
DekaBank Deutsche Girozentrale	-	-	✓	130.30	-
Landwirtschaftliche Rentenbank	-	-	✓	78.50	-
Wüstenrot & Württembergische	✓	-	✓	75.99	-
Landeskreditbank Baden-Württemberg	-	-	✓	61.00	-
Aareal Bank AG	✓	✓	-	41.22	-
IKB Deutsche Industriebank AG	✓	✓	-	37.50	✓

* Owned by the Federal Republic and the States of Germany.

** DZ Bank AG has traded CDS, but the data has quite some zero changes and is therefore left out of the dataset to prevent stale data.

*** Landesbank Berlin Holding has traded CDS, but the data has quite some zero changes and is therefore left out of the dataset to prevent stale data.

¬ Note: Eurohypo AG is owned by Commerzbank AG. Deutsche Pfandbriefbank AG is part of the Hypo Real Estate Group. WGZ-Bank AG is part of the Genossenschaftlicher FinanzVerbund, even as the Deutsche genossenschafts-Hypothekenbank and Sparda-bank. The Deutsche Kreditbank belongs to the Bayerische Landesbank. Therefore, these banks are not incorporated in the dataset.

Table B6: Greece

Name	Listed	RC/GT	Large	Total Assets	Present
National Bank of Greece SA	✓	✓	✓	120.74	✓
EFG Eurobank Ergasias SA	✓	✓	✓	87.19	✓
Alpha Bank AE	✓	✓	✓	66.80	✓
Piraeus Bank SA	✓	✓	✓	57.68	-
Agricultural Bank of Greece	✓	✓	-	31.22	-

¬ Note: Emporiki Bank of Greece SA was acquired by Crédit Agricole in 2006 and is therefore not incorporated in the dataset. Additionally, Aspis Bank S.A., Attica Bank S.A., General Bank of Greece S.A., Millennium Bank S.A. and Proton Bank S.A. were all recapitalized by the Greek government, however these banks are way too small to incorporate them in the dataset.

Table B7: Ireland

Name	Listed	RC/GT	Large	Total Assets	Present
Bank of Ireland Group	✓	✓	✓	167.00	✓
Allied Irish Banks Plc	✓	✓	✓	145.22	✓
Depfa Bank Plc*	-	✓	✓	144.00	✓
Irish Life & Permanent Plc	-	✓	✓	75.51	✓
Anglo Irish Bank**	-	✓	✓	72.18	✓
Ulster Bank Group***	-	-	✓	66.40	-

* Depfa Bank Plc was acquired by Hypo Real Estate Group in 2007 and has had his impact on the Irish and German credit risks. Since Hypo Real Estate Group encountered financial difficulties, especially due to the debt burden of Depfka Bank Plc it needed to be bailed out by the German government. However, Hypo Real Estate Group does not have traded CDS, therefore the traded CDS of Depfa Bank Plc itself is included.

** Anglo Irish bank is part of the Irish Bank Resolution Corporation, a court-mandated merger between Anglo Irish Bank and Irish Nationwide Building Society. Both banks were nationalized after large write-downs, due to risky lending practices. But since Irish Bank Resolution Corporation has no traded CDS, the traded CDS of Anglo Irish Bank is used.

*** Ulster Bank group is a subsidiary of the Royal Bank of Scotland Group, but since the UK is not included in the dataset, Ulster Bank group stands for itself in this dataset.

¬ Note: Bank of Ireland Mortgage Bank is part of the Bank of Ireland Group; therefore it is not separately included in the dataset, even as AIB Mortgage Bank, which is part of Allied Irish Bank plc.

Table B8: Italy

Name	Listed	RC/GT	Large	Total Assets	Present
UniCredito Bank	✓	-	✓	929.49	✓
Intesa Sanpaolo	✓	-	✓	658.76	✓
Cassa Depositi e Prestiti	-	-	✓	249.18	-
Bance Monte dei Paschi di Siena SPA	✓	-	✓	244.28	✓
Banco Popolare SPA	✓	-	✓	135.16	✓
Unione di Banche Italiane S.c.p.A	✓	-	✓	130.56	✓
Cassa di Compensazione e Garanzia SPA	-	-	✓	94.54	-
Mediobanca	✓	-	✓	61.11	✓
Banca popolare dell'Emilia Romagna	✓	-	✓	58.50	-
Banco Popolare di Milano	✓	-	✓	54.03	✓
Banca Carige SPA	✓	-	-	40.01	-

¬ Note: Banca IMI is part of Intesa Sanpaolo, therefore it is not incorporated in the dataset, even as Creditis Servizi finanziari Spa which is a subsidiary of Banca Carige SPA. Banca Nazionale del Lavoro SpA is part of BNP Paribas. Therefore BNP Paribas bears the eventual risk of BNL and not the Italian government if a bailout is needed, as a result of BNL is excluded from the dataset. At last, Banco Italease has its own traded CDS, but because it is a subsidiary of Banco Popolare it is excluded from the dataset.

Table B9: Netherlands

Name	Listed	RC/GT	Large	Total Assets	Present
ING Bank NV	✓	✓	✓	1247.11	✓
Rabobank Group	-	-	✓	652.54	✓
ABN AMRO NV*	-	✓	✓	379.90	✓
AEGON NV	✓	✓	✓	332.30	✓
Fortis Bank Nederland NV*	-	✓	✓	228.53	✓
SNS Reaal NV	✓	✓	✓	127.67	✓
Bank Nederlandse Gemeenten NV	-	-	✓	118.53	-
Delta Lloyd Group NV	✓	-	✓	69.19	-
Nederlandse Waterschapsbank NV	-	-	✓	57.22	-
NIBC Bank NV	-	✓	-	28.01	✓**
Van Lanschot NV	✓	-	-	20.33	✓
LeasePlan Corporation NV	-	✓	-	17.47	-

* Fortis Bank Nederland was settled under ABN AMRO Group NV after it was nationalized by the Dutch government. However, due to its impact on the financial position of the Dutch government, Fortis Bank Nederland is separately included in the database.

** NIBC Bank has traded CDS, but the data has quite some zero changes and is therefore left out of the dataset to prevent stale data.

Table B10: Portugal

Name	Listed	RC/GT	Large	Total Assets	Present
Caixa Geral de Depositos	-	✓	✓	125.86	✓
Banco Comercial Português, SA-(Millennium BCP)	✓	-	✓	100.01	✓
Espírito Santo Financial Group	✓	✓	✓	87.15	✓
Banco Privado Atlântico Europa SA	-	✓	✓	68.18	-
Banco BPI SA	✓	-	-	45.66	✓

¬ Note: Banco Finiantia, Banco Internacional do Funchal and Banco Invest were also guaranteed by the Portuguesa government, but are too small to incorporate them in the dataset.

Table B11: Spain

Name	Listed	RC/GT	Large	Total Assets	Present
Banco Santander Group SA	✓	-	✓	1217.50	✓
Banco Bilbao Vizcaya Argentaria SA	✓	-	✓	552.74	✓
Banco Financiero y de Ahorros SA – Bankia Group	✓*	-	✓	328.28	-
La Caixa	✓	-	✓	285.72	✓
Caja Madrid**	-	-	✓	186.52	✓
Banco Popular Espanol SA	✓	-	✓	130.14	✓
Banco de Sabadell SA	✓	-	✓	97.10	✓
Bancaja***	-	-	✓	87.52	✓
CatalunyaCaixa	-	-	✓	81.02	✓
Instituto de Crédito Oficial	-	-	✓	77.86	-
Novacaixagalicia (NCG)	-	-	✓	73.49	✓+
Banca Cívica SA++	✓	-	✓	71.37	-
Caja de Ahorros del Mediterraneo+++	✓	-	✓	70.67	✓
Banco Mare Nostrum SA-BMN	-	-	✓	69.86	-
Bankinter SA	✓	-	✓	54.02	✓
Liberbank SA (Cajastur)	-	✓	✓	53.24	-
Bolsas y Mercados Españoles (BME)	✓	-	-	31.39	-
Banco Pastor	✓	-	-	31.13	✓

* Only Bankia SAU which is part of Banco Financiero y de Ahorros SA is listed.

** Caja Madrid (formally Caja de Ahorros y Monte de Piedad de Madrid) is part of Banco Financiero y de Ahorros SA, but because BFA has no traded CDS and Caja Madrid has, it is separately incorporated in the dataset.

*** Bancaja (formally Caja de Ahorros de Valencia Castellon y Alicante) is part of Banco Financiero y de Ahorros SA, but because BFA has no traded CDS and Bancaja has, it is separately incorporated in the dataset.

+ Novacaixagalicia (NCG) has traded CDS, but the data have quite some zero changes and is therefore left out of the dataset to prevent stale data

++ Banca Cívica SA is recently (2012) acquired by Caixabank, but because my dataset measures total assets at the end of 2010, it is investigated as a separate entity.

+++ Caja de Ahorros del Mediterraneo was acquired by Banco Sabadell in 2011, but because this is rather late in the late-2000s financial crisis its own traded CDS is included in the dataset.

¬ Note: Banesto (Banco Espanol de crédito SA) is owned by Banco Santander Group SA and is therefore not incorporated in the dataset.

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Appendix C: Merging data

As was said in section 3.2, the CDS data are retrieved from Datastream which has two different databases for CDS data: CMA Datavision (CMA) and Thomson Reuters (TR). Since CMA data ceases to exist after 30-9-2010 in Datastream and TR data does not have data before 14-12-2007, both databases are needed to get data for the period 2-7-2007 up to 20-4-2012. With Datastream you can easily match the different datasets with the *'splice function'*. However, the value of the data in TR and CMA are unequal, meaning that differences between CDS data exist. The *'splice function'* in Datastream just ends CMA as TR starts, meaning that incorrect (large/small) differences can arise in the dataset.

In order to deal with the issue described above, I have merged the data from both databases manually. Via this way, I searched for dates in the databases that have more or less equal values for CDS data, so that switching from CMA to TR happens accurately. Since TR data does not always start on 14-12-2007 and/or has zero changes in the early stage some mergers are made in a later time period. Because of the differences in values between the two databases, I found it rather important that the merging dates for all the banks and the sovereign in a particular country are nearby each other. Even though I tried, it was sometimes too difficult or even impossible to do so. A survey of the start and end dates for both databases are presented in table C1 below.

A further noticeable issue was the fact that the sovereign CDS data from CMA was only available in USD. For Finland and the Netherlands the data from TR was even only available in USD. CDSs with the same underlying can be quoted in more than one currency; a CDS which is traded in another currency than the instrument it underlies is called a 'quanto'. These instruments are made to create attractiveness for foreign investors, since the foreign investor is not exposed to exchange rate risk (Wei, 1994). Under normal circumstances the value of the quanto and the normal CDS are more or less the same. However, due to the sovereign debt crisis, uncertainty about the Euro rises and the USD/EUR exchange rate is expected to fall. If the USD/EUR exchange rate weakens, Euro area countries have to pay more to the holders of a quanto CDS (denominated in USD) in the event of a default, since they have to pay more Euros to get the same amount of USD. Therefore, if many investors expect the USD/EUR exchange rate to weaken, they are more willing to invest in the quanto CDS. As a consequence, the values of the normal CDS and the quanto will differ. In figure C2 you can see the difference between German sovereign CDS denominated in EUR and USD. The differential between them starts to exist at the end of April 2010. The same applies to most other countries, only some have minor differences (1-2%) in earlier periods. Since the difference between TR USD and TR EUR started to arise around the 29th of April 2010, I

have assumed that the CMA data for sovereigns quoted in USD data, incorporated before this date, are just equal to Euros. For Finland and the Netherlands, I have adjusted the dollar values from the 29th of April 2010 onwards by the relative differences of Germany, because it has more or less the same credit risk level and progression over time.

Table C1: Merging dates

Country/Bank	Start CMA	End CMA	TR USD	Start TR EUR	End TR
*Austria**	2-7-2007	4-11-2008	5-11-2008 up to 27-4-2009┘	28-4-2009	20-4-2012
- Erste Group Bank AG	2-7-2007	4-11-2008	-	5-11-2008	20-4-2012
- Raiffeisen Zentral Bank AG	2-7-2007	3-11-2008	-	4-11-2008	20-4-2012
*Belgium**	2-7-2007	5-2-2008	-	6-2-2008	20-4-2012
- KBC Bank NV	2-7-2007	5-2-2008	-	6-2-2008	20-4-2012
- Dexia NV	2-7-2007	4-2-2008	-	5-2-2008	20-4-2012
- Fortis Bank NV	2-7-2007	30-9-2010	-	22-6-2011[M]	20-4-2012[M]
*Finland***	-	-	-	18-3-2008	20-4-2012
- Sampo	-	-	-	21-6-2011[M]	20-4-2012[M]
- Nordea	2-7-2007	29-7-2008	-	30-7-2008[M]	20-4-2012[M]
*France**	2-7-2007	1-1-2010	-	4-1-2010	20-4-2012
- BNP Paribas	2-7-2007	1-1-2010	-	4-1-2010	20-4-2012
- Crédit Agricole	2-7-2007	1-1-2010	-	4-1-2010	20-4-2012
- Société Générale	2-7-2007	1-1-2010	-	4-1-2010	20-4-2012
- Natixis	2-2-2007	6-1-2010	-	7-1-2010	20-4-2012
- Credit Lyonnais	-	-	-	14-12-2007	20-4-2012
*Germany**	2-2-2007	8-1-2008	-	9-1-2008	20-4-2012
- Deutsche Bank AG	2-2-2007	13-12-2007	-	14-12-2007	20-4-2012
- Commerzbank AG	2-2-2007	17-12-2007	-	18-12-2007	20-4-2012
- LB Baden-Wuerttemberg	-***	-***	-	14-12-2007	20-4-2012
- Bayerische Landesbank	-***	-***	-	14-12-2007	20-4-2012
- Norddeutsche Landesbank	-***	-***	-	18-6-2008[M]	20-4-2012[M]
- WestLB	2-2-2007	6-11-2008		7-11-2008	20-4-2012
- LB Hessen-Thueringen	-***	-***	-	18-6-2008[M]	20-4-2012[M]
- HSH Nordbank	-***	-***	-	14-12-2007[M]	20-4-2012[M]
- IKB Deutsche Industriebank	-***	-***	-	14-12-2007[M]	20-4-2012[M]
*Greece**	2-2-2007	27-12-2007	-	28-12-2007	20-4-2012
- National Bank of Greece	-***	-***	-	18-11-2008	20-4-2012
- EFG Eurobank Ergasias	-***	-***	-	29-2-2008[M]	20-4-2012[M]
- Alpha Bank	-***	-***	-	18-6-2008[M]	20-4-2012[M]

Country/Bank	Start CMA	End CMA	TR USD	Start TR EUR	End TR
*Ireland**	2-2-2007	28-10-2008	-	29-10-2008	20-4-2012
- Bank of Ireland	2-2-2007	24-10-2008	-	27-10-2008	20-4-2012
- Allied Irish Bank	2-2-2007	29-10-2008	-	30-10-2008	20-4-2012
- Irish life & permanent PLC	2-2-2007	30-10-2008	-	31-10-2008	20-4-2012
- Anglo Irish Bank	-	-	-	31-10-2008	20-4-2012
- Depfa Bank PLC	-	-	-	31-10-2008	30-9-2010
*Italy**	2-2-2007	27-12-2007	-	28-12-2007	20-4-2012
- UniCredito Bank	2-2-2007	21-10-2008	-	22-10-2008	20-4-2012
- Intesa Sanpaolo	2-2-2007	29-2-2008	-	3-3-2008	20-4-2012
- Bance Monte Paschi Siena	2-2-2007	13-12-2007	-	14-12-2007	20-4-2012
- Banco Popolare SPA	-	-	-	14-12-2007[M]	20-4-2012[M]
- Unione di Banche Italiane	-***	-***	-	14-12-2007[M]	20-4-2012[M]
- Mediobanca	2-2-2007	13-12-2007	-	14-12-2007	20-4-2012
- Banco Popolare di Milano	2-2-2007	13-12-2007	-	14-12-2007[M]	20-4-2012[M]
*The Netherlands***	2-2-2007	10-4-2008	-	11-4-2008	20-4-2012
- ING Bank	2-2-2007	13-12-2007	-	14-12-2007	20-4-2012
- Rabobank Group	2-2-2007	18-12-2007	-	19-12-2007	20-4-2012
- ABN AMRO NV	2-2-2007	30-9-2010	-	-	-
- AEGON NV	2-2-2007	14-12-2007	-	17-12-2007	20-4-2012
- Fortis Bank NL NV	-	-	-	14-12-2007	20-4-2012
- SNS Reaal NV	-***	-***	-	14-12-2007	20-4-2012
- F. van Lanschot NV	-	-	-	29-2-2008[M]	20-4-2012[M]
*Portugal**	2-2-2007	13-6-2008	16-6-2008 up to 30-10-2008[J]	31-10-2008	20-4-2012
- Caixa Geral de Depositos	-***	-***	-	18-6-2008[M]	20-4-2012[M]
- Banco Comercial Português	2-2-2007	17-6-2008	-	18-6-2008	20-4-2012
- Banco Espírito Santo	2-2-2007	17-6-2008	-	18-6-2008[M]	20-4-2012[M]
- Banco BPI SA	16-3-2009[+]	30-9-2010	-	-	-
*Spain**	2-2-2007	3-12-2008	-	4-12-2008	20-4-2012
- Banco Santander SA	2-2-2007	9-12-2008	-	10-12-2008	20-4-2012
- Banco Bilbao Vizcaya Arg.	2-2-2007	9-12-2008	-	10-12-2008	20-4-2012
- La Caixa	29-2-2008[++]	9-12-2008[++]	-	10-12-2008	20-4-2012
- Caja Madrid	29-2-2008[+]	11-12-2008	-	12-12-2008[M]	20-4-2012[M]
- Banco Populare Espanol	23-5-2008[+++]	27-11-2008	-	28-11-2008	20-4-2012
- Banco de Sabadell	2-2-2007	10-12-2008	-	11-12-2008[M]	20-4-2012[M]
- Bancaja	-	-	-	29-2-2008[M]	20-4-2012[M]
- CatalunyaCaixa	-	-	-	29-2-2008[M]	20-4-2012[M]
- Caja Ahorros Mediterraneo	29-2-2008[+]	11-12-2008	-	12-12-2008[M]	20-4-2012[M]
- BankInter	10-9-2008[+++]	11-12-2008	-	12-12-2008[M]	20-4-2012[M]
- Banco Pastor	10-9-2008[+++]	5-12-2008	-	8-12-2008[M]	20-4-2012[M]

* Country CMA data are in USD. Note that these data do not need to be adjusted since differences in quotation of USD and EUR started to exist from 29-4-2010 onwards.

** Country data are completely in USD. Therefore the TR USD data are adjusted from 29-4-2010 onwards based on the relative changes of Germany. Germany is chosen as a norm since it has more or less the same credit risk level and progression over time as Finland and the Netherlands.

*** All these banks have traded CDS in the database of CMA, but the data has a high amount of zero changes and is therefore left out of the dataset to prevent stale data.

+ These banks do not have traded CDS in the early stage of the CMA database.

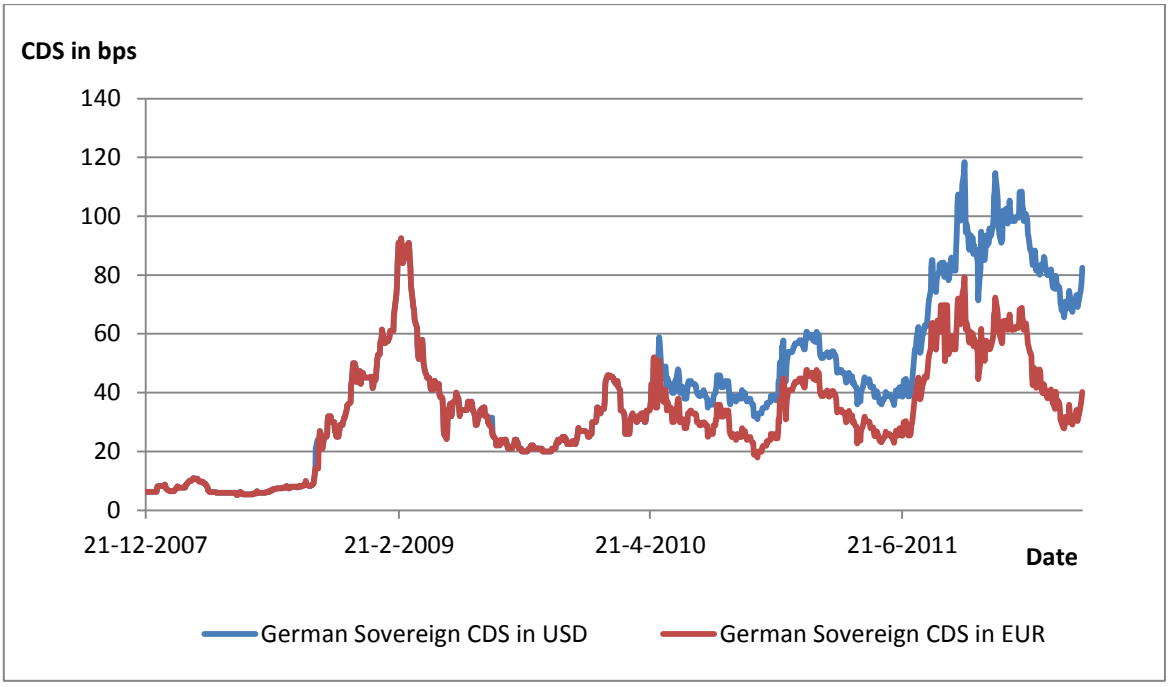
++ Data are not from CMA, but from TR. However the data are not regular Senior data, but MM Senior. MM stands for 'Modified-Modified' restructuring, a response to severe limitations of the normal modified restructuring to shorten the maturity of deliverable assets. The normal modified restructuring (MR) was introduced to limit the scope of opportunistic behavior during restructuring[7].

+++ These banks do have traded CDS from the start of the dataset (2-7-2007). However, the traded CDS in the early stage of the dataset has a large amount of zero changes. Additionally, the evolvement is unlikely to represent the credit risk level of these banks. To prevent stale data, the beginning of these datasets is omitted. Note that this was also the case in Austria and Finland, but because all banks in those datasets had zero changes, the weighted average bank CDS also faced many zero changes, meaning that these were automatically cancelled out. In a country with many banks, these particular small banks are not going to put the weighted average bank CDS at zero changes. Because they do have their impact on the size of a change, they need to me omitted from the dataset.

M The data for these periods is not regular 5-year senior CDS, but 5-year senior MM CDS.

┘ For Austria and Portugal the TR USD data is used in an earlier period, since the data on TR EUR did not exist yet.

Figure C2: German sovereign CDS denominated in USD and EUR



[7] Markit Credit Indices – A Primer. (2008, November). *Markit*

Table C3: Local Stock Market Index

The table below shows which local stock market index is used as a control variable for a respective country in the dataset.

Country	**Stock Exchange**	**Index**
Austria	Vienna Stock Exchange/ Wiener Börse AG	ATX
Belgium	Brussels Stock Exchange/ Euronext Brussels	BEL20
Finland	Helsinki Stock Echange/ NASDAQ OMX Helsinki	OMXH25/HEX25
France	Paris Bourse	CAC 40
Germany	Frankfurt Stock Exchange/ Deutsche Börse/DAX	DAX/ Xetra
Greece	Athens Stock Exchange/ ATHEX/ ASE	ATHEX
Ireland	Irish Stock Exchange/ ISE	ISE
Italy	Borsa Italiana/ Piazza Affari	FTSE MIB
Netherlands	Amsterdam Stock Exchange/ Euronext Amsterdam	AEX-Index
Portugal	Euronext Lisbon	PSI-20
Spain	Madrid Stock Exchange/ Bolsa de Madrid	IBEX 35

Appendix D: Summary statistics

Table D1: Summary statistics of Total Assets

	N	Mean	Std. Dev.	50th Per.	5th Per.	95th Per.	Min	Max
Total Assets (EUR billion)*	58	356.71	464.03	151.75	31.07	1739.59	20.33	1998.16

* Total Assets at the 31st of December 2010.

Table D2: Frequency table of recapitalized/guaranteed

		Frequency	Percent	Valid Percent
Valid	0	12	20.7	30.0
	1	28	48.3	70.0
	Total	40	69.0	100.0
Missing**	System	18	31.0	
Total		58	100.0	

** The banks from Italy and Spain are not included, since I could not find a reliable source to verify whether the banks in these countries were recapitalized or guaranteed. A 1 is assigned to banks that got recapitalized or guaranteed and a 0 is assigned to banks which are not.

Note to the tables D3-D7 below: the Δ LOG (Sovereign CDS) differs a bit for the weighted and unweighted average method, since almost zero changes (<1.000E-04) in average bank CDS are omitted. Thereby the summary statistics differ a bit from each other.

Table D3: Summary statistics Total Model (2/7/2007-20/4/2012)

	N	Mean	Std. Dev.	50th Per.	5th Per.	95th Per.	Min	Max
Weighted Average Bank CDS	13325	282.45	380.86	145.96	44.34	1162.35	7.52	2361.45
Unweighted Average Bank CDS	13325	301.45	386.88	169.02	46.39	1191.83	8.42	2510.11
Sovereign CDS	13325	256.83	1106.11	59.11	5.95	811.83	1.00	14911.74
Δ LOG(Weighted Average Bank CDS)	11978	0.00114	0.01120	0.00059	-0.01510	0.01870	-0.07467	0.12207
Δ LOG(Sovereign CDS) (WA)	11978	0.00158	0.01515	0.00100	-0.01993	0.02510	-0.10988	0.16673
Δ LOG(Unweighted Average Bank CDS)	11970	0.00114	0.01041	0.00054	-0.01329	0.01760	-0.07356	0.12248
Δ LOG(Sovereign CDS) (UA)	11970	0.00158	0.01515	0.00100	-0.01989	0.02506	-0.10988	0.16673

Tabel D4: Summary statistics Pre-bailout Period (2/7/2007-25/9/2008)

	N	Mean	Std. Dev.	50th Per.	5th Per.	95th Per.	Min	Max
Weighted Average Bank CDS	3120	83.19	52.38	69.76	21.75	195.84	7.52	331.56
Unweighted Average Bank CDS	3120	91.03	57.09	77.82	23.68	206.75	8.42	336.89
Sovereign CDS	3120	16.44	13.65	10.50	2.50	43.25	1.00	63.90
Δ LOG(Weighted Average Bank CDS)	2603	0.00344	0.01681	0.00262	-0.02292	0.03125	-0.05641	0.12207
Δ LOG(Sovereign CDS) (WA)	2603	0.00290	0.01912	0.00175	-0.02196	0.02945	-0.10988	0.16673
Δ LOG(Unweighted Average Bank CDS)	2604	0.00356	0.01554	0.00239	-0.02034	0.02911	-0.05660	0.12248
Δ LOG(Sovereign CDS) (UA)	2604	0.00288	0.01908	0.00171	-0.02193	0.02923	-0.10988	0.16673
Δ LOG(CDS Market Index)	2604	0.002	0.014	0.002	-0.215	0.024	-0.032	0.082
Stock Market Index (% change)	2603	-0.001	0.008	-0.001	-0.015	0.012	-0.030	0.017
International Risk Aversion	2603	0.007	0.001	0.007	0.005	0.008	0.005	0.009

Tabel D5: Summary statistics Bailout Period (26/9/2008-13/10/2008)

	N	Mean	Std. Dev.	50th Per.	5th Per.	95th Per.	Min	Max
Weighted Average Bank CDS	132	178.60	81.43	154.82	95.16	342.32	84.97	452.73
Unweighted Average Bank CDS	132	197.95	83.96	182.54	99.33	342.03	89.57	424.83
Sovereign CDS	132	40.44	20.27	41.00	11.46	72.35	8.45	81.38
Δ LOG(Weighted Average Bank CDS)	125	-0.00208	0.02507	-0.00391	-0.04099	0.04539	-0.07467	0.07707
Δ LOG(Sovereign CDS) (WA)	125	0.02694	0.02690	0.01877	-0.00109	0.08274	-0.00427	0.12973
Δ LOG(Unweighted Average Bank CDS)	125	-0.00130	0.02354	-0.00207	-0.04042	0.04181	-0.07356	0.08437
Δ LOG(Sovereign CDS) (UA)	125	0.02709	0.02710	0.01877	-0.00109	0.08274	-0.00427	0.12973
Δ LOG(CDS Market Index)	125	0.006	0.005	0.007	-0.004	0.014	-0.004	0.014
Stock Market Index (% change)	125	-0.030	0.019	-0.028	-0.065	0.004	-0.065	0.004
International Risk Aversion	125	0.008	0.000	0.008	0.008	0.009	0.008	0.009

Tabel D6: Summary statistics Post-bailout Period I (14/10/2008-22/7/2010)

	N	Mean	Std. Dev.	50th Per.	5th Per.	95th Per.	Min	Max
Weighted Average Bank CDS	5081	201.12	174.12	141.62	76.04	507.24	51.46	1068.96
Unweighted Average Bank CDS	5081	219.16	158.05	164.93	75.94	501.70	51.46	1078.70
Sovereign CDS	5081	101.74	103.99	70.00	24.00	255.00	17.01	977.59
Δ LOG(Weighted Average Bank CDS)	4622	0.00032	0.00933	0.00016	-0.01395	0.01592	-0.05572	0.06578
Δ LOG(Sovereign CDS) (WA)	4622	0.00081	0.01447	0.00039	-0.02079	0.02537	-0.08606	0.09176
Δ LOG(Unweighted Average Bank CDS)	4605	0.00027	0.00858	0.00013	-0.01263	0.01461	-0.05517	0.06901
Δ LOG(Sovereign CDS) (UA)	4605	0.00081	0.01446	0.00039	-0.02075	0.02539	-0.08606	0.09176
Δ LOG(CDS Market Index)	4622	-0.000	0.009	-0.001	-0.013	0.015	-0.003	0.055
Stock Market Index (% change)	4622	0.000	0.012	0.002	-0.020	0.019	-0.053	0.053
International Risk Aversion	4622	0.010	0.003	0.009	0.006	0.017	0.005	0.018

Tabel D7: Summary statistics Post-bailout Period II (23/7/2010-20/4/2012)

	N	Mean	Std. Dev.	50th Per.	5th Per.	95th Per.	Min	Max
Weighted Average Bank CDS	4992	493.49	531.73	252.56	90.18	1768.14	60.28	2361.45
Unweighted Average Bank CDS	4992	519.47	538.08	274.60	111.29	1807.17	60.28	2510.11
Sovereign CDS	4992	570.65	1759.18	133.31	23.91	1430.38	15.33	14911.74
Δ LOG(Weighted Average Bank CDS)	4627	0.00074	0.00760	0.00047	-0.01088	0.01329	-0.03928	0.05101
Δ LOG(Sovereign CDS) (WA)	4627	0.00093	0.01187	0.00090	-0.01817	0.02053	-0.04994	0.06114
Δ LOG(Unweighted Average Bank CDS)	4637	0.00072	0.00722	0.00042	-0.00973	0.01212	-0.04945	0.08052
Δ LOG(Sovereign CDS) (UA)	4637	0.00093	0.01188	0.00091	-0.01818	0.02055	-0.04994	0.06114
Δ LOG(CDS Market Index)	4627	0.000	0.006	0.000	-0.011	0.012	-0.021	0.020
Stock Market Index (% change)	4627	-0.000	0.008	0.000	-0.015	0.012	-0.041	0.027
International Risk Aversion	4627	0.008	0.002	0.008	0.006	0.012	0.005	0.012

Appendix E: Graphical representation

The figures in this Appendix are created to make a graphical representation of the evolvement of bank and sovereign credit risk from 2-7-2007 up to 20-4-2012. The figures E1 and E2 present the evolvement of average bank and sovereign CDS in respectively Germany and Portugal. The figures E3-E6 present the difference between the starting date and the end date of a period, for average bank and sovereign CDS in each country.

Figure E1: German bank and sovereign CDS

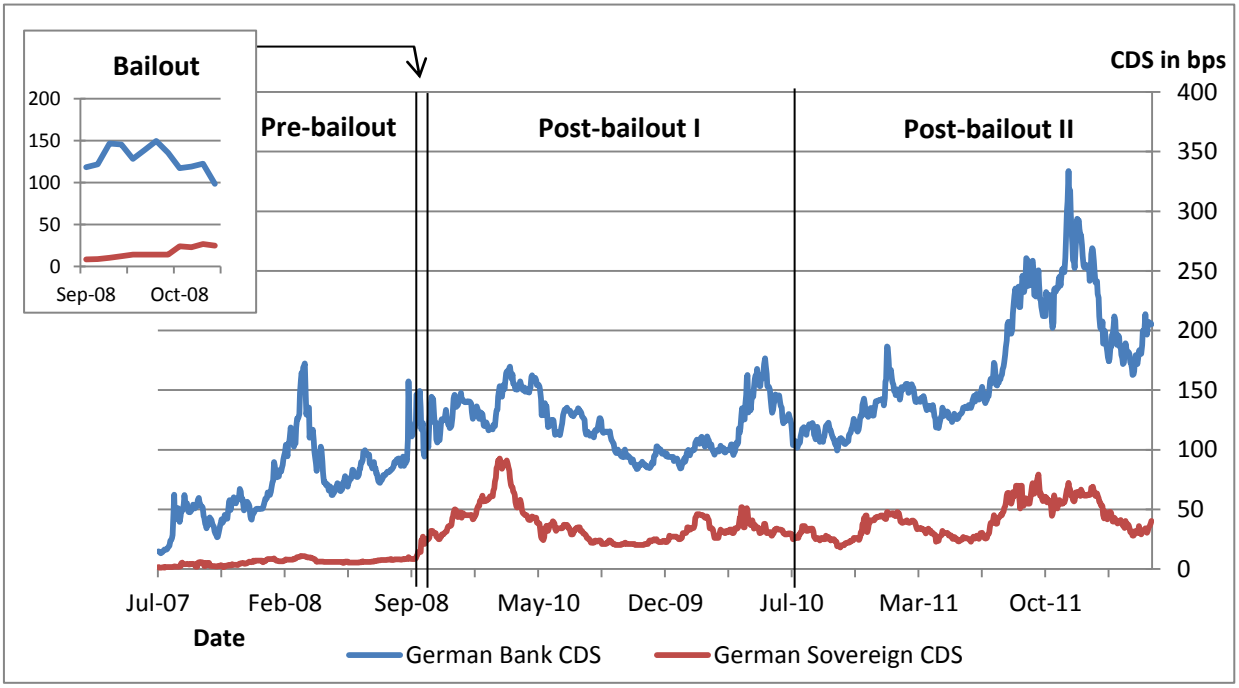


Figure E2: Portuguese bank and sovereign CDS

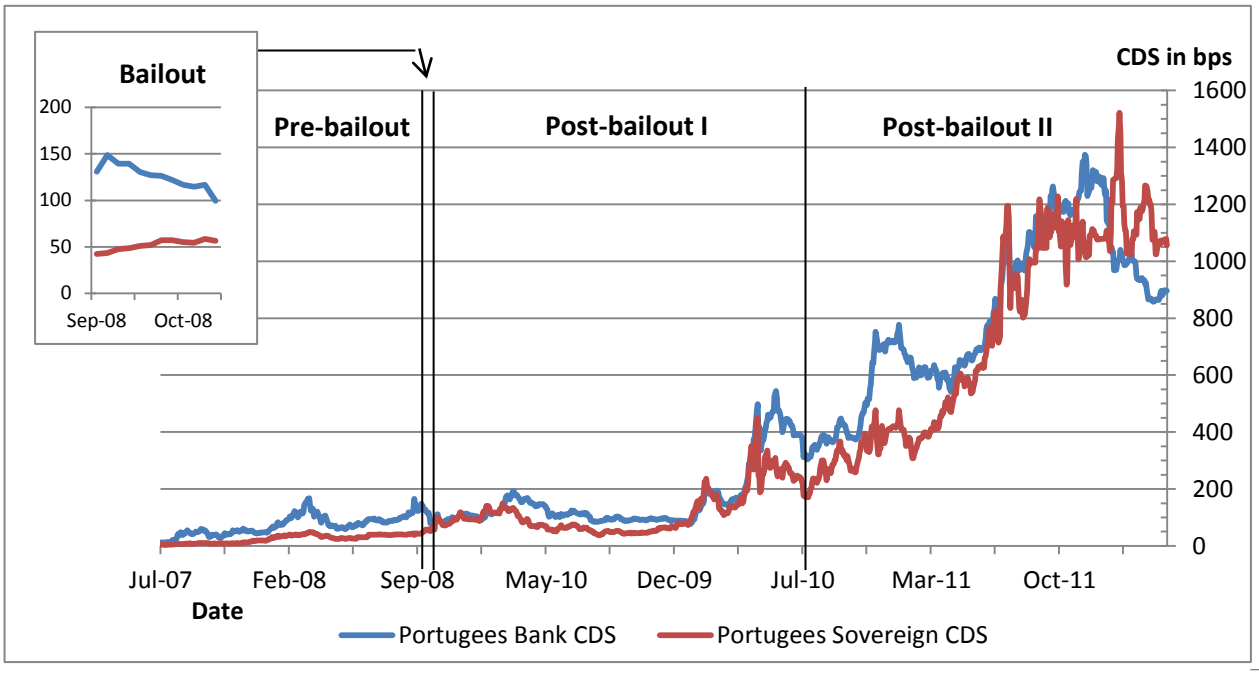


Figure E3: Changes in bank and sovereign CDS in the pre-bailout period

The diagram below shows the change in average bank CDS and sovereign CDS between the start of the pre-bailout period (2/7/2007) and the end of the pre-bailout period (25/9/2008) for each country separately.

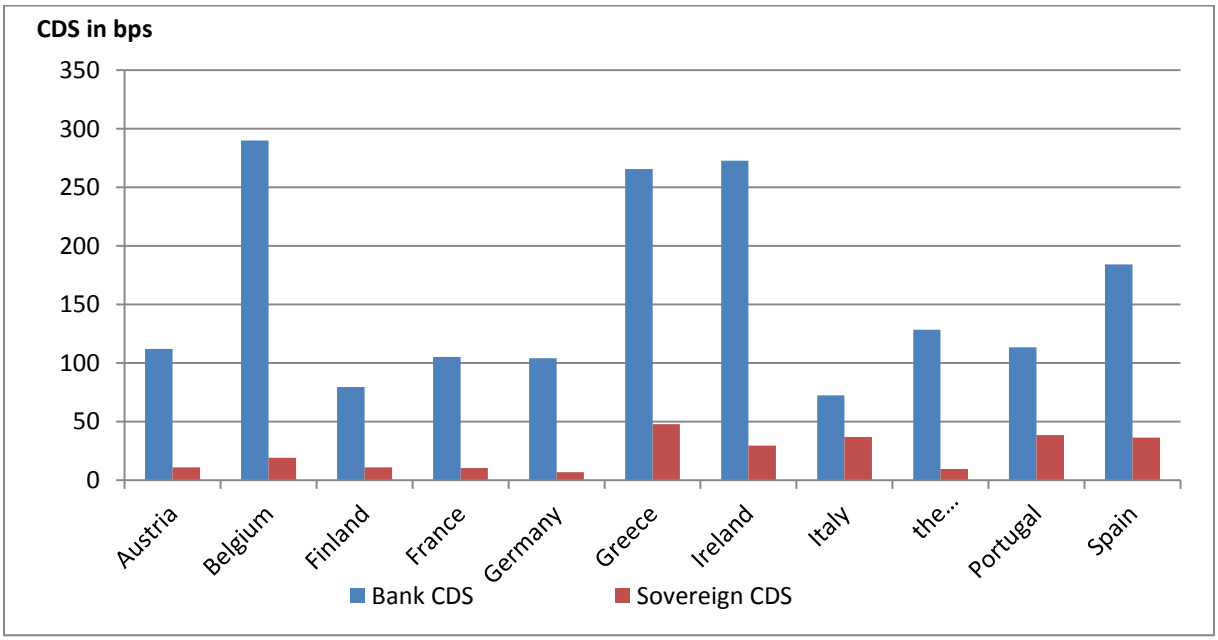


Figure E4: Changes in bank and sovereign CDS in the bailout period

The diagram below shows the change in average bank CDS and sovereign CDS between the start of the bailout period (26/9/2008) and the end of the bailout period (13/10/2008) for each country separately.

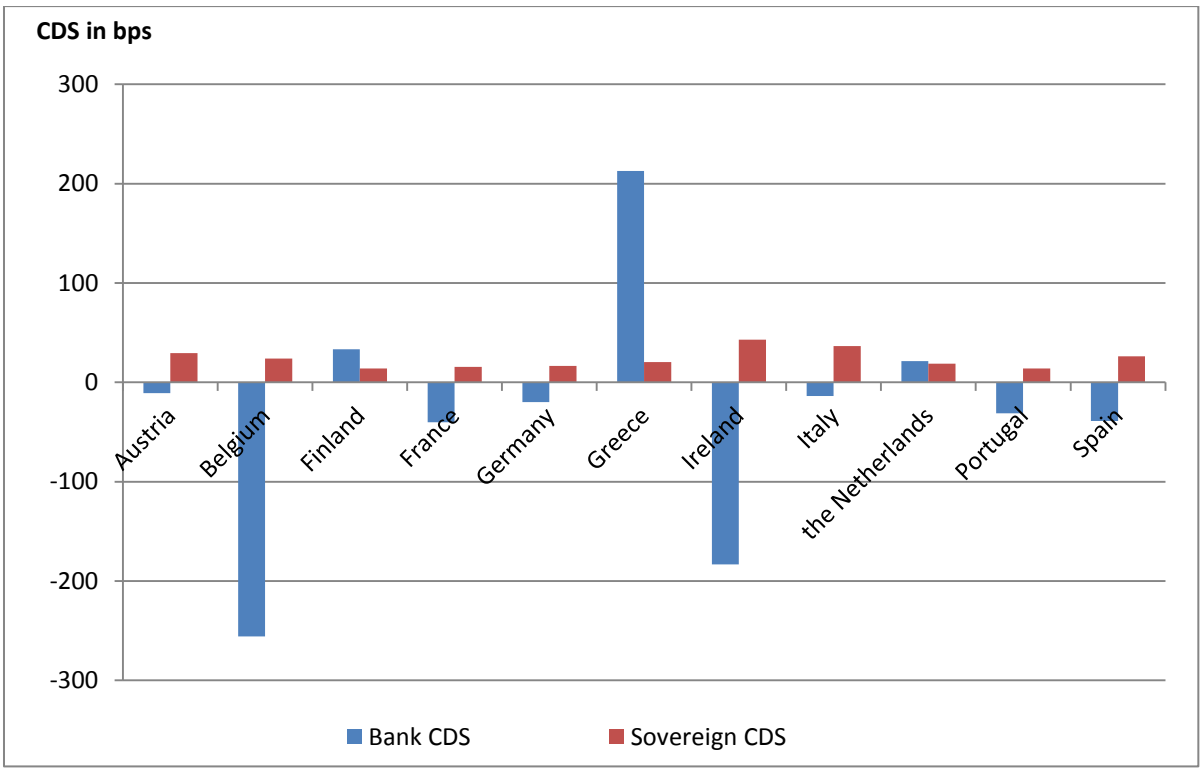


Figure E5: Changes in bank and sovereign CDS in the first post-bailout period

The diagram below shows the change in average bank CDS and sovereign CDS between the start of the first post-bailout period (14/10/2008) and the end of the first post-bailout period (22/7/2010) for each country separately.

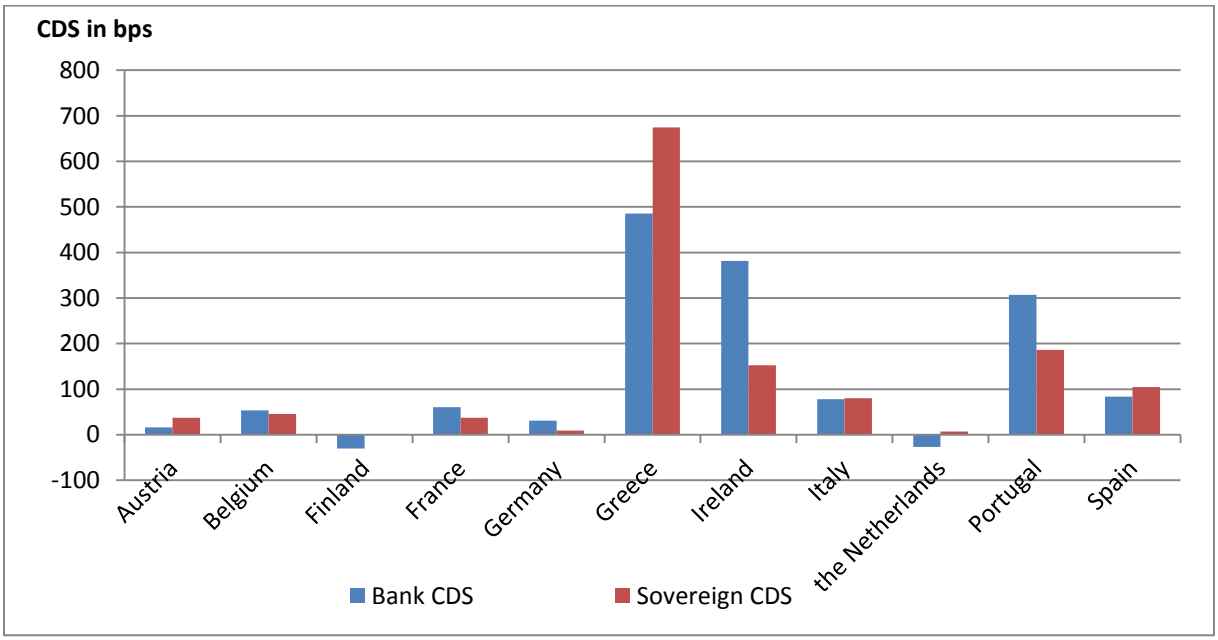
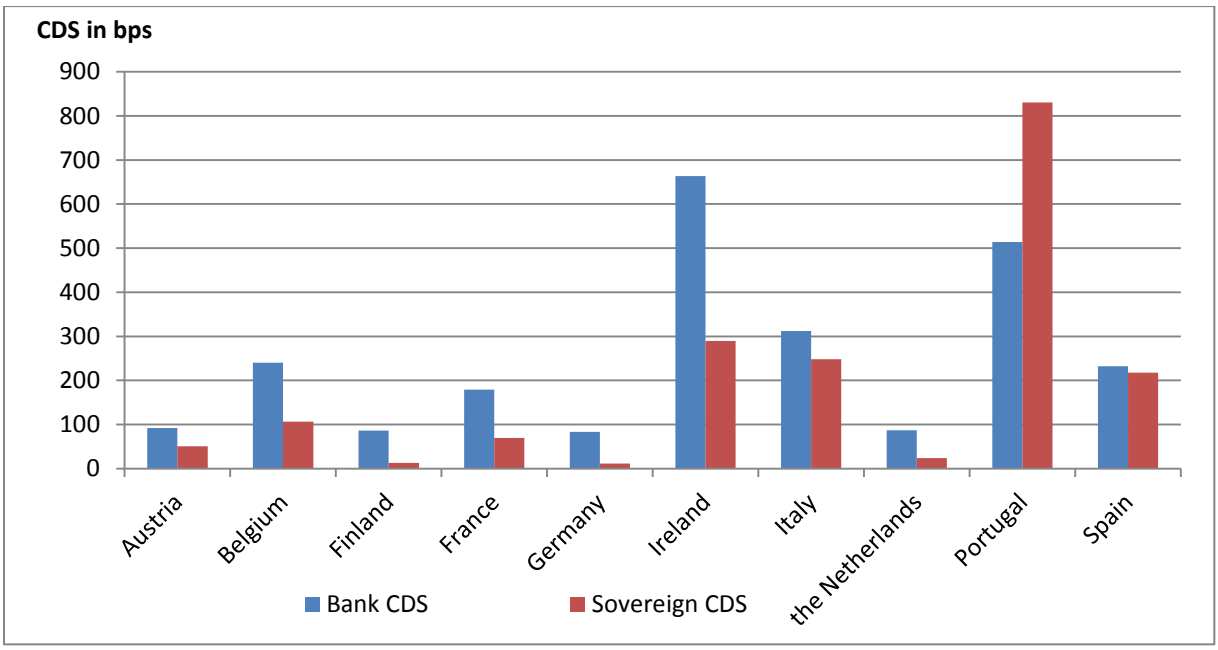


Figure E6: Changes in bank and sovereign CDS in the second post-bailout period

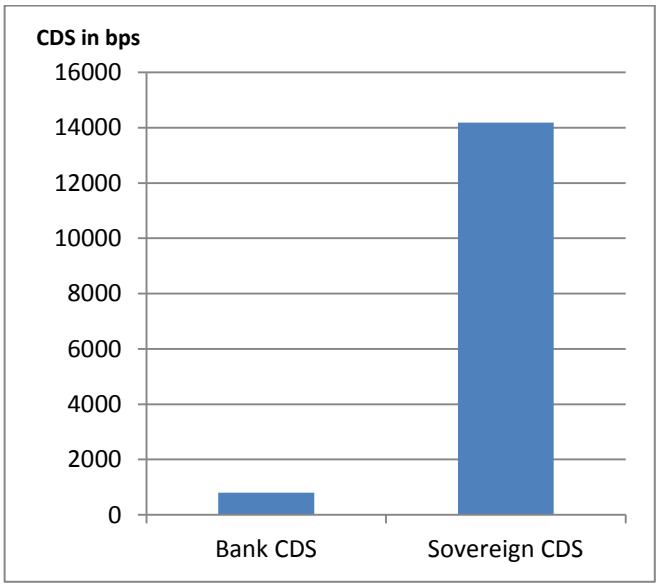
The diagram below shows the change in average bank CDS and sovereign CDS between the start of the second post-bailout period (23/7/2010) and the end of the second post-bailout period (20/4/2012) for each country separately.



* Note that Greece is left out of this figure and separately illustrated in figure E7 since the change in sovereign CDS disrupts a clear representation for the other countries.

Figure E7: Change in bank and sovereign CDS of Greece in post-bailout II

The diagram below shows the change in average bank CDS and sovereign CDS between the start of the second post-bailout period (23/7/2010) and the end of the second post-bailout period (20/4/2012) for Greece.



Appendix F: Results of testing the hypotheses

This appendix presents the results of the first four hypotheses tested in section 3.3.

Table F1: Correlation matrix of total model

The matrix below shows the correlations between Δ LOG (WA Bank CDS), Δ LOG (UA Bank CDS) and Δ LOG (Sovereign CDS).

	Δ LOG (WA Bank CDS)	Δ LOG (UA Bank CDS)	Δ LOG (Sovereign CDS)
Δ LOG (WA Bank CDS)	1	0.402*	0.964*
Δ LOG (UA Bank CDS)	0.402*	1	0.379*
Δ LOG (Sovereign CDS)	0.964*	0.379*	1

* Significant at $\alpha = 0.01$

Table F2: Direct relationship in total model (2/7/2007 – 20/4/2012)

The results for regressing Δ Log (Bank CDS) on Δ Log (Sovereign CDS) for the whole model, with the inclusion of a constant, are shown in the table below. The weighted average method is presented in column (a) and the unweighted average method in column (b). The standard errors of the betas are presented in parentheses.

	(2/7/2007 – 20/4/2012) Total Model	
	(a) WA	(b) UA
Constant	0.001*	0.001*
	(0.000)	(0.000)
Δ Log (Bank CDS)	0.544*	0.551*
	(0.011)	(0.012)
Observations	11977	11969
R-squared	0.162	0.144
F-test	2307.678*	2007.897*

* Significant at $\alpha = 0.01$

Table F3: Direct relationship of average Bank CDS and Sovereign CDS

The results for regressing Δ Log (Bank CDS) on Δ Log (Sovereign CDS) for the four periods, with the inclusion of a constant, are shown in the table below. The periods are separately presented in the columns (a) – (j). Note that the results for the shortened bailout period are also presented (see columns (e) and (f)). Additionally, note that the unweighted average (UA) method is added to this table in the second column of each period, to make a comparison between the two methods. The standard errors of the betas are presented in parentheses.

Δ Log (Sovereign CDS)										
	(2/7/2007 – 25/9/2008) Pre-bailout		(26/9/2008 – 13/10/2008) Bailout		(26/9/2012 – 3/10/2008) Shortened Bailout		(14/10/2008 – 22/7/2010) Post-bailout I		(23/7/2010 – 20/04/2012) Post-bailout II	
	(a) WA	(b) UA	(c) WA	(d) UA	(e) WA	(f) UA	(g) WA	(h) UA	(i) WA	(j) UA
Constant	0.002*	0.002*	0.026*	0.027*	0.036*	0.036*	0.001*	0.001*	0.000^{+}	0.000**
	(0.000)	(0.000)	(0.002)	(0.002)	(0.003)	(0.003)	(0.000)	(0.000)	(0.000)	(0.000)
Δ Log (Bank CDS)	0.287*	0.305*	-0.275*	-0.303*	-0.598*	-0.605*	0.947*	0.987*	0.917*	0.851*
	(0.022)	(0.023)	(0.094)	(0.100)	(0.123)	(0.129)	(0.018)	(0.020)	(0.019)	(0.021)
Observations	2603	2602	124	124	61	62	4621	4604	4626	4636
R-squared	0.063	0.062	0.066	0.069	0.282	0.265	0.373	0.343	0.344	0.268
F-test	176.410*	170.540*	8.658*	9.158*	23.509*	22.047*	2744.498*	2400.197*	2429.928*	1695.130*

* Significant at α = 0.01 ** Significant at α = 0.05 $^{+}$ Significant at α = 0.10

Table F4: Extended model with control variables

The results for regressing Δ Log (Bank CDS) on Δ Log (Sovereign CDS) for the four periods, with the inclusion of the control variables CDS Market Index, Stock Market Index and International Risk aversion, are shown in the table below. The periods are separately presented in the columns (a) – (h). Note that the results from the model with a direct relationship are shown in the first column of a respective period, to see improvements and/or other changes. The standard errors of the betas are presented in parentheses.

Δ Log (Sovereign CDS)								
	(2/7/2007 – 25/9/2008) Pre-bailout		(26/9/2008 – 13/10/2008) Bailout		(14/10/2008 – 22/7/2010) Post-bailout I		(23/7/2010 – 20/04/2012) Post-bailout II	
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
Constant	0.002* (0.000)	-	0.026* (0.002)	-	0.001* (0.000)	-	0.000^{+} (0.000)	-
Δ Log (Bank CDS)	0.287* (0.022)	0.197* (0.033)	-0.275* (0.094)	-0.348* (0.084)	0.947* (0.018)	0.539* (0.022)	0.917* (0.019)	0.532* (0.023)
Δ Log (CDS Market Index)	-	0.009 (0.041)	-	2.226* (0.434)	-	0.594* (0.028)	-	0.775* (0.036)
Stock Market Index (% change)	-	-0.376* (0.052)	-	0.335* (0.109)	-	-0.064* (0.018)	-	0.055** (0.025)
International Risk Aversion	-	0.218* (0.053)	-	2.787* (0.518)	-	0.031** (0.015)	-	0.045* (0.015)
Observations	2603	2604	124	125	4621	4622	4626	4627
R-squared	0.063	0.105	0.066	0.638	0.373	0.465	0.344	0.436
F-test	176.410*	76.552*	8.658*	53.426*	2744.498*	1004.291*	2429.928*	895.008*

* Significant at α = 0.01 ** Significant at α = 0.05 $^{+}$ Significant at α = 0.10

Table F5: Extended model with control variables and dummies (pre- and bailout) *(below)*

The results for regressing Δ Log (Bank CDS) on Δ Log (Sovereign CDS) for the pre-bailout and bailout period with the inclusion of the control variables CDS Market Index, Stock Market Index and International Risk aversion, the dummies for the countries and the interaction terms between the country dummies and Δ Log (Bank CDS) are shown in the table below. For the dummies; Germany is set as a standard and therefore left out of the regression, since it is represented by the Δ Log (Bank CDS). To acquire the Δ Log (Bank CDS) for each country separately, one should take the beta of Δ Log (Bank CDS) and add to that the beta of the respective interaction term of that country with Δ Log (Bank CDS). The periods are separately presented in the columns (a) – (d). Note that the results from the extended model with control variables but without dummies and interaction terms are shown in the first column of each period, to see improvements and/or other changes. The standard errors of the betas are presented in parentheses.

Table F6: Extended model with control variables and dummies (post- I and II) *(below)*

The results for regressing Δ Log (Bank CDS) on Δ Log (Sovereign CDS) for the first and second post bailout period with the inclusion of the control variables CDS Market Index, Stock Market Index and International Risk aversion, the dummies for the countries and the interaction terms between the country dummies and Δ Log (Bank CDS) are shown in the table below. For the dummies; Germany is set as a standard and therefore left out of the regression, since it is represented by the Δ Log (Bank CDS). To acquire the Δ Log (Bank CDS) for each country separately, one should take the beta of Δ Log (Bank CDS) and add to that the beta of the respective interaction term of that country with Δ Log (Bank CDS). The periods are separately presented in the columns (a) – (d). Note that the results from the extended model with control variables but without dummies and interaction terms are shown in the first column of each period, to see improvements and/or other changes. The standard errors of the betas are presented in parentheses.

Table F5: Extended model with control variables and dummies (pre- and bailout)

Δ Log (Sovereign CDS)				
	(2/7/2007 – 25/9/2008) Pre-bailout		(26/9/2008 – 13/10/2008) Bailout	
	(a)	(b)	(c)	(d)
Δ Log (CDS Market Index)	0.009	-0.004	2.226*	2.267*
	(0.041)	(0.042)	(0.434)	(0.434)
Stock Market Index (% change)	-0.376*	-0.401*	0.335*	0.317*
	(0.052)	(0.052)	(0.109)	(0.105)
International Risk Aversion	0.218*	0.109	2.787*	4.125*
	(0.053)	(0.157)	(0.518)	(0.858)
Δ Log (Bank CDS)	0.197*	0.343*	-0.348*	-0.933*
	(0.033)	(0.067)	(0.084)	(0.338)
Δ Log (Bank CDS)*Dummy Austria	-	-0.188+	-	0.820
		(0.110)		(0.664)
Δ Log (Bank CDS)*Dummy Belgium	-	-0.200**	-	0.701+
		(0.092)		(0.392)
Δ Log (Bank CDS)*Dummy Finland	-	-0.393*	-	0.141
		(0.143)		(0.548)
Δ Log (Bank CDS)*Dummy France	-	-0.155+	-	0.723
		(0.086)		(0.446)
Δ Log (Bank CDS)*Dummy Greece	-	-0.321+	-	0.968**
		(0.181)		(0.442)
Δ Log (Bank CDS)*Dummy Ireland	-	-0.176+	-	0.276
		(0.096)		(0.386)
Δ Log (Bank CDS)*Dummy Italy	-	-0.194**	-	0.510
		(0.083)		(0.438)
Δ Log (Bank CDS)*Dummy Netherlands	-	-0.059	-	0.428
		(0.088)		(0.486)
Δ Log (Bank CDS)*Dummy Portugal	-	-0.117	-	0.535
		(0.088)		(0.579)
Δ Log (Bank CDS)*Dummy Spain	-	-0.177+	-	0.752
		(0.091)		(0.723)
Dummy Austria	-	0.000	-	0.000
		(0.002)		(0.009)
Dummy Belgium	-	0.002	-	-0.014
		(0.002)		(0.009)
Dummy Finland	-	-0.002	-	0.007
		(0.003)		(0.010)
Dummy France	-	0.001	-	-0.011
		(0.002)		(0.009)
Dummy Greece	-	-0.001	-	-0.028**
		(0.002)		(0.011)
Dummy Ireland	-	0.002	-	-0.026**
		(0.002)		(0.010)
Dummy Italy	-	0.001	-	-0.018**
		(0.002)		(0.009)
Dummy Netherlands	-	0.000	-	0.003
		(0.002)		(0.010)
Dummy Portugal	-	0.001	-	-0.030*
		(0.002)		(0.009)
Dummy Spain	-	0.002	-	-0.018+
		(0.002)		(0.10)
Observations	2604	2604	125	125
R-squared	0.105	0.113	0.638	0.741
F-test	76.552*	13.716*	53.426*	12.056*

* Significant at α = 0.01 ** Significant at α = 0.05 + Significant at α = 0.10

Table F6: Extended model with control variables and dummies (Post-bailout I and II)

Δ Log (Sovereign CDS)				
	(14/10/2008 – 22/7/2010) Post-bailout I		(23/7/2010 – 20/04/2012) Post-bailout II	
	(a)	(b)	(c)	(d)
Δ Log (CDS Market Index)	0.594*	0.599*	0.775*	0.706*
	(0.028)	(0.028)	(0.036)	(0.037)
Stock Market Index (% change)	-0.064*	-0.068*	0.055**	0.061**
	(0.018)	(0.018)	(0.025)	(0.024)
International Risk Aversion	0.031**	-0.154*	0.045*	0.006
	(0.015)	(0.035)	(0.015)	(0.042)
Δ Log (Bank CDS)	0.539*	0.429*	0.532*	0.569*
	(0.022)	(0.067)	(0.023)	(0.058)
Δ Log (Bank CDS)*Dummy Austria	-	0.265*	-	-0.039
		(0.080)		(0.088)
Δ Log (Bank CDS)*Dummy Belgium	-	0.144	-	-0.069
		(0.096)		(0.084)
Δ Log (Bank CDS)*Dummy Finland	-	-0.042	-	-0.007
		(0.101)		(0.088)
Δ Log (Bank CDS)*Dummy France	-	-0.004	-	0.037
		(0.080)		(0.068)
Δ Log (Bank CDS)*Dummy Greece	-	0.161+	-	0.162
		(0.091)		(0.140)
Δ Log (Bank CDS)*Dummy Ireland	-	-0.041	-	-0.384*
		(0.092)		(0.072)
Δ Log (Bank CDS)*Dummy Italy	-	-0.013	-	0.196*
		(0.076)		(0.071)
Δ Log (Bank CDS)*Dummy Netherlands	-	-0.047	-	0.096
		(0.090)		(0.086)
Δ Log (Bank CDS)*Dummy Portugal	-	0.169**	-	0.105
		(0.078)		(0.084)
Δ Log (Bank CDS)*Dummy Spain	-	0.341*	-	0.214*
		(0.086)		(0.081)
Dummy Austria	-	0.002*	-	0.000
		(0.001)		(0.001)
Dummy Belgium	-	0.002*	-	0.000
		(0.001)		(0.001)
Dummy Finland	-	0.002**	-	0.000
		(0.001)		(0.001)
Dummy France	-	0.002*	-	0.000
		(0.001)		(0.001)
Dummy Greece	-	0.003*	-	0.003*
		(0.001)		(0.001)
Dummy Ireland	-	0.003*	-	0.001
		(0.001)		(0.001)
Dummy Italy	-	0.002*	-	0.000
		(0.001)		(0.001)
Dummy Netherlands	-	0.002*	-	0.000
		(0.001)		(0.001)
Dummy Portugal	-	0.002*	-	0.001
		(0.001)		(0.001)
Dummy Spain	-	0.002*	-	0.000
		(0.001)		(0.001)
Observations	4622	4622	4627	4627
R-squared	0.465	0.477	0.436	0.453
F-test	1004.291*	174.608*	895.008*	159.051*

* Significant at α = 0.01 ** Significant at α = 0.05 + Significant at α = 0.10

Appendix G: Comparing the post-bailout periods

This appendix will show the results and method of testing the fifth hypotheses, tested in section 3.3. The test will be done for the weighted average method, as well as for the unweighted average method.

The samples of the data used in the first and second post-bailout period are independent, since their timing is different from each other. The value of corresponding data does not necessarily rely on the value of the data from the other sample. Thereby, the samples are not paired so a paired t-test will not be necessary. At first, the equality of the variances needs to be tested via an F-test.

Weighted average method

Variables

b_1 = the estimated beta of the first post-bailout period (= 0.947)

b_2 = the estimated beta of the second post-bailout period (= 0.917)

S_{b1}^2 = the estimated variance of the beta from the first post-bailout period (= 0.018)

S_{b2}^2 = the estimated variance of the beta from the second post-bailout period (= 0.019)

r_1 = the correlation in the first post-bailout period (= 0.610)

r_2 = the correlation in the second post-bailout period (= 0.587)

n_1 = the number of observations in the first post-bailout period (= 4621)

n_2 = the number of observations in the second post-bailout period (= 4625)

SSE_1 = Sum of Squares Error in the first post-bailout period (= 0.607)

SSE_2 = Sum of Squares Error in the second post-bailout period (= 0.427)

S_{x1} = Std. deviation of the independent variable in the first post-bailout period (= 0.00933)

S_{x2} = Std. deviation of the independent variable in the second post-bailout period (= 0.00760)

Five-step procedure for testing on variance equality

(i) Testing problem: Test H_0: $\frac{\sigma_1^2}{\sigma_2^2} = 0$ against H_1: $\frac{\sigma_1^2}{\sigma_2^2} \neq 0$; $\alpha = 0.01$

(ii) Test statistic: $F = \frac{S_1^2}{S_2^2}$

(iii) Reject H_0 $\leftrightarrow$ $f \leq F_{1-\propto/2;n_1-1;\,n_2-1}$ (= 0.92702)

Or $f \geq F_{\propto/2;n_1-1;\,n_2-1}$ (= 1.07873)

(iv) Value = 0.94428

(v) Do not reject H_0 since the value does not belong to the rejection region

By this I cannot conclude that the variances are unequal, therefore an equal variance t-test will be used to compare the betas.

Five-step procedure for testing β_1- β_2:

(i) Testing problem: Test $H_{0:}\ \beta_1 - \beta_2 = 0$ against $H_1: \beta_1 - \beta_2 \neq 0$; $\alpha = 0.05$

(ii) Test statistic: $t = \dfrac{b_1 - b_2}{s_{b_1 - b_2}}$

Because of considered equality we can use the equation: $s^2_{y.x} = \dfrac{SSE_1 + SSE_2}{n_1 + n_2 - 4}$

and then $S_{b_1 - b_2} = \sqrt{\dfrac{s^2_{y.x}}{SS_{X_1}} + \dfrac{s^2_{y.x}}{SS_{X_2}}}$ (=0.02640)

(iii) Reject H_0 ↔ $t \leq -t_{a/2;\, n_1+n_2-4}$ (= -1.96022)

Or $t \geq t_{a/2;\, n_1+n_2-4}$ (= 1.96022)

(iv) Val = 1.13635 p-value = 0.20918

(v) Do not reject H_0 since the value does not belong to the rejection region

Additionally the correlation for the relationship between bank credit risks and sovereign credit risk of both samples are tested on equality, via the procedures of Fisher (1921).

Five-step procedure for testing ρ_1- ρ_2:

(i) Testing problem: Test $H_{0:}\ \rho_1 - \rho_2 = 0$ against $H_1: \rho_1 - \rho_2 \neq 0$; $\alpha = 0.05$

(ii) Test statistic: $z = \dfrac{r_1' - r_2'}{\sqrt{\dfrac{1}{n_1 - 3} + \dfrac{1}{n_2 - 3}}}$ $r' = (0.5)\log_e \left|\dfrac{1+r}{1-r}\right|$

(iii) Reject H_0 ↔ $Z \leq -z_{\alpha/2}$ (= -1.95996)

Or $Z \geq z_{\alpha/2}$ (= 1.95996)

(iv) Val = 0.74824 p-value = 0.30154

(v) Do not reject H_0 since the value does not belong to the rejection region

Unweighted method

Variables

b_1 = the estimated beta of the first post-bailout period (= 0.987)

b_2 = the estimated beta of the second post-bailout period (= 0.851)

S_{b1}^2 = the estimated variance of the beta from the first post-bailout period (= 0.020)

S_{b2}^2 = the estimated variance of the beta from the second post-bailout period (= 0.021)

r_1 = the correlation in the first post-bailout period (= 0.585)

r_2 = the correlation in the second post-bailout period (= 0.517)

n_1 = the number of observations in the first post-bailout period (= 4604)

n_2 = the number of observations in the second post-bailout period (= 4636)

Five-step procedure for testing on variance equality

(vi) Testing problem: Test H_0: $\frac{\sigma_1^2}{\sigma_2^2} = 0$ against H_1: $\frac{\sigma_1^2}{\sigma_2^2} \neq 0$; $\alpha = 0.01$

(vii) Test statistic: $F = \frac{S_1^2}{S_2^2}$

(viii) Reject H_0 ↔ $f \leq F_{1-\propto/2;n_1-1;\, n_2-1}$ (= 0.92698)

Or $f \geq F_{\propto/2;n_1-1;\, n_2-1}$ (= 1.07876)

(ix) Value = 1.10250

(x) Reject H_0 since the value does belong to the rejection region.

By this I can conclude that the variances are unequal, therefore an unequal variance t-test can be used to compare the betas. Since the sample sizes are more or less the same, I can use a pooled sample variance for testing.

Five-step procedure for testing β_1- β_2:

(vi) Testing problem: Test H_0: $\beta_1 - \beta_2 = 0$ against H_1: $\beta_1 - \beta_2 \neq 0$; $\alpha = 0.05$

(vii) Test statistic: $t = \frac{b_1 - b_2}{s_{b_1 - b_2}}$

Because of considered sample equality: $S_{b_1-b_2} = \sqrt{s_{b_1}^2 + s_{b_2}^2}$

(viii) Reject H_0 ↔ $t \leq -t_{a/2;\, n_1+n_2-4}$ (= -1.96022)

Or $t \geq t_{a/2;\, n_1+n_2-4}$ (= 1.96022)

(ix) Val = 4.68966 p-value = 0.0000

(x) Reject H_0 since the value does belong to the rejection region

Additionally the correlation for the relationship between bank credit risks and sovereign credit risk of both samples are tested on equality, via the procedures of Fisher (1921).

Five-step procedure for testing ρ_1- ρ_2:

(vi) Testing problem: Test $H_{0:}\ \rho_1 - \rho_2 = 0$ against $H_1: \rho_1 - \rho_2 \neq 0$; $\alpha = 0.05$

(vii) Test statistic: $z = \dfrac{r_1' - r_2'}{\sqrt{\dfrac{1}{n_1 - 3} + \dfrac{1}{n_2 - 3}}}$ $\qquad r' = (0.5)\log_e \left|\dfrac{1+r}{1-r}\right|$

(viii) Reject H_0 $\leftrightarrow$ $Z \leq -z_{\alpha/2}$ (= -1.95996)

Or $Z \geq z_{\alpha/2}$ (= 1.95996)

(ix) Val = 2.04060 p-value = 0.04974

(x) Reject H_0 since the value does belong to the rejection region