Aalto University
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DYNAMICS OF CORPORATE AND SOVEREIGN CREDIT SPREADS IN EUROPE

Changes during and after the debt crisis

Master's Thesis
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Abstract of a Master's thesis

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Abstract

Purpose of the study

The objective of this thesis is to study whether changes in European sovereigns' credit spreads affect credit spreads of local banks and firms, and the other way around. European banks and sovereigns have been proven to be interconnected through spillovers of credit risk during crisis periods (Acharya et al., 2014). The aim of this study is to test whether recently introduced regulation and the European Banking Union have been able to break the link that is harmful for the stability of the financial sector and to European economies. In addition, I study whether a similar connection of credit spreads exists between non-financial firms and sovereigns as well, a relation that is scarcely discussed in existing literature.

Data and methodology

The sample consists of a panel dataset of credit default swap spreads of 14 European sovereigns, 31 banks and 113 non-financial companies between January 2009 and June 2017. Historical CDS data is fetched from Datastream and control variables from several sources. Changes in the relation between sovereign and corporate credit spreads is studied with linear panel regressions on daily changes in CDS spreads, controlling for market movements and day and firm fixed effects. The sample is divided into four sub-periods to test whether regulatory improvements have decreased the co-movement between credit spreads. In addition, several interaction variables are added to the regression models to test for the existence of different channels of credit risk transfer.

Findings

The results show a two-way dynamic between sovereign and corporate credit risk in Eurozone countries. Changes in sovereign CDS spreads significantly affect firm CDS spreads over and above market movements and firms' own equity returns, while sovereign spreads are also meaningfully affected by changes in the private sector's credit risk. The findings differ meaningfully between studied sub-periods, and the two-way relation between financial sector and sovereign spreads diminishes after 2014. Effects for the non-financial sector are more persistent, but economically smaller.

In addition, I find that banks and firms are more affected by sovereign credit risk if they are likely to receive government support, or have a credit rating close to the sovereign rating. Banks holding large amounts of domestic bonds and firms that are more dependent on bank financing are also more vulnerable to sovereign risk.

Keywords Credit default swap, credit risk, sovereign risk, European banking union

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Tutkimuksen tarkoitus

Tutkielman tarkoituksena on selvittää, vaikuttavatko muutokset Euroopan valtioiden luottoriskipreemioissa paikallisten pankkien ja yritysten luottoriskiin, sekä toisin päin. Eurooppalaisten pankkien ja valtioiden luottoriskipreemioiden on todistettu olleen merkitsevästi yhteydessä toisiinsa velkakriisin aikana (Acharya et al., 2014). Tämän tutkimuksen tavoite on tutkia, ovatko hiljattain käyttöön otettu pankkisääntely sekä Euroopan pankkiunioni onnistuneet rikkomaan rahoitussektorin vakautta ja Euroopan talouksia heikentävän linkin pankkien ja valtioiden välillä. Lisäksi tutkin, onko samankaltainen yhteys olemassa myös valtioiden ja rahoitussektorin ulkopuolella toimivien yritysten luottopreemioiden välillä, sillä olemassa oleva kirjallisuus on tutkinut tätä suhdetta niukalti.

Aineisto ja tutkimusmenetelmät

Tutkimuksen paneeliaineisto koostuu 14 eurooppalaisen valtion, 31 pankin, ja 113 rahoitusalan ulkopuolella toimivan yrityksen luottoriskinvaihtosopimusten (”CDS”) preemioista tammikuun 2009 ja kesäkuun 2017 välillä. Historiallinen CDS-data on peräisin Datastreamista ja kontrollimuuttujat useasta eri lähteestä. Muutoksia valtioiden ja yritysten luottopreemioiden suhteessa tutkitaan kiinteiden vaikutusten paneeliregressiolla käyttäen päivämuutoksia CDS-preemioissa, kontrolloiden markkinamuutoksia sekä päivä- että yrityskohtaisia kiinteitä vaikutuksia. Otos on jaettu neljään jaksoon sen selvittämiseksi, onko sääntelyn parantaminen vähentänyt luottoriskipreemioiden yhteisliikkuvuutta. Lisäksi lisään regressiomalleihin useita vuorovaikutusmuuttujia, testatakseni erilaisia syitä, joiden takia luottoriski voi välittyä sektorilta toiselle.

Tulokset

Tutkimuksen tulokset antavat selviä viitteitä kaksisuuntaisesta dynamiikasta valtioiden ja yritysten luottoriskien välillä euroalueen maissa. Muutokset valtioiden CDS preemioissa vaikuttavat merkitsevästi yritysten CDS preemioihin kun kontrolloidaan markkinamuutoksia ja vaihteluita yritysten osakekurssissa, ja yrityssektorin luottoriski vaikuttaa merkittävästi myös valtioiden luottoriskipreemioihin. Tulokset poikkeavat merkittävästi toisistaan ajanjaksojen välillä ja kahdensuuntainen vuorovaikutus rahoitussektorin ja valtioiden välillä vähenee vuoden 2014 jälkeen. Vaikutus muiden yritysten ja valtioiden välillä jatkuu pidempään, mutta efekti on pienempi.

Tulokseni osoittavat, että valtioiden luottoriski vaikuttaa vahvemmin yrityksiin ja pankkeihin, jotka saavat todennäköisemmin taloudellista tukea valtioilta tai joiden luottoluokitus on lähellä valtion luottoluokituksen tasoa. Pankit, jotka pitävät taseessaan suuria määriä paikallisia valtionlainoja sekä pankkirahoituksesta riippuvaiset yritykset ovat myös herkempiä valtioriskin muutoksille.

Avainsanat Luottoriskinvaihtosopimus, luottoriski, valtioriski, Euroopan pankkiunioni

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1. Introduction

"The link between sovereigns and banks is indeed loosening. Following an upswing during the crisis, banks now tend to hold fewer domestic government bonds. And we see positive developments in the price of bank bonds, which are starting to decouple from sovereign ratings." – Speech by commissioner Valdis Dombrovskis, Vice-President for the Euro and Social Dialogue in May 2017

1.1 Background and motivation

Default risk of European governments became a topic of interest during the sovereign debt crisis, when it became imminent that developed countries are not immune to surges in credit spreads. Yields on Greek and other peripheral European countries' debt soared to levels that were unseen after the foundation of the common currency. Furthermore, credit rating agencies dramatically downgraded the ratings of several European sovereigns after the financial crisis caused a recession in the nations with vulnerable banking sectors and unsustainably high debt levels. In the long term, such severe increases in sovereign credit risk are associated with periods of low output growth, financial uncertainty and even restricted access to financial markets (Acharya et al., 2014). The increase in credit risk and the loss of reputation in capital markets can be transferred from sovereigns to the real sector, and consequently decrease access and availability of financing for domestic firms, and increase the cost of debt (Bedendo and Colla, 2015; Altavilla et al., 2017). For this reason, changes in sovereign spreads are of interest not only to bond investors, but also to regulators, politicians and company managers alike.

Especially the nexus between the European banking sector and governments has received a great deal of attention from policy makers, scholars and the press since the sovereign debt crisis. Several studies have documented strong mutual dependence between local banks and sovereigns during and after the debt crisis – a relationship poetically named the "hazardous tango", "vicious circle" or "doom loop" by researchers (Merler and Pisani-Ferry, 2012; Acharya et al., 2014; Fratzscher and Rieth, 2015). Previous research discusses two main drivers behind the two-way feedback loop between banking sectors and governments (Acharya et al., 2014). On one hand, European banks typically hold large amounts of domestic government bonds in their books due to their preferential treatment within capital requirements. If the credit spreads of these bonds widen and their value drops considerably – like happened during the debt crisis – the value of banks' bond portfolios decreases. On the other hand, investors expect

governments to support domestic banks and "too-big-to-fail" institutions in order to avoid banking crises. Thus, governments hold contingent guarantees to the domestic banking sector. If banks are rescued, bailouts increase the debt levels of already indebted governments, which reduce sovereign bond values further. Moreover, a bank bailout in one country increases the expectations of similar bailouts in other countries, leading to increased correlation between sovereign credit spreads (Dieckmann and Plank, 2012). Acharya et al. (2014) were one of the first to define and prove the theoretical relation behind the sovereign-bank doom loop, but several other studies document contagion between bank and sovereign credit spreads that cannot be justified solely by economic fundamentals (see for example, Alter and Schüler, 2012, De Bruyckere et al., 2013, and Altavilla et al., 2017).

The feedback loop is harmful for the stability of the financial sector and economic growth, and it increases risks of bank bailouts that consume taxpayers' money and decrease output growth. For example, Navaretti et al. (2016) and IMF (2017) have declared solving the issue to be of key importance to the health and growth aspects of European economies. Recent regulatory development and the founding of the European Banking Union have aimed to break the ties between sovereigns and domestic banking sectors. For example, the Single Resolution Mechanism that is part of the European Banking Union attempts to close the link between single sovereigns and their banks in the monetary union by centralizing the resolution of important financial institutions and effectively prohibiting national support for banks. Despite recent changes, previous research has mainly focused on documenting the correlation between risks during the sovereign debt crisis and, to the best of my knowledge, no studies have so far focused on whether new regulation has succeeded in its purpose. In this thesis, my goal is to fill this research gap and study whether the changes have been able to break the link that is important to politicians, investors and businesses alike within the EU.

Compared to the banking sector, distinctly less attention has been directed at the linkage of credit risks between non-financial companies and sovereigns, or how their relationship differs from the interconnection between banks and governments. Traditionally, sovereign risk has mostly been studied in the context of emerging countries and only very recently academic literature has paid attention to the transfers of credit risk in developed economies. In emerging countries, the possibility of currency depreciation, higher-than-expected inflation, or unexpected political changes are usually considered the most important factors for country risk for investors (Baldacci et al., 2011). These risks are distinctly lower in the European Union with

currency risk being negligible for countries that are part of the Eurozone. Despite this, in recent literature Bedendo and Colla (2015) find that after the financial crisis non-financial firms' CDS spreads are affected by changes in sovereign CDS spreads, and Augustin et al. (2016) find increased correlation between corporate and sovereign credit premiums after the bailout on Greek government debt in 2011. Although these studies document co-movement in credit spreads, none of them focus on studying the relationship and its dynamics during a longer period of time and therefore, the connection and its causes are yet to be fully understood. If government credit risk is a determinant of corporate spreads even in developed countries, it means that firms' borrowing costs are affected by country risk and companies and investors should consider it to be a factor in their investment decisions. Therefore, I am also interested in studying linkages of credit risks in the non-financial sector as well.

The reverse side of the puzzle is whether the riskiness of local banks and corporates also affect the credit risk of the sovereign. In addition to sovereign-bank risk transfer, many studies document spillovers from banking sector to sovereign credit spreads during the debt crisis, although most have found that contagion from sovereigns to banks is higher than the other way around (Erce 2015; Frazscher and Rieth, 2015). Acharya et al. (2014) propose that an increase of risks in the local banking sector should raise the riskiness of the government through an increased possibility of public bailouts, which may corrupt the credit quality of the sovereign. In addition, banks' role in economic growth through intermediate loan supply is major, especially in Europe (BIS, 2011). Empirically, Dieckmann and Plank (2012) show that the relative size and riskiness of the local banking sector are linked with higher sovereign spreads and Kallestrup et al. (2016) find that foreign exposures of local banks affect sovereign credit premiums. However, very little attention has been directed at studying whether the credit risk of local companies' affects sovereign credit risk, although sovereigns also provide implicit support to firms that are important to the local economy or partly owned by the state. In this thesis, I aim to supplement previous literature by considering credit risk transfer both from local banks' and from non-financial companies' to European sovereigns.

1.2 Research questions and contribution to literature

In this thesis I study dynamics between sovereign and corporate credit risks using credit default swap spreads. More specifically, I examine whether changes in sovereign spreads significantly leak to changes in banking sectors' and non-financial companies' credit spreads and the other way around. I aim to fill research gaps unresolved by previous literature that mainly focuses on

studying contagion between European banking sector and sovereigns. My research questions are formulated as follows:

1. Has the new regulation in the European Union been successful in resolving the bank-sovereign "doom loop", or is the two-way risk transfer still in effect?
2. Is there a relation between the credit default spreads' of sovereigns' and non-financial in Europe?
3. Is the risk transfer between sovereigns and companies two-sided? Hence, does corporate credit risk also leak to sovereign credit premiums?
4. What are the main drivers behind the possible risk transfers, and are some firms more affected than others?

There are several reasons why the bank-sovereign linkage could have shifted in the last couple of years. Firstly, the European Union has implemented the Bank Recovery and Resolution Directive that unifies the resolution of banks in different countries and forces creditors and investors to bear their part of the losses before governments can bail out a distressed bank. Secondly, the Single Resolution Mechanism came into force in the Eurozone countries starting from 2016 as the second pillar of the European Banking Union. The mechanism governs the resolution of banks in the monetary union so that no government is individually responsible for the restructuring of important banks domiciled in the country. Despite these recent improvements in regulation, it is unclear whether they have reached their desired outcomes. A recent report by IMF (Global Financial Report, April 2017) argues that policy-makers have done too little to break the connection and it still poses a risk to the region's financial stability. S&P ratings agency has stated that the "doom loop" will not be over as long as banks hold significant amounts of sovereign debt (S&P Global Ratings, 2016) and several politicians have discussed the possibility to change the current regime of assigning zero-risk weight to sovereign debt in capital requirements as one solution (Navaretti et al., 2016). By including a longer period and more countries than most previous studies, I am able to shed light on whether the relationship has changed after the heights of extreme credit conditions in sovereign debt crisis and study if the regulation has decreased correlation between credit spreads.

Regarding my second research question, two recent studies find significant correlation between corporate and sovereign CDS spreads in Eurozone countries (Bedendo and Colla, 2015; Augustin et al., 2016). Both studies focus on a narrow time period that was characterized by the sovereign debt crisis. To my knowledge, no previous studies have focused on the general

relationship between corporate and sovereign spreads in the developed countries alone. I expand on this question and study if the correlation between spreads documented by previous studies is permanent or mostly related to the turmoil in sovereign debt markets. If the former is true, sovereign risk is a factor that should be taken into account by investors of corporate debt and by corporate executives when they decide on their firms' funding and country of headquarters. However, even if the correlation between credit spreads relates only to the sovereign debt crisis, it is important for investors to understand that similar sovereign crises can affect corporate credit premiums in the future.

Additionally, to my knowledge, few studies have considered the credit risk transfer from corporate credit risk to sovereign credit risk. I aim to complement the first two research questions by studying the two-way dynamics between corporate and sovereign credit risk and test whether changes banks' or non-financial companies' credit spreads significantly leak to sovereign spreads. Many studies have documented credit risk transfer from banks to states after bank bailouts (Acharya et al., 2014), but none have so far considered a similar relation for non-financial firms. The possibility of large-scale bailouts to banks or other corporations may decrease the credit quality and debt-serving-capacity of the government, and raise costs of sovereign debt – costs that are in the end paid from the pocket of the taxpayer.

Unlike previous studies, I also aim to combine these views and include both financials and non-financials in same the analysis. I study whether changes in financial regulation have affected the relationship between sovereigns and banks, but I also acknowledge that the banking regulation may have affected the relation between sovereigns and non-financials as well. A key difference of this thesis compared to a large part of previous literature is also that I focus on the long-term transmission mechanisms behind spread changes instead of trying to catch and measure exact spillover effects during a certain time window.

1.3 Findings

To measure the linkages sovereign and corporate credit risk I use a large panel dataset of credit default swap spreads. My sample consists of daily CDS spreads of 31 banks, 113 non- financial companies and 14 sovereigns from Western Europe from January 2009 to June 2017. I mainly follow Acharya et al. (2014) in my methodology and control for several market variables and firm fixed effects in my regression analysis. I find that credit spreads of banks and sovereigns have been significantly correlated in the past, especially between 2010 and 2014, when a 10

percent daily increase in sovereign spreads translates to a 1.01 percent increase in bank spreads in peripheral countries, and a 0.53 percent increase elsewhere in the Eurozone. This relationship has weakened to insignificant after 2014. Systemically important banks are more affected than others, as well as banks that hold large amounts of domestic sovereign debt or have a credit rating close to their governments' rating. Results are robust to different model specifications and controlling for changes in CDS index spreads, volatility and the bank's own equity returns.

The findings show important remarks to regulators and investors. It seems that increased regulation in the financial sector and EU-wide directives on resolution of banks have succeeded in decreasing the nexus between the banking sector and European governments. Although the new rules have not yet been tested with a large bank bailout, my results indicate that markets think that the direction taken by regulators is correct. To ensure that future crises do not trigger similar risk loops as the sovereign debt crisis did, and to decrease potential costs to taxpayers and investors, it is important that the dynamics of the relation are monitored in the future. My findings also reveal which banks are most affected by sovereign risk. Practically speaking, this can help investors assessing the risk of their positions of bank and sovereign bonds.

In addition, non-financial companies' are affected by sovereign credit risk, with a 10% daily increase in sovereign spreads corresponding to a 0.7% increase in corporate spreads, on average. Although magnitude of my results is lower, they are in line with previous studies of Bedendo and Colla (2015) and Augustin et al. (2016). The risk transfer from sovereigns to non-financial firms has also diminished towards the end of the studied sample, but the decrease is not as distinctive as in the banking sector. Companies that are partly owned by the government, large in size compared to the local economy, or have a credit rating close to the sovereign rating are more affected than others, but I am not able to find any single variable that would determine which companies are affected and which are not. This is an important finding in itself, as it shows that sovereign risk affects the borrowing costs of non-financial companies even in developed markets, where the "traditional" country risks of currency depreciation or unexpectedly high inflation are small. In addition, the results hold for a period of almost 10 years even when several market and firm-specific factors are controlled for.

Moreover, my analysis documents a two-way dynamic between corporate and sovereign credit spreads. Sovereign CDS spreads are significantly affected by changes in local banks' and non-financial companies' credit spreads and this relation is robust to several control variables. My results show that corporate and sovereign credit risks are interlinked, with the transfer from

corporate to sovereign risk actually being stronger than the other way around during some of the periods. After 2014 changes in banking sector spreads discontinue to affect sovereign spreads. Few studies have previously documented such a high correlation between the credit risk of non-bank local companies and governments.

1.4 Limitations of the study

This study has a few main limitations. First, CDS contracts are traded only for large companies that are able to tap international capital markets and usually have outstanding bond financing or a relatively high credit rating. Therefore, I am not able to study what effects changes in sovereign risk have on the financing costs of smaller or privately owned companies. One could argue, that government credit risk and domestic loan supply are actually more relevant to smaller firms, as they are not able to diversify their funding or operations as globally as large firms. Including smaller companies in the study would have required a different approach of measuring credit risk, so I decided to focus on publicly listed firms with more data available. Assuming that smaller firms should be more affected than larger companies, not including them in the sample may actually mean that empirical results downplay the size of real effects.

Another limitation concerns the dataset. Data on CDS spreads can be noisy, because contracts on many corporate reference entities are not very liquid. Therefore, I had to leave several companies out of the final sample due to illiquid CDS prices, stale data or long gaps in the time series. To avoid most of the abovementioned problems, I conduct several checks and restrictions on the companies that I include in my dataset and I check the robustness of my results with a dataset of weekly changes in CDS spreads. Tests with weekly data are in line with the main analysis and actually show stronger results than tests with daily data. In addition, the availability of CDS data for some sovereigns restricted the sample to start from 2009, which limited my analysis to after-the-financial crisis period.

1.5 Structure of the study

Remainder of this thesis is structured as follows. Section 2 explains important concepts, theoretical background and previous literature discussing interdependencies between corporate and sovereign credit risks. Section 3 introduces hypotheses based on the literature discussed in Section 2. Data, construction of variables and methodology are presented in Section 4 and results of empirical analysis are presented in Section 5. In addition, Section 5 presents robustness checks and discussion of the analysis. Finally, Section 6 presents conclusions.

2. Literature review

This chapter presents an overview of literature on the dynamics between the credit spreads of sovereigns and banking and corporate sectors. First, I explain the concept of credit risk and credit spreads, and the mechanics of credit default swap markets. Then, I move to the theory behind the bank-sovereign risk nexus in Europe, and discuss findings of previous literature. I also review possible channels of transmission for the bank-sovereign and corporate-sovereign credit risk transfers. Finally, I conclude with reasons why the relationship may have changed after the sovereign debt crisis.

2.1 Determinants of corporate and sovereign credit spreads

Credit risk, or alternatively default risk, can be defined as the risk that a borrower is unable to pay back promised cash flows to the lender, who then loses either the whole invested principal or part of promised interest rate payments. Credit risk of a borrower can be measured in different ways of which accounting-based credit scoring methods, such as credit ratings, have traditionally been the most typical. However, rating agencies are often conservative and slow to adjust to new information, as they prefer to keep credit ratings stable, in order to avoid reversing decisions within a short time (Löffler, 2015). Another way to estimate credit risk is to look at market-based credit spreads, which reflect investors' current perceptions of the issuer's credit quality and requirements for return. The credit spread of an asset is defined as the difference between the yield of a risk-free asset of the same maturity and the yield of the security in question. The spread consists of two parts - the expected probability of default and the rate of recovery in case of a default:

$$Credit\ spread = (1 - recovery\ rate) * P(default) \quad (1)$$

If either the expected probability of a default increases or the expected recovery rate decreases, the credit spread and required return on the asset will consequently increase. The definition of an event of default depends on the obligation in question and is not limited to a bankruptcy. For example, governments cannot go bankrupt per se, so sovereign credit spreads reflect not only the ability to pay, but also the willingness to pay back debt (Moody's, 2010).

In general, sovereign defaults in developed countries are extremely rare and sovereign credit spreads are generally lower than corporate credit spreads. Gennaioli et al. (2014) argue that sovereign defaults are most costly in countries with developed financial institutions, because a

government default would destroy the balance sheets of the domestic banking sector. For this reason, defaults should be less likely to happen in more financially developed countries. However, defaults and debt crises in developing economies happen rather frequently and are often connected to a currency crisis. For example, Argentina has defaulted on its sovereign debt several times in the past twenty years (Reuters, 2014).

Several studies have researched the drivers of sovereign credit spreads. Longstaff et al. (2011) argue that the influence of US equity and high yield markets dominate local market variables as determinants of sovereign spreads in both developed and developing economies. They claim that global risk premiums and investment flows, rather than local economic factors, are the most important determinants of sovereign credit spreads and investors of sovereign credit default swaps largely bear global risk instead of country-specific risk premiums. Pan and Singleton (2008) study the term structure of CDS spreads of Korea, Mexico and Turkey. They find that risk premiums co-move strongly over time and are significantly related to movements in VIX option volatility index, the volatility of local-currency option markets and the spread between yields of 10-year US BB-rated industrial corporate bonds and the yield on 6-month US Treasury bills. Thus, even in emerging markets sovereign spreads are mostly affected by global factors.

After the financial crisis, yield spreads on European government bonds increased dramatically from their pre-crisis levels. Contrary to previous discussion, Dötz and Fischer (2010) find that this increase was mainly due to an increase in the expected loss component and country-specific factors, instead of an increase in illiquidity or global risk aversion. Whether sovereign yields are more affected by local or global factors seems to depend on the phase of the economic cycle. For example, Augustin (2013) argues that the term structure of sovereign CDS spreads signals about the relative importance of underlying sources of credit risk. During times of high economic growth the slope of the term structure is usually positive which signals that spreads are relatively more driven by global factors, while during a recession the curve typically turns downward sloping and variation in spreads tends to be more driven by country-specific shocks,. Thus, both global factors and country fundamentals are important determinants of sovereign CDS spreads, but they matter at different times.

Taking sovereign default risk and country risk into account in investment decisions is especially important in the international context, also for investors of corporate bonds. Bai and Wei (2012) study governments and companies from 30 countries internationally and find that sovereign risk has both a statistically and economically significant effect on corporate credit premiums.

They conclude that strong property rights and legal institutions weaken the impact, while the influence is stronger for state-owned companies. Hence, the effect of country risk on corporate spreads depends on the perceived riskiness of the government.

Changes in corporate credit spreads are also affected by changes in global factors. Collin-Dufresne et al. (2001) study yield spread changes of corporate bonds and find that traditional predictions of structural models are able to explain only one fourth of the variation in spreads. However, they find that the regressions residuals are highly cross-correlated, and possibly linked to local supply and demand and liquidity in the markets. Longstaff et al. (2005) study credit default swap spreads instead, and find that majority of corporate spreads consist of default risk instead of liquidity or taxation risk. They also discover that the non-default component of CDS spreads varies in time and is strongly correlated with bond-specific illiquidity and bond-market illiquidity in general. This could indicate that especially the yields in cash-bond markets are affected by market-specific factors, while CDS spreads are able to more accurately measure the actual default risk component of the firm.

2.2 Credit default swap markets

In this study, I use credit default swap ("CDS") spreads as a measure of credit risk. CDS contracts are standardized derivative instruments traded in over-the-counter ("OTC") markets. Contacts are bilateral and settled between two parties, not traded in exchanges. Usually the seller (or underwriter) of the contract is a large financial institution or a hedge fund. Like most other OTC derivatives, CDSs entail counterparty risk meaning the risk that either of the contract parties may default on their obligations.

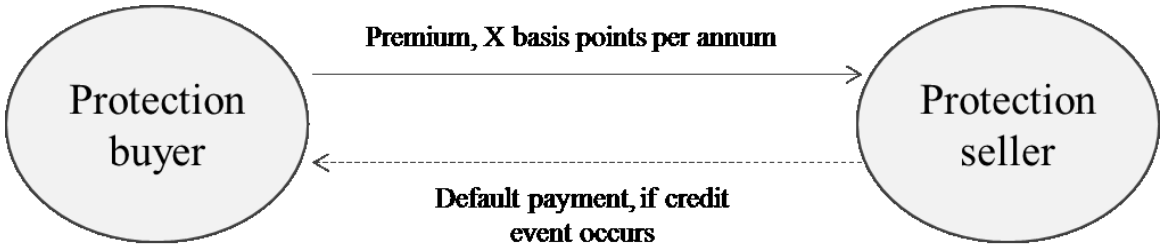
Trading in CDSs started in the 1990's and the market grew rapidly in the first decade of 2000's. According to statistics of Bank for International Settlements ("BIS"), the gross notional amount of outstanding contracts almost ten-folded from 6 billion dollars to 58 billion dollars between 2004 and 2007. During the financial crisis and after defaults of Lehman Brothers and AIG, CDS markets came under considerable criticism and concern by both the press and regulators. The market size and liquidity has decreased after the financial crisis and BIS estimated the notional amount of outstanding contracts to be around 10 billion US dollars at the end of 2016.[1]

[1] Actual size of the CDS market is difficult to estimate because the derivatives are traded OTC. Gross notional value of contracts traded refers to the sum of CDSs bought across all counterparties.

Theoretically, buying a CDS contract is similar to buying insurance on a reference entity's default. The reference entity, which can be a government, a municipality, a corporation or an asset-backed security, does not take part in the contract. The protection buyer pays a series of periodic payments to the protection seller, called a fee, a premium or a spread. The spread is the percentage of the notional amount that the buyer must pay to the seller annually over the maturity of the contract. Although the spread is measured in annual terms, payments are typically made quarterly. The seller, in turn, compensates the buyer in case the contract's reference entity defaults, or a *credit event* takes place. There are two types of settlements in case of a credit event. In a *physical settlement,* the buyer delivers the defaulted asset or bond to the seller, who in turn pays the par value to the buyer. In a *cash settlement*, the seller delivers the difference between the par value and the market value of the asset to the buyer in cash. CDS contracts can be used for hedging, speculation or arbitrage and contracts trade in several constant maturities, with five years being the most typical one for corporate entities. Figure 1 demonstrates the cash flows between the participants of a swap contract in more detail.

Figure 1: Cash flows of a credit default swap

The figure illustrates the cash flows of a typical credit default swap contract. The protection buyer pays a quarterly premium to the seller of the swap measured in basis points per annum called the spread. The seller in turn, makes a payment to the buyer only in case of a default event. The payment will be made as the difference between the nominal value and fair value of the insured instrument.



Depending on the type of the swap, credit events that trigger a payment can be defined differently. For example, contracts written on sovereigns often include *repudiation* and *moratorium* of debt as credit events, as governments cannot go bankrupt in the sense that corporations can. For example, the restructuring of Greek government debt in 2012 triggered a credit event and an auction in the sovereign CDSs. The recovery price for the CDS settlement was 21.5 cents per dollar (Reuters, 2012). The most typical credit event clause for European corporate contracts is called "modified-modified" while "full restructuring" is the most typical one for sovereign contracts. These clauses are also used in the sample construction of this study.

I decided to use CDS spreads instead of bond yield spreads for a number of reasons. Firstly, CDS spreads are a more pure measure of credit risk than bond yields. In theory, a CDS spread should be equal to the spread of a floating-rate note above a specified risk-free rate while in practice, floating-rate bonds of corporate entities are rare and there are several contractual reasons why CDS spreads and bond yield spreads can differ in the short run. However, Blanco et al. (2005) and Palladini and Portes (2011), among others, have found that CDS prices usually lead bond yields in the price discovery process. CDSs have several other advantages over bond yields in an empirical setting. Corporate bonds are usually less liquid than government bonds, because they are typically bought with a buy-and-hold strategy and not, for example, for hedging purposes. Thus, their yields may include a priced liquidity premium in addition to measuring creditworthiness (Longstaff et al., 2005). During crisis periods, trading in bonds may halt completely, making them an unreliable measure of credit risk during the Eurozone debt crisis. This is illustrated by the study of Palladini and Portes (2011), who find evidence of an unusually large CDS-bond basis spread during the sovereign debt crisis.

Corporate and government bonds trade in different maturities and with different characteristics related to market microstructure, which makes bond yields hard to compare objectively with each other. In turn, CDSs are traded in constant maturities. Finally, especially corporate bonds are affected by bond- and country-specific factors such as different debt covenants, coupon structures, issue amounts and laws of different jurisdictions. In efficient markets, these aspects will be priced in yields although they do not reflect the credit risk of the entity.

2.3 Bank-sovereign feedback loop

After the financial crisis, it became clear that debt levels of several European countries were unsustainably high which dramatically widened the credit spreads of over-indebted sovereigns between 2008 and 2009, and again in 2010. The increase in sovereign risk revealed hidden problems in the European banking sector, a twin crisis named “the tale of two debt overhangs” by Acharya et al. (2014). Firstly, several banks had significant exposures to their domestic government’s debt. A decline in the bonds’ market price decreased the value of bank’s asset portfolios, which increased risks in already highly leveraged financial sectors. Secondly, governments in many countries had to support domestic financial institutions by providing additional capital or liquidity, which in turn increased the level of government debt and credit spreads soared even wider.

Since the financial crisis, the stability of the European financial system has been of considerable worry to politicians and regulators for several reasons. First, Europe is much more bank-focused than the United States and many European banks failed to reform and clean up their balance sheets like the financial sector in the US did after the crisis. Secondly, European banks are often important creditors to their own sovereigns and the banking sector has incentives to hold large amounts of government bonds (Acharya et al., 2015). In the capital frameworks of Basel III/CRD IV, EU government bonds are allocated a zero-risk weight in the calculation of minimum capital requirements to risk-weighted assets, no matter which credit rating the bond is assigned. When yields of peripheral countries' sovereign debt increased, the banking sector had incentives to increase holdings of high-yielding government bonds, as they provided both high returns and do not weigh on the bank's capital. In case that the domestic government would default on its debt, it is likely that the local bank itself would go down in any case, which leads to distorted incentives to hold large amounts of domestic bonds. Acharya et al. (2015) have named the phenomenon the "greatest carry trade ever". They explain bank's behavior with the regulatory arbitrage described above, with general tendency of home bias in investments, and with suasion by domestic government to maintain asset exposures.

In a recent study, Ongena et al. (2016) find that during the debt crisis, domestic banks were substantially more likely to purchase newly issued domestic debt than foreign banks, in months with high sovereign bond issuance. These results support the concept of "moral suasion" whereby sovereign entities may put pressure on their own financial sector to support the government by purchasing debt. Altavilla et al. (2017) provide additional evidence showing that especially banks that were publicly owned or recently bailed-out purchased more domestic debt than other banks as a response to sovereign stress. This is consistent with the concept moral suasion as such banks are more likely than others be under the pressure of their governments. In addition, Andreeva and Vlassopoulos (2016) find evidence that the pre-existing link between bank and sovereign credit spreads may have actually caused the affected banks to increase purchase amounts of domestic government bonds. Those banks' whose credit spreads were most correlated with their sovereign spreads in the turn of 2011 and 2012 bought more domestic assets if the credit spreads on these bonds were high. This evidence also supports the concept of "risk shifting" behavior where banks purchase high-yielding assets while the downside risk is mostly borne by the bank's creditors and taxpayers, not by its shareholders.

However, the loop also works the other way around. To avoid a banking crisis, governments are likely to serve as providers of liquidity and capital if an important bank is in financial trouble. Providing a large-scale bailout to the financial sector usually increases the level of government debt and expands the fiscal budget, consequently affecting sovereign credit risk and diluting the value of currently outstanding bonds. Hence, policies to bail out troubled banks may have reduced the risks of the banking sector partly at the expense of raising the credit risk of the sovereigns (Fratzscher and Rieth, 2015). Bailing out banks serves as a credit risk transfer between the financial sector and the real sector: as the bailout has to be funded either with increased taxation or with additional debt, the riskiness of the country's economy increases as a whole. Contagion between sovereign risks may also occur because investors update their beliefs on the probability of failure after a default event. For example, Benzoni et al. (2015) suggest that during turbulent times, sovereign credit premiums co-move more strongly than what would be justified based on macroeconomic principles.

After correlation between credit spreads increased dramatically during the European debt crisis, the link between sovereign and banking sector default risk has been studied extensively. Increased correlation and spillover during and after the euro crisis has been documented by several studies (Alter and Schüler, 2012; Acharya et al., 2014; Fratzher and Rieth, 2015; among others). Acharya et al. (2014) present a theoretical model in which banking sector credit risk is a determinant of sovereign credit spreads and the other way around, leading to a feedback loop. They also empirically study the risk nexus and find that there was no relationship between bank and sovereign credit spreads before first bank bailouts in Europe. During the bank bailouts in 2008, the feedback loop became statistically and economically important: bank spreads were negatively correlated with sovereign spreads. While sovereign CDS spreads increased, bank spreads decreased. The authors explain this as a credit risk transfer from the banking sector to the sovereign sector. Post-bailouts, sovereign risks significantly and positively affect banking sector's credit spreads (Acharya et al., 2014).

Several other papers have studied the spillover or contagion effect between sovereign and bank credit spreads. Alter and Beyer (2014) define spillovers as excessive co-movement of credit spreads, while contagion is defined as correlation over and above what can be explained by fundamental factors. Alter and Schüler (2012) find that before government interventions of troubled banks, contagion occurs from bank spreads to sovereign spreads. However, after bank bailouts the direction changes, and sovereign CDS spreads increase importance over bank CDS

spreads. They stress that countries with large contingent liabilities to the financial sector should acknowledge that this might have an impact on their own financing costs. Alter and Beyer (2014) construct a contagion index from CDS spreads of European sovereigns and banks and conclude that spillovers and the likelihood of contagion increased prior to several key financial market events and policy interventions during a period from October 2009 to July 2012. They find spillover effects both from banks to sovereigns and vice versa. Using structural vector auto regression (VAR) models, Frazscher and Rieth (2015) study the relationship from 2003 to 2013 and find two-way causality between shocks to sovereign and bank risk. They find that shocks to sovereign risk are more important in explaining bank risk than the other way around. A 100 basis point increase in sovereign spreads raises bank spreads by 38 basis points, on average.

Most studies find that the feedback loop is stronger from sovereigns to banks (Erce, 2015; Fratzscher and Rieth, 2015). For example, Erce (2015) finds that sovereign risk affects the financial sector more strongly than banks affect sovereigns. He studies the effect of several sovereign factors that affect the correlation between CDS premiums and finds that feedback from sovereigns to banks is greater in countries with higher debt levels and in countries where banks hold large amounts of their own government's bonds. The effect is stronger in countries where the sovereign credit rating has been downgraded to a high yield -category. Bank-to-sovereign feedback, on the other hand, is stronger in countries where the banking sector is larger and in countries with a large share of non-performing loans. This provides evidence that the bank-sovereign risk is transferred by distinctive channels. In the next two chapters, I focus more deeply on the transfer channels from bank to sovereign risk and from sovereigns to bank risk.

2.3.1 Channels from bank to sovereign credit risk

Firstly, banks indirectly impact government credit risk through credit supply to the real sector. Banks that are facing problems with solvency or liquidity may be forced or incentivized to cut back on lending to the real sector. In the long term, a decrease in credit supply will contract investments and growth in the economy as a whole, causing a decrease in the tax base and in tax revenue to the government. If the government is already heavily indebted, a decrease in taxes can cause financial problems and increase the credit risk of the state (BIS, 2011). Thus, the credit supply channel may increase the governments' credit risk even if the country does not suffer a banking crisis.

Secondly, because of the importance of the banking sector to the health of the economy, large financial institutions usually hold both explicit guarantees, such as deposit insurance, and implicit guarantees from the government, meaning that it is likely that the state will support a bank in financial difficulties. Systemically important, large banks are often deemed to be "too big to fail" that means that their failure would significantly increase the risk of a severe banking crisis and possibly a recession. Therefore, it is in the interests of the government to avoid failures and keep the financial sector as stable as possible even if it means providing support in a crisis and eroding the country's own financial status. For this reason, banks may have incentives to seek growth through mergers or acquisitions, as bank size can imply lower financing costs due to the "too-big-to-fail" status (O'Hara and Shaw, 1990).

During the financial crisis, banks were granted liquidity injections and recapitalizations and in in several cases a government even bought a significant equity stake in a systemic financial institution, both in Europe and in the US. For example, more than 200 banks in 16 advanced economies issued government-guaranteed bonds (BIS, 2011). Consequently, if investors expect that the government will bail out troubled banks these expectations may leak out from the private sector to governments as a perception of higher sovereign credit risk (Dieckmann and Plank, 2012). For example, Acharya et al. (2014) document that after the Irish government announced that it would guarantee deposits in its biggest banks, the CDS rate of the banks fell dramatically while simultaneously the spreads of Ireland's sovereign CDS increased.

Empirically, Dieckmann and Plank (2012) show that the relative size of the local banking sector pre-financial crisis is a determinant of sovereign CDS spreads. They find that higher exposure to the financial sector is linked with higher sovereign spreads after controlling for the country's debt level and general market volatility. The health of the local banking sector is also associated with sovereign CDS spread levels. If the country's economy was strongly dependent on the financial sector before the crisis, its CDS spreads show tighter correlation with the state of the banks' financial health and this effect is further emphasized for countries that are part of the monetary union. The results support the hypothesis that an increase in the possibility of a banking sector bailout decreases sovereign creditworthiness, as markets incorporate the expected costs of the bailout to sovereign spreads.

Kallestrup et al. (2016) show that the size and riskiness of foreign asset holdings of the domestic banking sector significantly affect not only the credit premiums of the banks, but also sovereign CDS spreads. They measure exposures of the local banking system using CDS premiums and

expected default frequencies of the local stock market, weighted with banks' exposures to foreign and domestic private and sovereign sector. One standard deviation change in the risk weighted measure changes sovereign spreads by 24 basis points on average. The risk of the local banking system is an important determinant of sovereign CDS spreads even after controlling for global CDS indices and local fiscal measures. The researchers argue that the transmission effect is due to implicit government guarantees and contingent liabilities to the banking system. Also Bekooij et al. (2016) find that implicit contingent guarantees, measured as the size of the country's banking sector's equity cushion, are significantly linked to higher correlation between bank and sovereign spreads.

Ahmed et al. (2015) find somewhat contradicting evidence on the assumption of implicit guarantees to too-big-to-fail institutions. They show that while there is a difference between the borrowing costs of large and small financial firms, this effect is not unique to the banking sector but is also observed with non-financial firms. This contradicts with the hypotheses that the size effect between credit spreads of large and small banks is due to increased expectations of implicit government guarantees to "too-big-to-fail" banks. However, they also find that banks have, on average, lower borrowing costs than non-financial companies do, when other company characteristics are controlled for.

2.3.2 Channels from sovereign to bank credit risk

BIS (2011) defines four channels through which sovereign risk feeds back to the banking sector: through devaluation of banks' sovereign bond holdings, deterioration in funding conditions due to collateral damage, credit rating ceiling and through decreased value of implicit and explicit guarantees from governments. Recent literature has found empirical evidence on all of the distinctive channels, which I review next.

The most direct way changes in government credit premiums affect banks is through holdings of sovereign bonds, the so-called *asset value channel*. European banks have traditionally held large amounts of sovereign bonds and institutions are often overexposed to their home country (BIS, 2011). In addition, many banks have large exposures to the debt of other Eurozone sovereigns, for example German and French banks held sizeable holdings of "GIIPS"[2]

[2] The acronym "GIIPS" refers to the peripheral EU-countries that were especially affected by the sovereign debt crisis. GIIPS refers to Greece, Ireland, Italy, Portugal and Spain. The alternative spelling, sometimes used by the press is "PIIGS". In this study, I use the acronym GIIPS to refer to the five peripheral countries.

countries' debt before the sovereign debt crisis. When the credit risk of a sovereign increases, the fair value of their outstanding debt decreases, consequently weakening asset values in the financial sector's balance sheet. The impact is direct for bonds that are "held-for-trading" and valued at fair values, and somewhat slower for bonds held at amortized cost[3].

Asset value channel is the most typically cited reason as a cause of the sovereign-bank feedback loop. Among the first to research it were De Bruyckere et al. (2013) who study excess correlation between bank and sovereign CDS spreads and variables that contribute to the correlation. They find that banks with higher exposure to sovereign bonds experience, on average, much higher excess correlation with the corresponding countries' credit spreads. Correlation is also stronger the higher the sovereign credit spread. The researchers conclude that government bond holdings are relevant only if the risk of sovereign default increases, while decreases in credit risk do not have significant impact on the excess correlation. This supports the hypothesis that the observed excess correlation is due to the asset holdings channel. Both Acharya et al. (2014) and Erce (2015) find evidence that sovereign-to-bank feedback is higher for banks that hold large amounts of government bonds.

The second channel is through deterioration in short-term funding conditions, so-called *collateral channel*. Government securities are often used as collateral in interbank loans, repurchase agreements and wholesale funding from the central bank (BIS, 2011). If the market values of bonds deteriorate, value of this collateral will shrink. According to BIS (2011) especially private repo markets are sensitive to changes in collateral value. As the repo markets are an important source of bank funding, sourcing financing from the capital markets becomes more expensive. De Bruyckere et al. (2013) provide evidence that banks relying excessively on interbank funding are more vulnerable to contagion than banks funding their operations mainly with traditional deposits. They also show that banks holding higher amounts of sovereign bonds are more vulnerable to changes in sovereign credit risk and the effect is even stronger for those relying extensively on short-term funding.

Thirdly, sovereign risk transmits through the *sovereign rating channel.* Traditionally, credit rating agencies have required that a company's credit rating cannot exceed the rating of its

[3] According to accounting rules, banks can value holdings of debt in two ways: at fair value or at amortized cost. If the bonds are "held-for-trading" or "available for sale" they are valued in the books at fair value, and drops in market prices directly affect asset valuations and profit-and-loss statements. If bonds are "held-to-maturity", for example to strengthen the balance sheet, they can be valued at amortized cost. For these holdings, the book value will only decrease if holdings are impaired, i.e. when a default on the bond is deemed to be likely.

sovereign. More generally, a common expectation is that private sector claims cannot be offered at better terms or lower spreads than those of the local government. According to Almeida et al. (2017), rating agencies have been moving away from the rating requirement in the past few years, but it is still uncommon for a company to have a higher rating than its government. A lower rating makes financing more expensive because investors require higher credit premiums for taking the risk. Therefore, a credit rating downgrade will increase the financing costs of the bank. Alsakka et al. (2014) find that changes in sovereign credit ratings strongly increase the possibility of bank rating downgrades. They find no evidence before the sovereign debt crisis, but the effect increases strongly after the crisis. Because of the implicit credit rating ceiling, a decrease in government rating thus increases the risk that the bank rating will also be downgraded in the near future.

In addition, a downgrade on sovereign debt affects banks through financial sector regulation, especially if the downgrade is near to a speculative rating class. Aretzki et al. (2011) find that sovereign rating downgrades significantly affect bank stock prices between 2007 and 2010 and downgrades near the speculative grade had systematic spillover effects to the financial sector. They argue that this effect is due to rating-based triggers in bank regulation, OTC derivatives contracts and different investment mandates. Adelino and Ferreira (2016) show that, after a sovereign downgrade, banks with ratings bound by the sovereign ceiling reduce their lending significantly more than similar banks whose ratings are not at the sovereign bound. Decreases in sovereign ratings also affect the market value of the government's outstanding debt, which is deemed to be riskier than before. This affects the banking sector through the two previously described channels, devaluation of assets and collateral. In case the downgrade results in a move from investment grade -class to high yield the effects are even more pronounced, as in most cases only investment grade securities are accepted as collateral in interbank markets.

Finally, *government guarantee channel* discussed in Part 2.3.1 also works the other way around by channeling government credit risk to the banking sector. Contingent guarantees lower banks' costs of funding as investors expect that governments will rescue banks in case of severe problems. If the sovereign's own creditworthiness deteriorates, however, the value and credibility of these guarantees decreases because it becomes less likely that the government will be able to support its financial sector. Acharya et al. (2014) argue that the value of government guarantees decreases quickly especially if the state is highly indebted because of the difficulty to source new funding from the capital markets. However, Demirgüç-Kunt and Huizinga (2013)

argue that some banks may have actually become "too big to save" in the past few years. During the financial crisis doubts arose whether governments' have the financial abilities to save their largest financial institutions. The researchers find that bank valuation is negatively related to bank size and positively related to their headquarter country's fiscal balance. The researchers suggest that systemically important banks could actually increase their value by downsizing.

Figure 2: Sovereign-bank feedback loop

This figure demonstrates the feedback loop between sovereign and banking sector credit risks, also called the "doom loop" (Acharya et al., 2014). Sovereign risk affects banks through their holdings of government bonds, availability of funding and credibility and value of offered guarantees. Banks affect sovereign risks through the implicit guarantees and possibility of bail-outs and through banks' general importance to the real economy.

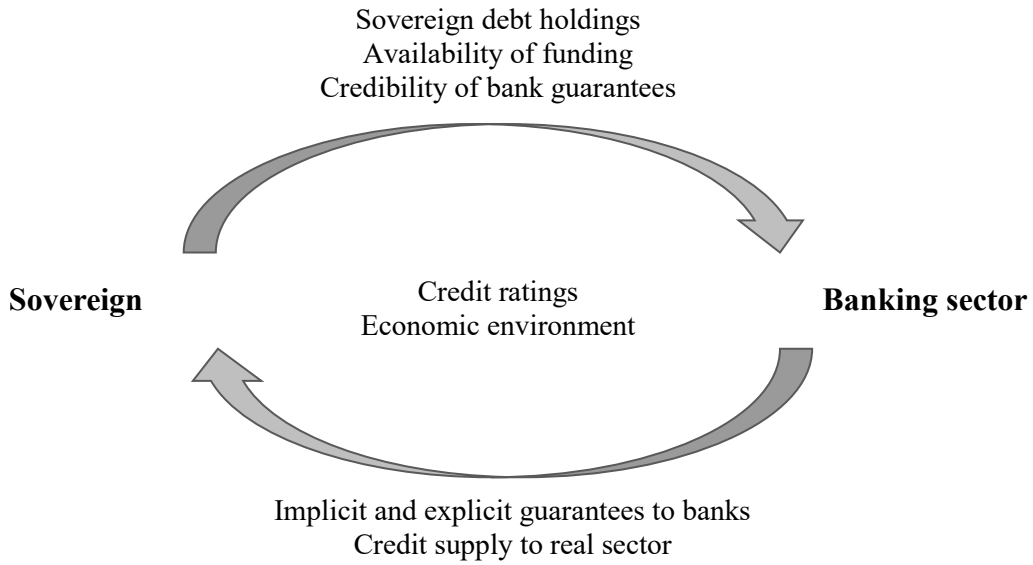


Figure 2 demonstrates the feedback loop between the sovereign and the banking sector: both are affected by general economic environment and their own and each other's credit ratings. Bank credit risk affects sovereigns' through contingent guarantees, and in the long term, through credit supply to the economy. Sovereigns, in turn, affect banks through holdings of government bonds, value of collateral and the credibility and value of government guarantees.

2.4 Corporate and sovereign credit risk beyond the banking sector

Compared to the banking sector, it is less evident why an industrial corporation's credit spreads should be affected by the credit risk of its sovereign or the other way around. If a government defaults on its debt, it does not necessarily mean that companies' financial figures deteriorate or that the risk of a corporate default increases. This is especially true for companies operating in open, developed market economies like the European Union. Most companies in the free-trade area are able to move their operations to another country and the largest are able to tap

global capital markets for financing. In addition, risks typical for emerging economies such as currency controls or expropriation of private assets are extremely unlikely in Western Europe. Countries that are part of the monetary union are not able to print money in order to deflate their debt either. Thus, the risk of currency depreciation of corporate bonds is also very small. Likewise, if a non-financial company ends up in bankruptcy, it is less likely to cause a large systemic crisis in the economy as the failure of an important bank. Compared to the banking sector, the spillover from corporate risk to sovereign risk should therefore intuitively be smaller.

Despite this, recent studies find significant correlation between corporate and sovereign credit spreads in Eurozone countries within the context of the sovereign debt crisis. Augustin et al. (2016) study spillovers of credit risk from sovereigns to non-financial corporations before and after the bailout of Greek debt in April 2010. They find that a ten percent increase in sovereign spreads increases corporate spreads by 1.1 percent after the bailout, while the relation was statistically insignificant before the event. The spillover is more pronounced for companies from the Eurozone and from the GIIPS countries. Bedendo and Colla (2015) study the corporate-sovereign credit risk relation from January 2008 to December 2011 and find a somewhat smaller effect. A ten percent increase in sovereign CDS spread is associated with a 0.5 percent change in corporate spreads. Klein and Stellner (2014), in turn, focus on bond yield spreads in the Eurozone and find that corporate credit ratings and bond Z-spreads are affected by sovereign ratings and Z-spreads. In the next chapters, I review literature on the channels that may transfer sovereign credit risk to corporations' and the other way around.

2.4.1 Channels from corporate to sovereign credit risk

Most previous research focuses on the effect of sovereign risk to corporate credit spreads, but corporate risk may also affect sovereign creditworthiness. In aggregate, riskiness of the country's corporate sector affects the volatility of GDP and imports – for example, some industries may be very important to the GDP growth and tax revenue of a certain sovereign. If a single corporation is very important to employment or GDP growth, it may itself affect the riskiness of the country as well (BIS, 2011). Secondly, in addition to the banking sector governments hold different implicit contingent guarantees to corporations that have a "too-big-to-fail" status or are otherwise of importance to the state. Thus, if a company is very important to the country in terms of employment or tax revenues, a large decrease in the firm's credit risk may indirectly affect the state through the economy, and directly through increased likelihood that the company may require financial support from the government. Governments may also

bail out a company to prevent socioeconomic problems and unemployment, or to control power over natural resources or national security. Although examples of state-support to non-financial corporations are rarer than for banks, one example of a well-known corporate bailout is the automotive sector and in the United States after the financial crisis. In addition to full on bailouts, sovereigns may also back corporate debt. For instance, energy sector companies in Europe are often partly owned by the state and thus the government effectively backs their debt.

2.4.2 Channels from sovereign to corporate credit risk

Bedendo and Colla (2015) identify three distinct channels through which sovereign credit risk may leak out to corporate credit risk in developed economies. Firstly, a strong decrease in sovereign creditworthiness may lead to a contraction in domestic demand both through increases in taxation and tightening in fiscal policy. Secondly, like banks, some companies enjoy guarantees, backed debt and credit lines from the government. Thirdly, the state of the local banking sector affects domestic credit conditions. An increase in sovereign credit risk may lead banks to contract their credit supply to the real sector, causing higher costs of financing or even difficulties in obtaining credit in the first place. Additionally Augustin et al. (2016) suggest that the credit rating channel is an important mechanism in the context of non-financial firms as well. Next, I will go through evidence on four channels in more detail.

Increased sovereign credit risk can be a consequence of high debt levels, budget deficit or low economic growth. To restore creditworthiness, governments often need to decrease spending and adopt restrictive fiscal policy measures. Restrictive policy measures directly affect revenues of companies that supply goods and services to the public sector, including for example utilities or transportation sectors. Budget deficits may also lead to increases in taxation, which affects profitability directly through corporate taxes and indirectly due to a contraction in domestic demand that slows down economic growth and incentives to invest in general. This increases the default risk of companies whose sales that are highly concentrated in the domestic markets. For example, Bedendo and Colla (2015) and Klein and Stellner (2014) find that firms with sales concentrated on the domestic market are significantly affected by sovereign credit spreads. On the contrary, Bai and Wei (2012) argue that the taxation channel is less emphasized in countries with stronger institutions, as the government is not able to change the taxation system surprisingly at its discretion.

As discussed in the previous chapter, non-financial companies may also enjoy implicit or explicit guarantees from the state. Guarantees are especially relevant for companies where the government is an important shareholder or where the state otherwise holds significant influence on including, for instance, companies operating in telecommunications or utilities, where investments are typically state-supported financially for different strategic reasons. Like for banks, government guarantees for non-financial firms may come in the form of debt guarantees or promises of support in times of financial stress. Faccio et al. (2006) study 450 firms from 35 countries and find that firms that have political connections are significantly more likely to be bailed out than similar firms with no political connections. Interestingly, politically connected firms also borrow more than others do, indicating that lenders are more willing to extend credit to firms with a higher probability of a future bailout.

If the government is under financial distress, these guarantees lose credibility and value, which affects the creditworthiness of supported companies. Bedendo and Colla (2015) find high correlation between credit risk of sovereigns and firms that are under significant government influence and Augustin et al. (2016) find that spreads of firms with public ownership have higher correlation than others with sovereign spreads. Bai and Wei (2012) study the sovereign-to-corporate credit spreads in an international context and find that the relationship is stronger for companies that are owned by the state. Klein and Stellner (2014) find that bond Z-spreads of government-owned companies or those that operate in transportation, utilities or telecommunications are more affected by sovereign credit risk.

Thirdly, European economies have traditionally relied strongly on banks and the importance of capital markets has been minor. Thus, if banks are suffering and contracting their credit supply in the economy, companies that finance a large part of their operations with bank loans may need to reduce investment, which decreases future growth and profitability. In the longer term, this erodes the creditworthiness of affected companies. Both Augustin et al. (2016) and Bedendo and Colla (2015) find that the credit risk of firms that are dependent on bank financing are more affected by changes in sovereign spreads. Besides bank lending, deterioration of sovereign creditworthiness affects companies that source financing from the capital markets. Most importantly, a sovereign default lowers the country's reputation among investors, but already increased uncertainty about commitment to serving debt may restrict access to bond markets (Augustin et. al., 2016). For example, Arteta and Hale (2008) show in the context of emerging economies that sovereign debt crises are usually accompanied with a decline of

foreign credit and lending to private firms. Altavilla et al. (2017) find evidence that when sovereign risks increased, banks from stressed countries with large sovereign bond exposures cut their lending more than less-exposed banks.

In a recent study Acharya et al. (2016) study the effects of the sovereign crisis in the context of syndicated loan markets. They find firm-level evidence that banking sector's lending contraction decreased investments, job creation and sales growth for the firms that were affiliated with banks from countries that were most affected by the sovereign debt crisis. Between 2008 and 2013, the volume of newly issued syndicated loans fell by 82%, 66% and 45% in Ireland, Spain and Portugal correspondingly, and the effect was strongest for banks with high exposures to sovereign risk.

The fourth channel how credit risk of the sovereign affects the pricing of corporate credit risk is through the previously discussed *sovereign rating ceiling*. Firms rarely have credit ratings higher than their sovereign, and in case of a sovereign downgrade, the perceived creditworthiness and funding costs of the firm are therefore also under pressure. Almeida et al. (2017) study the effect of sovereign downgrades on firms' credit ratings. They divide firms to "bound firms" which have a rating equal to, or above, their sovereigns' and "non-bound firms" which have a lower rating. They find that after a sovereign downgrade, bound firms are significantly more likely to be downgraded as well and the downgrade affects the firm's investment decisions and net debt issuance. Economically, the effect on investment decisions is significant: bound firms decrease investment by 8.9 percent in the year of the downgrade and are also more likely to reduce net debt issuance. Credit rating is an important determinant of access to bond financing and if there are doubts that the firm will be downgraded, sourcing new debt may become more difficult. In addition, Almeida et al. (2017) find that downgrades increase the yields of bound firms' more than those of non-bound firms'. Three months after the sovereign downgrade, the average yield on bound firms' bonds increased 34 basis points more than those of non-bound firms'.

Drago and Gallo (2017) find supporting evidence on the importance of sovereign downgrades on the context of European syndicated loan spreads. They discover that downgrades significantly increase costs of debt, while an upgrade does not have a significant effect. Investment grade -firms are most affected, but downgrade significantly affects also the firms that are most dependent on bank financing. Interestingly, they find that downgrades also affect the lending costs of unrated firms. They argue that unrated companies have fewer opportunities

to source funding from capital markets and thus, have to rely on bank loans. Importantly, the study suggests that increases of sovereign credit risk have direct effects on the lending costs of non-financial corporations.

However, the sovereign ceiling does not relate to credit ratings alone, but also to financing terms in general. Companies are often not able to secure any financing at better terms than their government (Borensztein et al., 2013). Lee et al. (2016) research sovereign ceiling on private sector firms in the context of CDS spreads in developed and developing countries. They find that compared to other firms in the same country, companies that have important foreign asset holdings or whose shares are dual-listed in a country with better property rights or stricter disclosure requirements, are more likely to have lower CDS spreads than their governments. Their finding suggests that it is possible for firms to break the link to sovereign risk if they are internationally diversified.

In conclusion, there is plenty of evidence supporting the credit rating channel, both for banks and for non-financial firms. Previous literature discusses the linkages between non-financial firms' and sovereigns' but clear proof of links between credit risks are still scarcer than for the financial sector.

2.5 The European Banking Union – an end to the doom loop?

In the aftermath of the sovereign debt crisis several regulatory changes have taken place in the European Union with the aim of resolving the unwanted link between the fragile banking sectors and their sovereigns and to stabilize the financial systems. In this chapter, I discuss and explain the recent policy developments and their possible effects to the credit risk transfers to and from European sovereigns.

The EU-wide Bank Recovery and Resolution Directive (hereafter "the BRRD") was adopted in spring 2014. The directive requires banks to prepare recovery plans and grants national authorities the powers to ensure resolution with minimal costs to taxpayers through setting minimum requirements for banks' own funds and eligible liabilities (MREL) that are based on bank size and risk. The idea is that bank shareholders and creditors instead of taxpayers will have to pay a share of the costs through a "bail-in" mechanism. In addition, the directive includes requirements of national resolution funds. The aim has been to reduce moral hazard by setting the burden of bank failures on investors instead of taxpayers and to harmonize the resolution of financial institutions' throughout Europe (European Commission). In addition, the

directive targets to decrease the likelihood of government bailouts with taxpayers money, which should decrease the importance of contingent government guarantees to bank credit spreads.

Secondly, the decision on the European Banking Union was initiated in 2012 as a policy reaction to the bank-sovereign circle. The banking union consists of three pillars: the Single Supervisory Mechanism ("SSM"), the Single Resolution Mechanism ("SRM") and the Joint Deposit Insurance, which are legislated by the so-called Single Rulebook. As of 2018, the first two pillars have been implemented in countries that are part of the monetary union. The deposit insurance has not been fully decided on due to open questions on who is going to provide the funds to and how the insurance should be implemented in several EU countries.

The first part of the banking union, The Single Supervisory Mechanism (SSM) has been in effect since 2014. From November 4th, 2014, the ECB has centrally conducted the stress testing and supervision of the most important financial institutions in the Eurozone. Before the SSM, supervision was performed on a country level by local authorities. The aims of the mechanism have been to make bank balance sheets more transparent and to align the stress testing conducted across the monetary union, directly assessing the problem of asymmetric information from an investor point of view, and avoiding regulatory arbitrage. However, the SSM does not in itself aim to weaken the link between governments and banks. The second part of the union, The Single Resolution Mechanism ("SRM") came into force from the start of 2016 through the BRRD directive. The purpose of the SRM has been to ensure that resolution of failing banks is done orderly and to limit resolution costs to taxpayers and to financial stability. Authority that makes decisions in the SRM is called the Single Resolution Board (SRB) and financing of the restructuring is done through a common Single Resolution Fund (SRF), which is controlled by the SRB. The SRM directly targets to break the link between banks and sovereigns by ensuring that no bank can have preferential treatment by their government and that no government is solely responsible for saving a failing bank. Thus, if the mechanism works as it should it should reduce the costs of a bank failure to a single sovereign and break the *guarantee channel* within the bank-sovereign feedback loop.

Although the banking union and the BRRD have mostly received positive feedback that they are guiding EU-wide banking regulation to the right direction, several critics have voiced that the "too-big-to-fail" problem and bank-sovereign feedback loop are still yet to be solved. In addition, some critics argue that a "bail-in" may work in case of an isolated bank failure, but letting banks fail is never optimal in a systemic banking crisis (Financial Times, 7.1.2018).

Another often discussed initiative would be to change the treatment of EU government debt in bank capital requirements by tightening the rules and introducing limits to the size of sovereign exposures (Navaretti et al., 2016). Despite the extensive discussion, such changes to capital requirements are yet to be made.

So far, there is very little academic research on the success of the regulation. One of the few is Neuberg et al. (2016), who research whether the market-implied probability of a bank bail-in has increased after the BRRD was implemented. Bail-in can be defined as an action where creditors suffer the losses of a bank failure, but the bank stays in business afterwards. In other words, the bank does not go bankrupt but continues to operate. The researchers find that after 2014 the likelihood of a bank default has increased, while the likelihood of a bail-in has fallen and the likelihood of a government bailout has not increased in succession. The researchers interpret the evidence to signal that policymakers have succeeded in reducing market expectations of government support to troubled banks. The BRRD requires that a minimum of eight percent of bank's liabilities need to be bailed in before a government can come to the rescue. Thus, the likelihood of government support has decreased, and holders of junior-seniority debt would almost never be bailed out under the directive. The evidence supports the hypothesis that BRRD has at least partly succeeded in its aims and market participants estimate the likelihood of government-support is lower than before the BRRD regulation. In addition, Vergote (2016) studies bank-sovereign correlation between years 2007 and 2015 and concludes that some financial institutions still seem to be "too-big-to-fail" and their resolution plans lack credibility. However, so far there is no conclusive evidence on the effectiveness of the regulation.

3. Hypotheses

In this chapter, I present the hypotheses of the study based on previously discussed literature and recent developments. Numerous studies have proved excess correlation and feedback loop between European governments' and banking sectors' credit spreads during and after the sovereign debt crisis (Alter and Schüler, 2012; Acharya et al., 2014; Kallestrup et al., 2016). However, several regulatory changes and improvements have taken place since the bailout on Greek debt in 2010, including the founding of the European Banking Union and application of the Bank Recovery and Resolution Directive. The aim of the BRRD has been to integrate resolution mechanisms inside the EU countries, forcing investors to take the first hit before government bailouts. This should have theoretically decreased the expectations that a sovereign will bail out its local financial sector in times of a banking crisis. In addition, implementation of the Single Resolution Mechanism that is part of the Banking Union should have significantly reduced the risk that taxpayers from a single country will be held liable for the failure of a domestic bank. Nevertheless, very little academic research has been done to test the success of the regulation. I aim to study whether the bank-sovereign feedback loop has changed during the past few years and meanwhile test the effectiveness of new regulation[4]:

Hypothesis 1: *Direct link from sovereign to bank credit spreads has existed after the sovereign debt crisis, but this relation has diminished after the BRRD and SRM have been implemented.*

I study four sub-hypotheses related to the distinctive channels of risk transmission between sovereigns and banks discussed in chapter 2.3. Firstly, I expect that banks holding large amounts of domestic sovereign bonds are more exposed to changes in sovereign credit risk due to the asset holdings channel (BIS, 2011).

Hypothesis 2: *The link from sovereign to bank credit risk is stronger for some banks than for others.*

[4] The BRRD has been implemented by all members of the European Union as of 7th of January 2016, with exception of Poland, not included in this study. However, only banks domiciled in the EMU countries are under the SRM. For this reason, it is possible that only banks from the Eurozone are fully affected by the new regulation. Nevertheless, it is also possible that investors see the banking sectors in other countries are less risky after the new regulation has been put in place. Therefore, I test the relationship both on the EU-level and with subsamples of Eurozone and non-Eurozone countries. I am also interested in seeing whether the effect is stronger in the GIIPS countries, where previous studies have found a stronger feedback loop.

> **Hypothesis 2A:** *The transmission from sovereign credit risk is stronger for banks with higher holdings of domestic sovereign bonds ("asset-holdings channel").*

Secondly, banks hold implicit and explicit guarantees from their home states (BIS, 2011). The more important these guarantees are, the stronger I expect the feedback loop from sovereign risk to bank risk to be. I test this hypothesis in two ways. Firstly, if the bank is expected to benefit from government support, it will be more affected by changes in sovereign creditworthiness. This expected benefit is measured using Moody's credit ratings. Secondly, if the financial institution in question is deemed to be a globally systemically important institution, it is more likely that the government will implement emergency measures if the bank ends up in financial trouble, as the risk of a banking crisis increases with the importance and size of the bank.

> **Hypothesis 2B:** *The transmission from sovereign credit risk is higher for banks that benefit from government support, or are deemed to be of systemic importance ("guarantee channel").*

Thirdly, I test the effect of the *credit rating channel*. If the credit rating of a bank is equal to, or above, than its sovereigns' rating I expect it to be more affected by downward changes in sovereign spreads due to the rating ceiling documented by Alsakka et al. (2014).

> **Hypothesis 2C:** *The transmission from sovereign credit risk is stronger for banks with a rating closer to their sovereign ("credit rating channel").*

In line with hypothesis one, I am interested in testing the three parts of hypothesis two over time to see whether the channels have become negligible after the implementation of the BRRD and SRM. Especially the effects of the guarantee channel should have decreased if market participants estimate that the BRRD has diminished the probability of government bailouts. Out of the four transmission channels described in Chapter 2, I do not test for the *collateral channel* (BIS, 2011), as I do not have exact information of the collateral posed by banks against their trades.

My second research question relates to the relationship between non-financial companies' and sovereign credit risk. I formulate my hypothesis based on previous literature which shows that increases in sovereign credit risk feeds back to the real sector, although the magnitude of the relationship is lower than it is for banks (Bedendo and Colla, 2015; Augustin et al., 2016). I am

interested in testing whether the previous results hold for a longer period and during periods that are not characterized by stressed financial markets. This aspect has been uncovered by previous empirical research. My hypothesis is that credit spreads of non-financial companies' are affected by credit spreads of their governments'.

Hypothesis 3: *Corporate credit spreads are affected by sovereign credit spreads of their country of domicile.*

Chapter 2 discussed four channels through which sovereign credit risk can be channeled to the real sector. Based on this discussion, I formulate four hypotheses to test if these factors have a significant effect on the magnitude of the relationship. Firstly, in times of sovereign distress, the credit risk of the domestic banking sector tends to increase (Alter and Schüler, 2012; Acharya et al., 2014), which can cause a decrease in credit supply to the real sector (Acharya et al., 2016). Thus, companies that are more dependent on bank financing may find it more difficult than before to source funding, causing an increase in financing costs.

Hypothesis 4: *The link from sovereign to corporate and risk is stronger for some companies than for others.*

> **Hypothesis 4A:** *The link from sovereign to corporate credit risk is stronger for companies that are highly dependent on bank financing ("bank channel").*

Secondly, companies that enjoy implicit or explicit guarantees from the government are expected to be more affected by changes in sovereign credit risk, because the value of these guarantees is affected by sovereign creditworthiness (Bedendo and Colla, 2015). I expect that government-controlled companies or firms otherwise enjoying state support are more affected by sovereign credit risk than others.

> **Hypothesis 4B:** *The link from sovereign to corporate credit risk is stronger for companies that are controlled by, or otherwise important to, the state ("guarantee channel").*

According to the theory on sovereign rating ceilings, the credit quality of a firm is bound by the credit rating or credit spreads of its sovereign. Firms with a rating close to, or equal to, that of their home country, are more affected in case of a sovereign downgrade (Almeida et al., 2017; Drago and Gallo, 2017).

Hypothesis 4C: *The link is stronger for companies that have a credit rating equal to, or above, their sovereign ("credit rating channel").*

Lastly, significant distress to sovereign creditworthiness can result in a decrease of domestic demand if the government is expected to increase taxation, decrease public investment or state demand for goods and services. I expect that firms which source a higher portion of their revenue from their domestic market are more affected by changes in sovereign spreads than firms that collect revenue more globally.

Hypothesis 4D: *The link is stronger for companies that source a large part of their revenue from the domestic market ("revenue channel").*

Finally, my third research question asks whether the relation between corporate and sovereign credit risk is two-sided and sovereigns are also affected by the credit spreads of local companies. Hypothesis 5 predicts that the dynamic is two-sided and the credit risk of banks' and non-financial companies' also affects sovereign credit spreads through contingent guarantees and their importance to the health of the economy. However, as predicted by Hypothesis 1, I expect that the link from banks to sovereigns has diminished after the new EU-wide regulation on bank resolution has been put in place.

Hypothesis 5: *Sovereign credit spreads are affected by spreads of local companies and banks, leading to a two-way dynamic between the sectors. Bank to sovereign credit risk transfer has diminished after the BRRD and SRM have been put in place in Europe.*

4. Data and methodology

In this section I describe the data sample of CDS spreads and other variables used in the analysis. I also illustrate how control variables are constructed and present summary statistics of my sample. Finally, I present and discuss the methodology and regression models used to study hypotheses developed in the previous section.

4.1 Data

CDS spread data is obtained from Datastream for both sovereigns and corporates. I include corporate entities headquartered in one of the Eurozone countries, in Denmark, Norway, Sweden and the United Kingdom. I use Datastream to search for banks and non-financial companies that are headquartered in the abovementioned countries and have a traded credit default swap. I exclude all non-bank financial companies and European subsidiaries of companies that are headquartered elsewhere. In addition, I require that all entities have their shares listed in a stock exchange in a sample country and further exclude companies that have been merged or delisted during the study period. Further, companies included in the dataset need to have a traded CDS and equity for the whole period. Eight Eurozone sovereigns[5] were left out of the analysis due to a lack of liquid CDS data for the study period. Greece is also excluded due to restrictions in the country's CDS after the bailout on its debt.

From Datastream I retrieve mid-quote CDS spreads with a daily frequency from 1.1.2009 to 30.6.2017. I use senior unsecured contracts with a 5-year maturity, as this is the most liquid contract maturity especially for corporate entities, and the most typical CDS maturity to be studied in financial literature. All contracts are traded in either in euros or in US dollars: almost all of the corporate and bank contracts are traded in euros, as well as all sovereign CDSs with the exception of contracts on Finland, the Netherlands and Norway which are traded in dollars. The sovereign contracts trade with a Full Restructuring -clause while corporate contracts are traded with a Modified-modified restructuring (MMR) –clause. These are the most typical clauses for European sovereign and corporate contracts correspondingly.

In line with Acharya et al. (2014), I use daily CDS spreads to ensure a large sample and to make it easier to control for daily variation in other variables. The alternative would have been to use weekly changes in spreads, which is the approach taken by, for example, Bedendo and Colla

[5] These are Cyprus, Estonia, Latvia, Lithuania, Luxembourg, Malta, Slovakia and Slovenia.

(2015). I address this question in the robustness checks in Chapter 5.6. The downside of using daily data is that daily changes in CDS spreads tend to be noisy, because some contracts' illiquidity. To ensure that results are not driven by unavailable CDS quotes or measurement error, I restrict the sample to entities that have a traded CDS for the whole period with several data checks. Firstly, I exclude CDS series for firms that are missing more than 15% of daily spreads for the studied period. In addition, I drop observations with longer than two days of zero changes in the CDS to avoid stale data, and I exclude one entity that filed for bankruptcy during the study period. Because I do not exclude all entities with missing data, but instead drop time series observations, I end up with an unbalanced panel with 67,489 observations for banks, 245,920 observations for non-financials and 30,426 observations for sovereigns.

In addition to CDS spreads, I collect data of country- and company-specific factors. I obtain quarterly government debt and GDP data from OECD's statistics and balance sheet information for firms from Thomson One and Orbis. From Thomson One, I fetch financial statement data at annual frequency for total assets, long- and short-term debt, book equity, deposits (for banks) and S&P long-term issuer credit ratings. In addition, I collect two types of Moody's issuer credit ratings, long-term issuer ratings and baseline credit assessment (BCA) ratings, which measure the creditworthiness of a bank before expected external support. Because some data is not available in Thomson One, I collect data on bank loans, the share of each firm's revenues from the domestic country and the percentage of firm's shares owned by the local government from Orbis. There are some entities where Orbis data is unavailable, and these entities are left out of part of the analyses. I fetch data on the market capitalization of each of the studied countries from Bloomberg and data on banking sector's assets from the ECB's statistical warehouse. In addition, I hand-collect data of banks' holdings of government bonds from the transparency tests of the European Banking Authority. The bank-level holdings of sovereign debt are publicly available for 30 banks with half-a-year frequency from 2010 to 2017.

For control variables, I fetch daily data of credit default swap index, equity market volatility and local stock index returns, 5-year US Treasury yields and exchange rates against the US dollar from Bloomberg. For CDS market returns, I use iTraxx Europe Investment Grade index that tracks the movements in CDS premiums of 125 European investment grade corporates. To control for aggregate market volatility, I use the VSTOXX index, which tracks the index option volatility of the Euro STOXX 50 equity index, and is similar to the well-known VIX index for S&P 500. For equity index returns in each country I use the local total return index.

4.2 Variables and descriptive statistics

The dependent variable in the study is the daily change in the natural logarithm of the relevant CDS spread of a bank, a firm or a sovereign. The independent variable of interest is the daily change in either the logarithm of the sovereign CDS spread, or an index of firm CDS spreads from the relevant country. Construction of the CDS spread indices is described in the next chapter. Variables that are used to study hypotheses 2 and 4 will be explained next. Variable descriptions and data used to construct them are also presented in Appendix 1.

First, I measure banks' sovereign bond holdings by two ratios, which are calculated at the end of each semi-annual period for which the bond holdings data is available:

$$Domestic\ holdings_{it} = \frac{Domestic\ bond\ holdings_{i,t}}{Total\ assets_{i,t}} \tag{2}$$

$$Domestic\ share_{it} = \frac{Domestic\ bond\ holdings_{i,t}}{Sovereign\ bond\ holdings_{i,t}} \tag{3}$$

where *i* denominates the bank and *t* the six-month period for which the ratio is measured. Based on the ratios I create two dummy variables, which I use to divide the sample in half according to sovereign exposures. Variable *Domestic exposure* is equal to one if the ratio of domestic bond holdings to total assets is higher than the sample median at the end of each half-year period and zero otherwise:

$$Domestic\ exposure_{it} = \begin{cases} 1 & if\ Domestic\ share_{it} > median(Domestic\ share)_t \\ 0 & if Domestic\ share_{it} \leq median(Domestic\ share)_t \end{cases}. \tag{4}$$

Similarly, *Home share* is equal to one if the ratio of domestic bond holdings to total sovereign bond holdings is higher than the sample median at the end of a semi-annual period. I construct many other dummy variables in a similar manner by comparing the firm-specific value of a variable to the sample median at time *t.*

For Hypothesis 2B I create two variables. The first variable is based on the credit ratings of rating agency Moody's. Moody's assigns financial institutions two types of ratings, with and without government support (Moody's Investor Services, 2014). The Baseline Credit Assessment (hereafter "BCA") rating represents the bank' intrinsic, or standalone, probability

of failure before taking into account any possible external support that the bank may receive. This rating is solely based on bank's financial situation and business positioning. However, to rate the bank as an issuer of debt, Moody's also takes into account the possibility that the bank may receive public support, which usually increases the bank's creditworthiness through expected government guarantees. Assessment of probability and extent of government support is included in the bank's Issuer Credit Rating[6]. The BCA is always either equal to, or lower, than the Issuer Credit Rating, as the expected government support cannot be "negative". Thus, the difference between the two ratings acts as a proxy for the likelihood that Moody's expects the bank to benefit from government guarantees, and a higher difference indicates a higher probability of support (Acharya et al., 2014). I construct a variable *Ratings uplift* that takes the value of one if the bank's BCA rating is lower than the Issuer rating and the bank is hence expected to benefit from government support. Each rating is first assigned a numerical score from 1 to 26, so that the highest rating Aaa is assigned a score of 1 and the lowest is assigned a score of 26. If the issuer rating score is lower than the BCA rating score, Moody's assesses that the bank benefits from government support:

$$Ratings\ uplift_{it} = \begin{cases} 1 & if\ Issuer\ rating\ score_{ijt} < BCA\ rating\ score_{jt} \\ 0 & if\ Issuer\ rating\ score_{ijt} \geq BCA\ rating\ score_{jt} \end{cases}. \quad (5)$$

The variable is re-measured annually. The second variable, *Systemic importance* is a dummy that takes the value of one if the bank is deemed to be a global systematically important bank ("G-SIB") by the Financial Stability Board. The bank sample includes 13 systematically important financial institutions in total.

To test the effect of the credit rating ceiling, I create a variable called *Rating ceiling*, that is equal to one if the bank's or firm's S&P Long Term Issuer Rating is equal to, or higher than, the rating of its sovereign and zero otherwise. Similarly as before, each S&P rating is first assigned a score from 1 to 26, so that the highest rating gets a score of 1. If the firm's rating score is lower than or equal to that of the sovereign, its creditworthiness is deemed to be higher, and variable *Rating ceiling* is equal to one:

[6] The extent of support is assessed by looking at the probability of support, the state's capacity to provide support and general dependence between the support provider (the state) and support recipient (the bank), among others (Moody's Investor Services, 2014).

$$Rating\ ceiling_{it} = \begin{cases} 1 & if\ Firm\ rating\ score_{ijt} \leq Sovereign\ rating\ score_{jt} \\ 0 & if\ Firm\ rating\ score_{ijt} > Sovereign\ rating\ score_{jt} \end{cases} \quad (6)$$

where *i* denotes the firm from country *j* and *t* is the year of measurement for the credit rating. The variable is used both for banks and for non-financial companies. 8 banks and 10 non-financial companies have a rating higher than or equal to their sovereign at some point during the sample period. Alternatively, I measure the sovereign ceiling in terms of credit spreads. The variable *Spread ceiling* is constructed similarly to *Rating ceiling* and it equals one if the CDS spread of the firm is higher than that of the sovereign, measured at daily level.

For the non-financial sample, I construct a dummy variable *Bank dependent* to test companies' dependence on the banking sector. The variable measured how large a fraction of the firm's debt is in in the form of bank loans. *Bank dependent* is equal to one if the ratio of the firm's bank loans to total liabilities is higher than the sample's median ratio at the end of each financial year. In the end of 2016, the median and average shares of bank loans to total liabilities in the non-financial sample were 3.4 percent and 9.4 percent of total liabilities, correspondingly. Hence, the sample does not seem to be very dependent on bank financing. One reason may be that companies which have a traded CDS have good access to public bond markets. Alternatively, I measure dependence on bank financing based on the size of the country's banking sector, which is measured as the ratio of the domestic' banking sector's total assets to the country's total equity market capitalization at the end of each calendar year. The variable *Bank based* is a dummy variable takes the value of one if this ratio is higher than the median of all countries' ratios, and zero otherwise. Thus, if *Bank based* is equal to one, the country is in the top half of the sample of European countries, measured with the size of the banking sector.

Similarly, I measure the share of revenue that companies' source from their country of domicile. Dummy variable *Domestic revenue* is equal to one if the ratio of the firm's sales from the domestic country to its total revenue is higher than the median of the total sample. This variable is based on data at the end of financial year in 2016 due to lack of annual data. The median and average share of domestic revenues at the end of 2016 are 28.1 and 36.7 percent, respectively.

Finally, to test the effect of government influence in the interdependence between credit spreads, I construct three variables. Firstly, variable *Government control* indicates government ownership and is equal to one if the local government holds more than 5% of the company's shares at the end of 2016. There are in total 16 companies, where the domestic government

holds a significant share of ownership. However, I also acknowledge that governments may hold power over a company in other ways than directly owning its shares. I expect that companies which are strategically more important to their countries, for example in terms of employment or GDP contribution, are more likely to be supported by the state. I construct a variable called *Strategic relevance* which equals one if the ratio of the company's market capitalization to the total equity market capitalization of the country is higher than the 75th percentile of the total sample at the end of each year (Bedendo and Colla, 2015). In other words, *Strategic relevance*, measures the relative size of the company compared to the total size of the country's equity markets. Instead of using the median like with other dummy variables, I decided to use the 75th percentile, because most of the companies in the sample are quite small, and I expect that strategic importance measured with market cap only becomes relevant only if the company is substantially large. On average, the companies represent 2.6% of their country's total market capitalization. Finally, I create a variable *Supported sector* that takes the value of one for firms operating in telecommunications, utilities or transportation sectors, as these sectors are most expected to both benefit from government guarantees and be affected by changes in state demand. 24 firms out of 113 operate in these four sectors.

Figure 3: Geographical distribution of sample firms

The figure illustrates the geographical distribution of number firms and banks in the sample. The grey bars represent the number of banks and the blue bars represent the number of non-financial firms from each country.

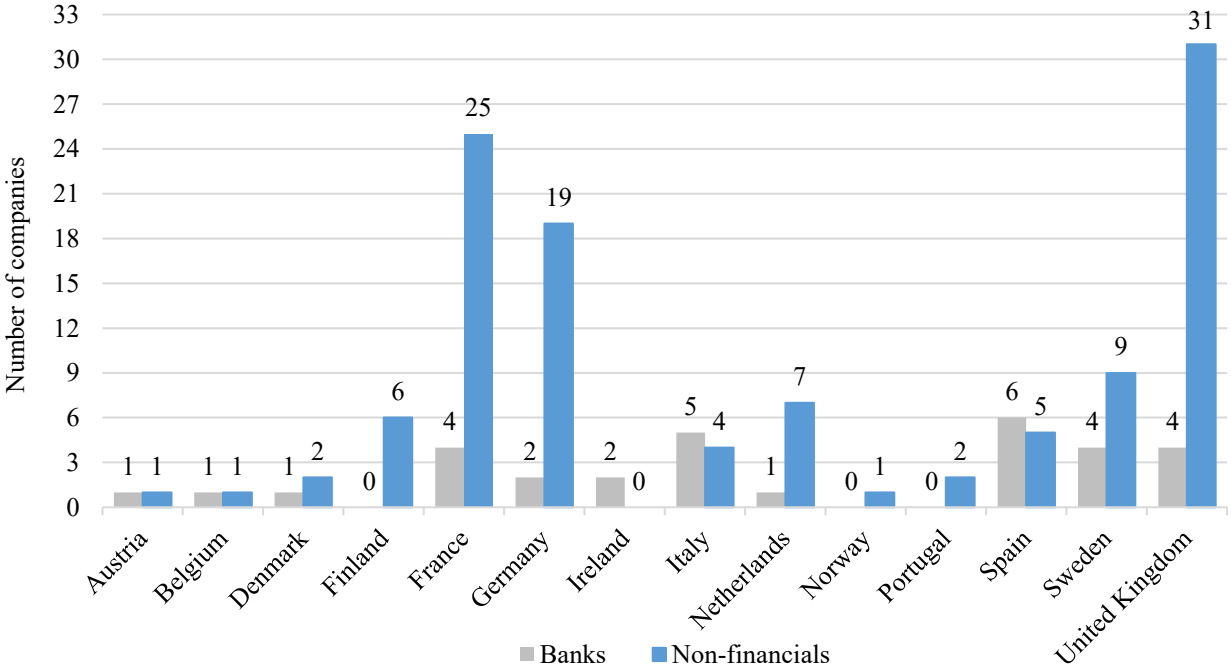


Figure 3 illustrates the geographical distribution of the sample companies and banks. The sample includes 14 sovereigns, 31 banks from 10 countries and 113 non-financial companies from 13 countries. Thus, there are 3 countries where the sample includes only a non-financial company but not a bank. Largest proportion of banks comes from Spain (6 banks) and largest number of non-financials come from the United Kingdom (31 companies) and France (25 companies), which in total represent a total of 49.6 percent of the non-financial sample.

Table 1 reports descriptive statistics of banks, non-financial companies and sovereigns measured on 31.12.2016. Banks are considerably larger than non-financial companies when measured with total assets. In addition, banks have on average higher credit ratings: the median credit rating of the bank sample is A- and the median rating of the corporate sample is BBB. Banks are mostly funded with customer deposits (44%), while non-financials are mostly funded with equity (31%). A higher proportion of the bank sample comes from both GIIPS and Eurozone countries (42% and 71%, respectively) than of the non-financial sample (9% and 61%). This is mainly due to the high number of Italian and Spanish banks in the financial sample. An average bank holds 10.5 % of its assets in sovereign bonds, with 40 % of those invested in the bonds of the home government. The holdings of domestic sovereign bonds range from 0.7% of total assets for Svenska Handelsbanken and Skandinaviska Enskilda Banken from Sweden, to 9.6% for Banco de Sabadell from Spain.

Table 2 reports descriptive statistics of the time-series for the three samples. The panel data sample for banks consists of 67,489 observations in total, while non-financial sample includes 245,920 observations and sovereign sample includes 30,426 observations. The sample size was somewhat decreased because of missing CDS observations. I divide the sample to four distinctive periods. First period runs from 1.1.2009 until the bailout of Greek debt on 11.4.2010. The start of the period was restricted by data availability and I chose the period to end when the debt crisis extrapolated in the Eurozone. During this time, the average CDS premiums were 141.7, 226.6, and 69 basis points for banks, non-financials and sovereigns, respectively. The second period ranges from 12.4.2010 to the date when the BRRD was implemented, 11.5.2014. During this period sovereign and bank CDS spreads increase, on average. The spreads of non-financial companies' decrease. On the third period, from 12.5.2014 to 31.12.2015 all of the CDS spreads and their standard deviations are at their lowest. Finally, the last period runs from the date when the Single Resolution Mechanism came into force, 1.1.2016, until the end of the sample in 30.6.2017. During this period the average CDS spreads increase again for all entities.

Table 1: Descriptive statistics

This table reports the summary statistics of European banks, non-financial companies and sovereigns included in the study for a cross-section on December 31st, 2016. *Assets* and *Equity* are measured in billions of euros. *Equity (%), long-term debt (%), short-term debt (%)* and *deposits (%)* present relative proportions of firm's total assets. *Credit rating* is S&P Foreign Currency Long-Term Issuer rating coded into numerical values such that AAA/Aaa is equal to 1 and D is equal to 26. *Ratings uplift* is the difference between Moody's long-term issuer rating and baseline credit assessment rating (BCA) where ratings are coded to numerical values. *Systemically important* equals one if the bank is deemed to be a Global Systemically Important Bank. *Bank loans to liabilities* is the percentage of bank loans divided by total liabilities and *Domestic revenue* is the percentage of revenue sourced from the domicile country divided by total revenue. *Government controlled* takes the value of one if the local government owns more than 5% of the company's shares. *Strategic relevance* is the ratio of the company's market capitalization to the total market capitalization of the country. *Supported sector* is equal to one if the firm operates in telecommunications, utilities or transportation. *GIIPS* and *Eurozone* indicate the percentage of the sample headquartered in the GIIPS (Ireland, Italy, Portugal or Spain) or Eurozone countries, respectively. *Debt-to-GDP* is total government gross debt divided by GDP and *Banking Sector assets/Equity Market* is the ratio of local banking sector's total assets to the equity market capitalization of the country. Data sources: Thomson ONE, Orbis, ECB, OECD, and Bloomberg.

	Obs.	Average	SD	Median	25th percentile	75th percentile
Panel A: Banks						
Assets (billion euros)	31	692.4	612.1	497.9	199.4	1102.7
Equity (billion euros)	31	39.0	36.4	25.2	12.50	59.04
Equity (%)	31	6.3%	2.0%	5.8%	5.1%	7.0%
Long-term debt (%)	31	15.0%	10.5%	11.2%	7.5%	19.4%
Short-term debt (%)	31	13.1%	7.0%	10.7%	7.8%	18.0%
Deposits (%)	31	44.4%	14.2%	46.6%	33.9%	56.9%
Credit rating	29	7.4	2.4	7.0		
Ratings uplift	29	2.3	1.4	2.0		
Domestic bonds/Assets (%)	30	4.2%	3.0%	3.6%	1.5%	7.2%
Home share (%)	30	40.1%	20.9%	35.9%	21.2%	58.0%
Systemically important (%)	31	43.3%				
GIIPS (%)	31	41.9%				
Eurozone (%)	31	71.0%				
Panel B: Non-financials						
Assets (billion euros)	113	50.7	69.8	26.7	9.3	54.1
Equity (%)	113	31.1%	17.0%	31.0%	19.9%	43.2%
Long-term debt (%)	113	23.2%	11.5%	21.5%	16.1%	30.3%
Short-term debt (%)	113	5.1%	5.3%	3.9%	1.8%	6.5%
Credit rating	98	8.8	2.5	9.0		
Bank loans to liabilities (%)	107	9.4%	14.4%	3.4%		
Domestic revenue (%)	93	36.7%	28.1%	29.2%	13.3%	54.5%
Government controlled (%)	108	14.8%				
Strategic relevance (%)	107	2.6%	3.2%	1.3%	0.5%	3.2%
Supported sector (%)	109	21.1%				
GIIPS (%)	113	8.8%				
Eurozone (%)	113	61.9%				
Panel C: Sovereigns						
Debt to GDP (%)	14	85.2%	32.2%	81.9%		
Banking sector assets / Equity market	13	4.89x	2.61x	4.10x	2.95x	6.04x
Credit rating	14	2.2	1.9	1.0		

Table 2: Descriptive statistics of CDS spreads

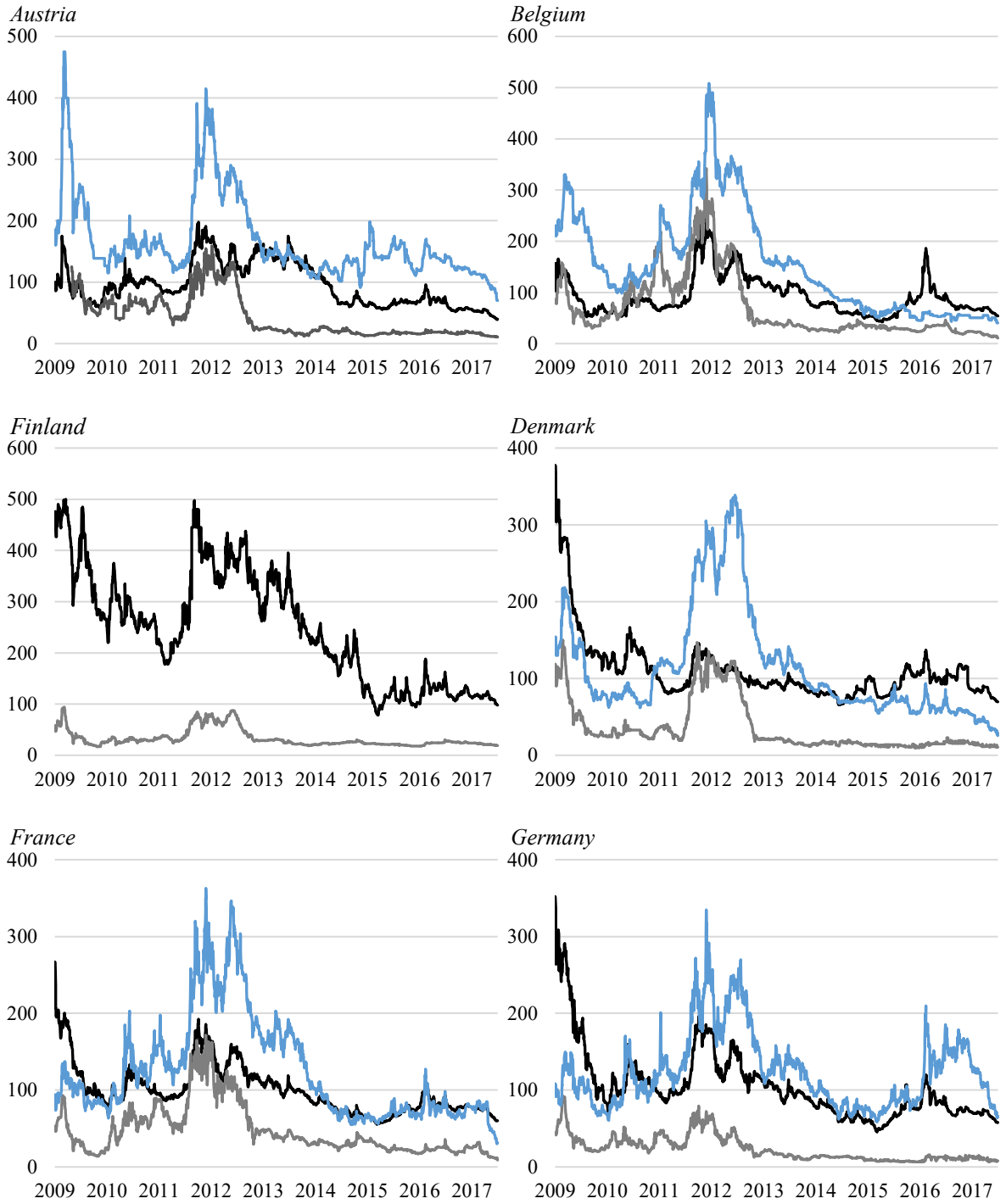
This table reports the average and median CDS spreads and daily changes in the spreads for European banks, non-financial companies and sovereigns. "Total" refers to a time period from 1.1.2009 to 30.6.2017, Period 1 from 1.1.2009 to 11.4.2010, Period 2 from 12.4.2010 to 11.5.2014, Period 3 from 12.5.2014 to 31.12.2015 and Period 4 from 1.1.2016 to 30.6.2017. Daily changes are percentage-changes in the CDS spread of the company or sovereign. Source: Datastream.

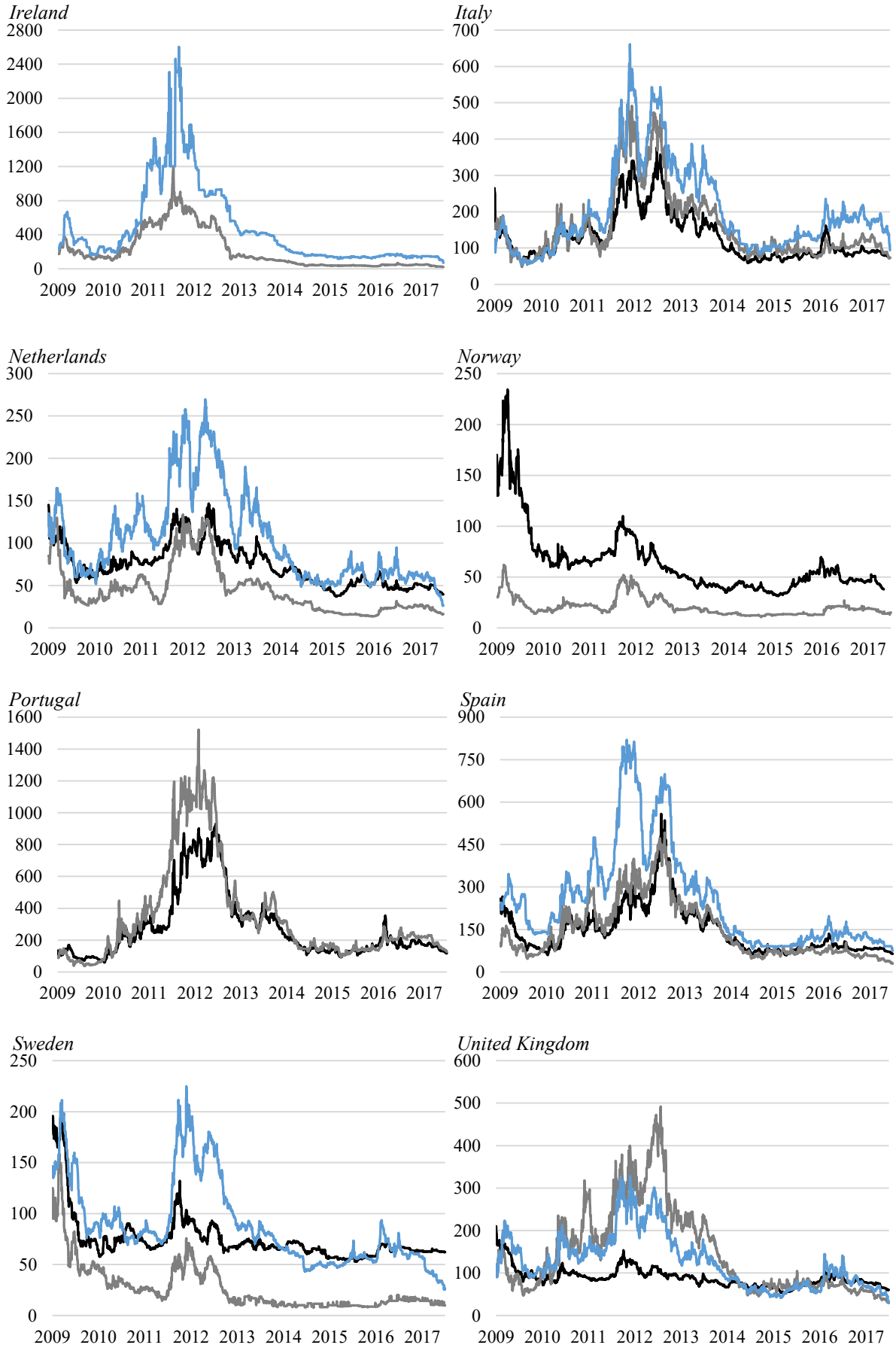
	No. of observations	Average CDS spread (bps)	Standard deviation	Median CDS spread (bps)	Mean daily change (%)	Standard deviation
Panel A: Banks						
Period 1	9,966	141.68	84.30	117.00	-0.021 %	3.715 %
Period 2	32,520	265.43	257.73	182.13	0.055 %	3.450 %
Period 3	13,099	93.49	54.41	79.27	0.035 %	3.131 %
Period 4	11,904	118.01	80.26	97.52	-0.065 %	3.702 %
Total	67,489	187.72	201.33	130.00	0.019 %	3.478 %
Panel B: Non-financials						
Period 1	36,531	226.61	382.19	106.50	-0.308 %	3.173 %
Period 2	118,311	166.25	172.26	106.58	0.016 %	2.670 %
Period 3	47,686	89.84	75.96	66.61	0.008 %	2.249 %
Period 4	43,392	103.99	112.44	75.36	-0.076 %	2.267 %
Total	245,920	149.41	203.46	90.13	-0.652 %	2.612 %
Panel C: Sovereigns						
Period 1	4,458	69.03	49.18	56.00	-0.042 %	4.911 %
Period 2	14,679	133.08	191.26	55.98	0.055 %	4.816 %
Period 3	5,913	37.76	38.35	21.24	0.061 %	5.016 %
Period 4	5,376	43.88	52.37	23.45	0.107 %	5.674 %
Total	30,426	89.41	143.66	38.80	0.005 %	5.030 %

Figure 4 shows historical development of CDS spreads for studied sovereigns, and the median CDS spreads of the country's banks and corporates. In the long term, corporate CDS spreads move in line with the sovereign spreads. Credit spreads are significantly higher between 2011 and 2013, and decrease again towards the end of the period. The median bank spreads are on average higher than spreads of non-financials, especially during the period when CDS spreads are high for all entities. In most countries, sovereign and corporate spread levels move close to each other but there are exceptions. For instance, in Finland median corporate CDS spread is higher than the sovereign CDS spread for the whole period. Co-movement between credit spreads seems to be the tightest in GIIPS countries. In some countries, for example in United Kingdom and Italy, the sovereign CDS spread is actually higher than the median corporate spread for part of the period. This shows that corporate credit spreads are not necessarily bound by the credit quality of the government.

Figure 4: Median CDS spreads

The graphs show the development of sovereign CDS spreads (in basis points) and the median corporate CDS spreads of the companies headquartered in the country, from 1.1.2009 to 30.6.2017. The dark grey line represents the sovereign spread, the black line represents median corporate spread of domestic non-financial firms and the blue line represents median bank CDS spreads in basis points. Source: Datastream.




Ireland
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4.3 Methodology

I closely follow the empirical approaches of Acharya et al. (2014) and Bedendo and Colla (2015) and employ fixed effects regression models to test for the relation between sovereign and corporate credit spreads. I include a large set of control variables in all model specifications to control for both market movements and for firm- and country-specific factors. According to Longstaff et al. (2011) credit spreads tend to increase during times of market turbulence and they are driven by changes in global macroeconomic factors and investor sentiment. Markets also price expectations of changes macroeconomic fundamentals and economic growth in sovereign credit spreads and these factors may affect the expected profitability and consequently the credit spreads of local banks and firms. It is likely that changes in these market variables affect both sovereign and firm credit spreads, creating correlation that is unrelated to the actual risk nexus that I aim to test.

In the main model, I regress daily logarithmic changes of corporate or bank CDS spreads on daily logarithmic changes in sovereign CDS spreads. I follow Acharya et al. (2014) and use changes in CDS spreads instead of levels, because I am interested in whether changes in sovereign spreads cause changes in corporate spreads. In addition, Bedendo and Colla (2015) report that time series of CDS spread levels tend to be non-stationary. I test the stationarity of my CDS spread dataset with Dickey-Fuller tests that include a time trend and an intercept. The null hypothesis of unit root is rejected only for 84 firms out of 144 for log-levels of CDS spreads. Changes in CDS spreads in my sample, in turn, are always stationary.

I include time fixed effects at the daily level in all model specifications to control for daily changes in global market fundamentals. In addition, I control for bank- and firm-level heterogeneity by including firm fixed effects, which capture company-level heterogeneity. In line with existing literature (Acharya et al., 2014, Bedendo and Colla, 2015) I prefer using a fixed effects model instead of adding a set of macroeconomic and firm control variables in order to avoid any omitted variable problems. In addition, I control for general market-wide variation in European CDS spreads and equity markets by including firm-level interactions on log-changes in two market indices. I use iTraxx Europe CDS index to capture market-level changes in corporate credit default swaps and VSTOXX index to capture changes in the market-level volatility. Market-level changes in the CDS spreads may be due to liquidity or other market specific shocks that do not directly relate to the correlation between sovereigns and firms.

I test hypotheses 1 and 3 with the following regression models:

$$\Delta \log\left(FirmCDS_{ijt}\right) = \alpha_0 + \beta_1 \Delta \log\left(SovereignCDS_{jt}\right) + \delta_t + \varepsilon_{ijt} \quad (7)$$

where $\Delta \log\left(FirmCDS_{ijt}\right)$ is the change in the natural logarithm of the CDS spread (in bps) of a bank or firm *i,* from country *j,* from day *t-1* to day *t.* $\Delta \log\left(SovereignCDS_{jt}\right)$ is the daily change in the natural logarithm of the CDS spread of a sovereign *j.* δ_t denotes time (day) fixed effects. The alternative model specification is:

$$\begin{aligned} &\Delta \log\left(FirmCDS_{ijt}\right) = \alpha_0 + \beta_1 \Delta \log\left(SovereignCDS_{jt}\right) + \\ &\gamma_1 \Delta \log(iTraxx_t)\, \varphi_i + \gamma_2 \Delta \log(Volatility_t)\, \varphi_i + \delta_t + \varphi_i + \varepsilon_{ijt} \end{aligned} \quad (8)$$

where I add firm-level fixed effects, denoted by φ_i, and control variables to the regression. $\Delta \log(iTraxx_t)$ and $\Delta \log(Volatility_t)$ are daily log changes in the market indices, which are allowed to vary at the firm level by interacting them with the firm fixed effects. In both model specifications the coefficient of interest is β_1 which captures the effect of change in sovereign's CDS to the change in the firm's CDS spread. In addition, I follow Acharya et al. (2014) and estimate the regression model controlling for the firm's equity returns:

$$\begin{aligned} &\Delta \log\left(FirmCDS_{ijt}\right) = \alpha_0 + \beta_1 \Delta \log\left(SovereignCDS_{jt}\right) + \beta_2 \Delta \log(EQ_{it}) \\ &+\gamma_1 \Delta \log(iTraxx_t)\, \varphi_i + \gamma_2 \Delta \log(Volatility_t)\, \varphi_i + \delta_t + \varphi_i + \varepsilon_{ijt} \end{aligned} \quad (9)$$

where $\Delta \log(EQ_{it})$ is the daily change in the logarithm of the firm's equity price. Controlling for company's own equity return allows me to control for any remaining omitted variables that could be related to changes in the company's financial status. Controlling for the equity returns is relevant especially for banks, since most bank bailout schemes aim at supporting the company's debtholders instead of its shareholders (Acharya et al., 2014). Therefore, all company-specific events that do not relate to debtholders should be caught by changes in the equity returns. I expect that equity returns are negatively (positively) correlated with increases (decreases) in corporate CDS spreads, as increases in credit spreads and decreases in equity prices can both signal of weakening financial status.

To test hypotheses 2 and 4 I include additional dummy variables to the regression model to capture changes that may be explained by the channel mechanisms. The dummy variables are interacted with the main dependent variable, the log-change in the sovereign CDS:

$$\begin{aligned}\Delta\log(FirmCDS_{ijt}) = \alpha_0 + \beta_3(D_i * \Delta\log(SovereignCDS_{jt})) + \\ \beta_1\Delta\log(SovereignCDS_{jt}) + \beta_2\Delta\log(EQ_{it}) + \gamma_1\Delta\log(iTraxx_t)\,\varphi_i \\ + \gamma_2\Delta\log(Volatility_t)\varphi_i + \varphi_i + \delta_t + \varepsilon_{ijt}\end{aligned} \quad (10)$$

where variable D_i is the dummy variable that is different for each sub-hypothesis. Here, the coefficient of interest is on the interaction term, β_3 that captures the variation for firms belonging to group D_i.

For Hypothesis 5, I create two credit spread indices to measure local banks' and firms' and non-effect on sovereign credit spreads. The credit risk indices are determined separately for banks and for non-financials as follows:

$$FirmRisk_{jt} = \sum(w_{ij} * FirmCDS_{ijt}) \quad (11)$$

where w_{ij} are weights determined according to the total assets of a firm *i* from country *j* to the total assets of all firms in the sample from country *j*. The created indices act as dependent variables in the regression model for H5. I also add additional variables suggested by previous literature to control for country- and market-level changes that may have an effect in sovereign spreads. The regression model for H5 is as follows:

$$\begin{aligned}\Delta\log(SovereignCDS_{jt}) = \alpha_0 + \beta_1\Delta\log(FirmRisk_{jt}) + \gamma_1\Delta\log(iTraxx_t)\,\varphi_j \\ +\gamma_2\Delta\log(Volatility_t)\,\varphi_j + \gamma_3\Delta\log(EquityMarket_{jt}) + \gamma_4\Delta\log(FXRate_{jt}) \\ +\gamma_5\Delta\log(TreasuryYield_t)\,\varphi_j + \gamma_6(Debt/GDP)_{jt} + \delta_t + \varphi_j + \varepsilon_{jt}\end{aligned} \quad (12)$$

where $\Delta\log(FirmRisk_{jt})$ is the daily change in the logarithm of the weighted CDS spread of the country's banks or non-financials. In addition to market variables defined previously, I control for changes in the local stock index with variable $\Delta\log(EquityMarket_{jt})$, change in 5-year US Treasury yields with $\Delta\log(TreasuryYield_t)$, changes in the currency rate against

US dollar with $\Delta \log(FXRate_{jt})$, and the country's quarterly ratio of government debt to GDP with $Debt/GDP_{tj}$. The control variables are based on previous studies of Longstaff et al. (2011) and Dieckmann and Plank (2012). I leave out part of the control variables the previous researchers have used, as I study daily changes instead of levels and most macroeconomic variables are updated only quarterly or annually. However, I expect that the country- and day-fixed effects will capture most of the variation in economic variables between countries.

A possible problem when using cross-sectional time-series data is heteroskedasticity of error terms. To control for this effect, I cluster all standard errors at the firm level (at the country level when the dependent variable is the change in sovereign spreads). An alternative would have been to cluster standard errors at the country level to ensure that standard errors are not affected by between-country heterogeneity. I additionally estimate the models by clustering errors at the country level, but all of the results stay effectively unchanged.

As a robustness check, I add lags of the main variables in regression models (6) and (9) to control for the possibility that changes in firm or sovereign CDS spreads are affected by past changes in CDS spreads. Including lagged variables controls for possible endogeneity due to dynamic nature between the dependent and independent variables (Bedendo and Colla, 2014; Erce, 2015). As documented by Nickell (1981) least squares estimates of dynamic panel models are biased in cases of "large *N* and small *T"* samples*,* because the demeaning process creates correlation between estimated regressors and the error term. In my sample, the time dimension ("T") is remarkably large compared to the number of firms ("N"), and the bias becomes negligible (see similar approach taken by Bedendo and Colla, 2014). I estimate the following dynamic models with least squares dependent variables (LSDV):

$$\begin{aligned}\Delta \log(FirmCDS_{ijt}) &= \alpha_0 + \beta_1 \Delta \log(SovCDS_{jt}) + \omega_1 \Delta \log(SovCDS_{j,t-1}) \\ &+ \omega_2 \Delta \log(FirmCDS_{ij,t-1}) + CONTROLS * \varphi_i + \delta_t + \varphi_i + \varepsilon_{ijt}\end{aligned} \tag{13}$$

$$\begin{aligned}\Delta \log(SovCDS_{jt}) &= \alpha_0 + \beta_1 \Delta \log(FirmRisk_{jt}) + \omega_1 \Delta \log(SovCDS_{j,t-1}) \\ &+ \omega_2 \Delta \log(FirmRisk_{j,t-1}) + CONTROLS * \varphi_i + \delta_t + \varphi_i + \varepsilon_{jt}\end{aligned} \tag{14}$$

where $\Delta \log(FirmCDS_{j,t-1})$ is one-day lag of firm/bank CDS spread and $\Delta \log(SovCDS_{j,t-1})$ is one-day lag in sovereign spread, $CONTROLS$ include control variables specified for previous models.

5. Empirical results

This section presents the findings of my empirical tests based on the discussed methodology and data. I go through the empirical results for each hypothesis, first separately for the bank sample, then for the non-financial sample and finally for sovereigns. In addition, I conduct additional checks to ensure robustness of my results. Lastly, I discuss the findings and their impact on future policy choices and firm financing decisions.

5.1 Credit risk transfer from sovereigns to banks

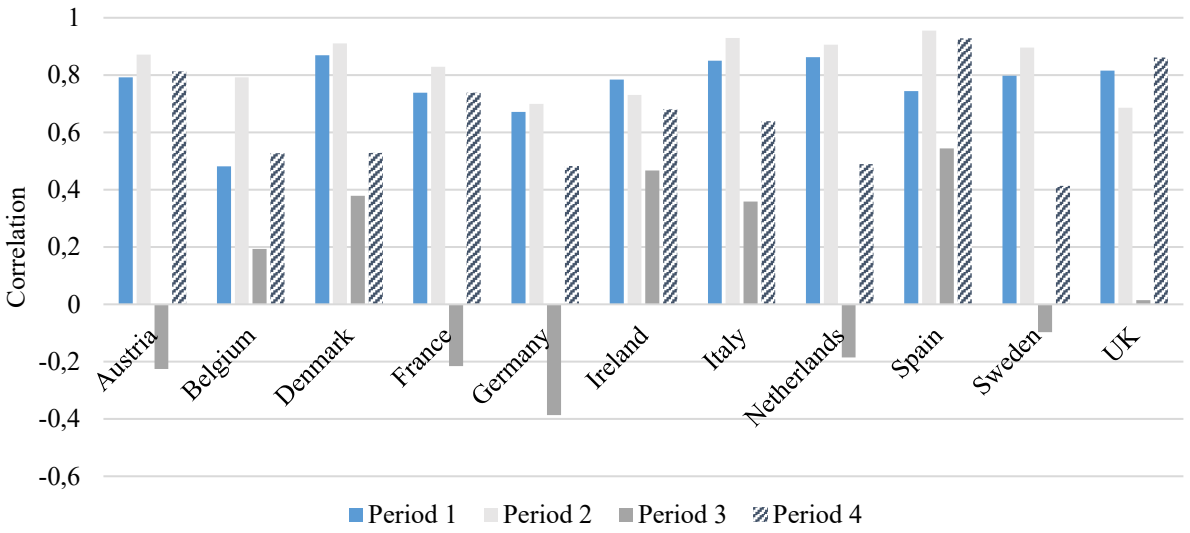
In this section, I analyze the regression results for hypotheses one and two which concern the relation between CDS spread changes of European banking sectors and sovereigns.

To test whether the relation has changed after regulatory improvements, I first divide the sample into four sub-periods. I use the same regression models in each period to see if the significance of the relation changes in time. The first time period runs from 1.1.2009 until the bailout on Greek government debt on 11.4.2010. This period is characterized by decreasing credit spreads, after the worst part of the financial crisis and bank bailouts is over. The second period runs from 12.4.2010 until the date when the BRRD regulation was announced to be effective, 11.5.2014. During this period, we see a strong increase in sovereign and bank credit spreads. The third period runs from 12.5.2014 until 31.12.2015, and the final period starts from the date when the SRM was implemented 1.1.2016, and runs until the end of the sample to 30.6.2017. The SSM was implemented during Period 3. H1 predicts that the relation between sovereign and bank spreads diminishes after period two or possibly after period three when the SRM is introduced.

Figure 5 presents correlations between banking sector's CDS spreads and sovereign CDS spreads in each country in the four sub-periods. Correlation coefficients between CDS spreads are generally high and close to 0.80 in most of the countries during periods 1 and 2. However, period 3 starting from May 2014 shows a clearly different pattern. During this period, correlations between bank and sovereign spreads are negative in Austria, France, Germany, Netherlands and Sweden. In all countries the correlations are clearly lower in the third period. During period 4 correlations mostly return to their previous levels. In general, correlations are lowest for banks from Germany and the United Kingdom and highest for Spain and Italy, where the correlation coefficients during the total study period are higher than 0.90. In line with Hypothesis 1, something clearly happens to the relation between sovereign and banking sector spreads in period 3.

Figure 5: Correlations between bank and sovereign spreads by country

This figure shows the pairwise correlations between sovereign CDS spreads and median CDS spreads for the country's banks. Period 1 in blue ranges from 1.1.2009 to 11.4.2010, Period 2 in light grey from 12.4.2010 to 11.4.2014, Period 3 in dark grey from 12.4.2014 to 31.12.2015 and Period 4 in dashed from 1.1.2016 until 30.6.2017. Source: Datastream.



5.1.1 Effects of bank regulation to sovereign-bank transfer

In this chapter, I analyze regression results for Hypothesis 1 and in the next sub-chapter I will focus more on the transmission channels and test Hypothesis 2. Regression results for model specifications (7) and (8) are presented in Table 3. Specification marked with (1) includes day fixed effects and specification marked with (2) adds bank fixed effects and their interactions with changes in the CDS index and market volatility. In all models standard errors are clustered at the bank level. From the first two columns it can be seen that the main dependent variable, *Δlog(Sovereign CDS),* is significant at the 1% level for the total period with a coefficient of 0.016 when both bank and time fixed effects are included. Bank CDS spreads are significantly affected by changes in sovereign spreads. The effect is economically rather small: a ten percent daily increase in home sovereigns' CDS spread increases log bank CDS spread by 0.16 %, on average. The results are similar in both model specifications, but including bank fixed effects and control variables increases the adjusted R^2 of from 0.40 to 0.46.

There are interesting differences between the sub-periods. During first two periods variable *Δlog(Sovereign CDS)* is statistically significant but the significance disappears in the last two periods. In period 3, the coefficient on *Δlog(Sovereign CDS)* is actually negative, although statistically insignificant. The main dependent variable is most highly significant during second period and the coefficient increases from 0.023 to 0.037 from the first period to the second.

Table 3: Sovereign-to-bank risk transfer

This table reports regression results for fixed effects regressions where the independent variable is the daily change in the natural logarithm of a bank's CDS spread, *ΔLog (Bank CDS)*. *ΔLog (Sovereign CDS)* is the daily change in the natural logarithm of the corresponding sovereign's CDS spread. *ΔLog (EQ)* is the daily change in the natural logarithm of the bank's equity price. All regressions control for day fixed effects. Specifications (2) and (3) control for bank fixed effects and include interactions of bank fixed effects with the logarithm of daily change in the iTraxx EUR Investment Grade index and daily change in the VSTOXX volatility index. Standard errors (in parentheses) are clustered at the bank level. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, correspondingly. Constants are included in the regressions but not shown in the table.

	Total (1/2009 – 6/2017)			Period 1 (1/2009 – 4/2010)			Period 2 (4/2010 – 5/2014)			Period 3 (5/2014 – 12/2015)			Period 4 (1/2016 – 6/2017)		
Δlog (Bank CDS)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Δlog (Sovereign CDS)	0.019** (0.009)	0.016*** (0.006)	0.015*** (0.006)	0.030** (0.014)	0.023* (0.012)	0.022* (0.012)	0.045*** (0.011)	0.037*** (0.008)	0.036*** (0.007)	-0.004 (0.013)	-0.003 (0.005)	-0.003 (0.012)	0.002 (0.007)	0.003 (0.006)	0.003 (0.006)
Δlog(EQ)			-0.050*** (0.008)			-0.045*** (0.011)			-0.045*** (0.010)			-0.064*** (0.014)			-0.084*** (0.018)
Control variables	NO	YES	YES	NO	YES	YES	NO	YES	YES	NO	YES	YES	NO	YES	YES
Day FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bank FE	NO	YES	YES	NO	YES	YES	NO	YES	YES	NO	YES	YES	NO	YES	YES
Observations	67,489	67,489	67,489	9,966	9,966	9,966	32,520	32,520	32,520	13,099	13,099	13,099	11,904	11,904	11,904
No of banks	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
Adjusted R^2	0.403	0.455	0.456	0.439	0.475	0.477	0.455	0.510	0.511	0.314	0.382	0.383	0.338	0.420	0.445

Economically, the effect is also strongest during the second period: ceteris paribus, a 10% increase in sovereign CDS spread increases log bank CDS by 37 basis points. The evidence supports Hypothesis 1, as it indicates that the relation between bank and sovereign credit spreads has diminished since the implementation of the BRRD and the SRM.

Table 3 also shows regression results for model (9) (marked in the table with number (3)), which adds banks' own equity returns as a control variable. As expected, the coefficient on equity returns is negative and statistically significant at the 1% level in all periods. An increase in equity price correlates with a decrease in bank credit spreads, which is expected as higher equity value signals of expectations of increased profitability or growth. On average, a 10 percent increase in the equity price decreases log of CDS spread by 0.5 percent. Including equity returns in the regression model controls for daily variation in the banks' fundamentals and future expectations, which bank fixed effects may not capture. However, things that solely affect debtholders but not equity owners – such as contingent debt-bailout guarantees from the government – are not controlled for. Including bank equity returns increases the adjusted R^2 of the models, but has no effect on the main results. *ΔLog(Sovereign CDS)* stays significant during periods 1 and 2 and in the total time sample. Hence, changes in sovereign spreads significantly affect bank CDS spreads over and above the effects that the government's creditworthiness may have on the bank's market value. These variations should be captured by changes in the bank's equity price, which further confirms the impact sovereign risk has to banks' credit risk.

Period 2 is considerably longer than the other sub-periods. To ensure that the results are not driven by a single significant year, I conduct the same regressions for annual subsamples. Results are presented in Appendix 2. There are clear differences between different years, but effects are mostly in line with those presented in Table 3. Changes in sovereign CDS spreads significantly explain changes in bank CDS spreads between years 2009 and 2013, after which the relation becomes insignificant. This is in line with the periods specified in the main regressions. The relation is most significant in years 2011 and 2013, when a 10% daily increase in sovereign spread corresponds to a 0.45% increase in bank spread, on average. Banks' equity returns are significant in explaining spread changes in all of the years except for 2012 and 2015.

Based on the analysis I cannot reject Hypothesis 1 and conclude that a significant link between bank and sovereign credit spreads has existed, but has weakened after new banking sector regulation has been put in place in Europe. Results for the first periods are in line with Acharya et al. (2014), who study co-movement between bank and sovereign spreads from 2007 to 2011.

However, the magnitude of the results in Table 3 is lower than of Acharya et al (2014). They find that during a period from 22.10.2008 to 30.4.2011 a 10% increase in sovereign CDS translates to a 0.9% increase in bank CDS (or 0.7% when equity returns are controlled for). The difference in magnitude of the effect may be due to a longer study period or differences in the sample of banks[7]. Interestingly, Acharya et al. (2014) found a negative and significant relation between CDS spreads during a period of bank bailouts during 2008, which they explain as a transfer of credit risk from the banking sector to sovereign creditworthiness. Hence, by bailing out banks governments effectively transferred some of the banking sector's credit risk to their own. The negative relation changes to positive after the bailout period, during which the results are similar to those of the first period in my sample.

Results presented in Table 3 and in Figure 5 add new and meaningful evidence to previous literature by proving that bank and sovereign credit spreads have been linked even after the sovereign debt crisis. The relation diminishes after 2014. This proves that either the banking regulation has been able to reach its goals and break the link between sovereigns and banks, or that the sovereign-bank risk feedback is something that is only observed during times of economic turbulence. The latter explanation is questionable though, as for example in the start of 2016 bank credit spreads widened substantially due to fears of Deutsche Bank failure (VOX News, 2016) and this turbulence in the markets did not have a meaningful effect in the relation between sovereign and banking sector spreads.

Moreover, I test if there are differences between banks from Eurozone and non-Eurozone countries, and banks from the GIIPS and non-GIIPS countries by interacting the main dependent variable with a dummy that takes the value of one if the bank is domiciled in one of the GIIPS countries or in the Eurozone, but not in the GIIPS countries. Results are presented in Table 4. Interaction of with an indicator variable that takes the value of one if the bank is domiciled in a GIIPS country, is statistically significant for the total sample and for the second period. Similarly, interaction with *Non-GIIPS Eurozone,* an indicator variable for other Eurozone countries, is strongly significant in period 2, but insignificant in other years. Main variable *Δlog(Sovereign CDS)* is statistically insignificant when it measures the effects of spread changes only for banks outside of Eurozone.

[7] I had to leave some of the banks Acharya et al. (2014) sample out of my analyses due to unavailable data for the longer period. In addition, Acharya et al. (2014) included Greek banks in their tests, which I decided to exclude due to illiquidity and trading restrictions in the CDS of the Hellenic Republic.

Table 4: Sovereign-to-bank risk – Eurozone and GIIPS banks

This table reports regression results for fixed effects regression where the independent variable is the daily change in the natural logarithm of a bank's CDS spread, *Δlog(Bank CDS)*. *Δlog(Sovereign CDS)* is the daily change in the natural logarithm of the corresponding sovereign's CDS spread. All regressions control for day and bank fixed effects and bank's own equity returns and include interactions of bank fixed effects with the daily change in the iTraxx EUR Investment Grade index and daily change in the VSTOXX volatility index. *GIIPS* is an indicator variable that takes the value of one if the bank is domiciled in Ireland, Italy, Portugal or Spain, and *Non-GIIPS Eurozone* takes the value of one if the bank is domiciled in a Eurozone country, but not in one of the GIIPS countries. Standard errors (in parentheses) are clustered at the bank level. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, correspondingly. Constants are included in the regressions but not shown in the table.

Δlog(Bank CDS)	Total (1/2009 – 6/2017)	Period 1 (1/2009 – 4/2010)	Period 2 (4/2010 – 5/2014)	Period 3 (5/2014 – 12/2015)	Period 4 (1/2016 – 6/2017)
Δlog(Sovereign CDS)	0.002	0.001	0.008	0.006	-0.003
	(0.004)	(0.030)	(0.005)	(0.006)	(0.006)
GIIPS * Δlog(Sovereign CDS)	0.068**	0.032	0.101***	0.033	0.040
	(0.027)	(0.028)	(0.030)	(0.043)	(0.029)
Non-GIIPS Eurozone * Δlog(Sovereign CDS)	0.019	0.023	0.053***	-0.064	0.007
	(0.013)	(0.022)	(0.014)	(0.043)	(0.011)
Control for equity returns	YES	YES	YES	YES	YES
Control variables	YES	YES	YES	YES	YES
Day FE	YES	YES	YES	YES	YES
Bank FE	YES	YES	YES	YES	YES
Observations	67,489	9,966	32,520	13,099	11,904
No of banks	31	31	31	31	31
Adjusted R^2	0.457	0.477	0.513	0.385	0.422

Results suggest that only banks from countries in the monetary union were affected by the sovereign-bank feedback loop in the first place. In both Eurozone sub-samples, the effect is also economically more important than for the total-country sample. Controlling for equity returns, a 10 percent increase in sovereign spreads increases bank CDS spreads by 1.0 percent for banks from GIIPS countries and 0.53 percent for other Eurozone banks during period 2. The result for the sample as a whole was an increase of 0.36 percent. I conclude that the GIIPS-countries most likely drive the previous results in Table 3. This is in line with Acharya et al. (2014) who also find that the sovereign-bank feedback loop is stronger for countries in the monetary union.

5.1.2 Channels of sovereign-bank risk transmission

To get a more thorough understanding which factors expose banks to sovereign risk, I test Hypothesis 2 by including a set of interactions between *Δlog(Sovereign CDS)* and different dummy variables in the regression models. I run the regression model (10) on the total bank CDS sample and for the four sub-periods. Results for the total sample are presented in Table 5 and results for the sub-periods are presented in Appendix 3.

Firstly, I test Hypothesis 2A and include variables *Domestic exposure* and *Home share* to test whether the bank-sovereign feedback loop is stronger for banks with higher exposure to domestic government bonds. Results are shown in first two columns of Table 5. Interaction with *Domestic exposure*, indicator for the share of domestic sovereign bond holdings out of bank's total assets, is insignificant for the total period. Interaction with the second variable *Home share,* measuring domestic exposures out of total government bond holdings, is significant at the 5% level with a coefficient of 0.029. Changes in sovereign spreads significantly affect only those banks that have comparably high holdings of domestic bonds to total sovereign bond holdings. The effect is insignificant for other banks. When the same relation is observed for different sub-periods in Appendix 3, it can be seen that both interactions on *Domestic exposure* and *Home bias* are statistically significant during period 2. During the second period, exposure to changes in sovereign spreads is more than two-times higher for banks that hold a high amount of assets in domestic debt. For other periods, the interactions are insignificant.

Based on the results, I do not reject H2A, and conclude that banks' bond holdings have been an important channel of sovereign-to-bank risk transmission, but the relation has meaningfully decreased since the introduction of the BRRD and the SRM. It is not theoretically clear whether the new regulation has aimed at breaking the *asset holdings channel*, since it has not introduced new rules regarding holdings of sovereign debt, only regarding treatment of bank failures. An alternative explanation for the decreased importance of sovereign bond holdings channel may be due to a significant decrease in the credit spreads of European government bonds have after period 2, which can make domestic exposures less of an issue for banks, at least temporarily. As risky countries' debt has yielded less than before, decrease in credit spreads may also have decreased the profitability of the so-called "carry trade in peripheral bonds" (Acharya et al., 2015; Andreeva and Vlassopoulos, 2016). However, my results do signal that domestic bond holdings have been an important channel of sovereign credit risk in the past.

I test Hypothesis 2B on the government guarantee channel by including two interaction variables. Firstly, variable *Ratings uplift* measures the difference between Moody's the bank's Issuer Credit Rating and its Baseline Credit Assessment rating and hence serves as a proxy for the value of government support (as assessed by the rating agency). Secondly, interaction term with variable *Systemic importance* tests whether the effects are stronger for banks with a global systematically important bank -status. Results are presented in columns three and four. Interaction between *Ratings uplift* and *Δlog(Sovereign CDS)* is significant at the 1% level with a coefficient of 0.017. Including the interaction makes the main effect insignificant, which indicates that only those banks whose Moody's Issuer rating includes expectations of state support are significantly affected by changes in sovereign credit spreads. This result is as expected and shows support for Hypothesis 2B. In addition, the result may signal of two things. It may show that the rating agency Moody's has been able to correctly analyze the likelihood and importance of government support in line with market expectations, or that investors have included regarded the Moody's credit assessment to be valuable information and priced it in banks' credit spreads. If the latter is true and these ratings actually bring new information to markets, then movements in sovereign spreads may actually only affect those banks which Moody's expects to receive state support, because investors expect that only those banks' credit spreads should be affected.

To verify the previous results, I analyze results with the second variable *Systemic Importance,* which takes the value of one if the bank is identified to be a Global Systemically Important Bank (G-SIB). The variable also controls for effects of bank size, as banks deemed to be of systemic importance are usually the largest banks as measured by assets and the most international. I expect G-SIBs to be more affected by sovereign spreads, as these banks are the most likely ones to be supported by the state to avoid a banking crisis. Interaction between the sovereign CDS change and dummy *Systemic importance* is also statistically significant with a coefficient of 0.030. As expected, spreads of systemically important, large banks are more affected by changes to sovereign spreads. In addition, periodical results in Appendix 3 show that systemically important banks are the only ones that are continuously affected by sovereign spreads from period 1 to period 3. In this aspect, they differ from other financials, where the effect disappears before period 3. It seems that expectations of government support continue for G-SIBs although the BRRD regulation is already in effect, and these expectations disappear only during the last period.

Table 5: Sovereign-to-bank risk – Channels of transmission

This table reports regression results for fixed effects regression where the independent variable is the daily change in the natural logarithm of a bank's CDS spread, *Δlog(Bank CDS)*. *Δlog(Sovereign CDS)* is the daily change in the natural logarithm of the corresponding sovereign's CDS spread. *Domestic exposure* is equal to one if the ratio of domestic bond holdings to total assets of the bank is higher than the median of the sample in a half-a-year period. *Home bias* is equal to one if the ratio of domestic bond holdings to total sovereign bond holdings is higher than the median of the sample in a half-a-year period. *Ratings uplift* is equal to one if the Moody's BCA rating is lower than Moody's issuer rating when ratings are assigned numerical scores. *Systemic importance* is equal to one if the bank is deemed a G-SIB institution. *Rating ceiling* is equal to one if the S&P long-term rating of the bank is equal to, or higher than, the rating of their sovereign. *CDS ceiling* is equal to one if the CDS spread of a bank is lower than that of their sovereign. All regressions control for day and bank fixed effects and include interactions of bank fixed effects with the daily change in the iTraxx EUR Investment Grade index and daily change in the VSTOXX volatility index. Standard errors (in parentheses) are clustered at the bank level. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, correspondingly. Constants are included in the regressions but not shown in the table.

Δlog(Bank CDS)	Domestic exposure	Home bias	Ratings uplift	Systemic importance	Rating ceiling	Spread ceiling
Δ log(Sovereign CDS)	0.011**	0.007	-0.002	0.002	0.009**	0.013**
	(0.005)	(0.006)	(0.019)	(0.009)	(0.004)	(0.005)
Domestic exposure *	0.028					
Δ log(Sovereign CDS)	(0.018)					
Home bias *		0.029**				
Δ log(Sovereign CDS)		(0.012)				
Ratings uplift *			0.017***			
Δ log(Sovereign CDS)			(0.006)			
Systemic importance *				0.030***		
Δ log(Sovereign CDS)				(0.011)		
Rating ceiling *					0.089**	
Δ log(Sovereign CDS)					(0.037)	
Spread ceiling *						0.098***
Δ log(Sovereign CDS)						(0.026)
Control for equity returns	YES	YES	YES	YES	YES	YES
Control variables	YES	YES	YES	YES	YES	YES
Day FE	YES	YES	YES	YES	YES	YES
Bank FE	YES	YES	YES	YES	YES	YES
Observations	52,830	53,213	63,131	67,489	64,157	67,489
No of banks	30	30	28	31	31	31
Adjusted R^2	0.492	0.493	0.487	0.457	0.496	0.457

Hypothesis 2B cannot be rejected based on the analysis, and I conclude that banks which are more likely to enjoy government guarantees are more affected by changes in sovereign credit premiums. Nonetheless, the results also show that systemically important banks may differ from other banks with regards to regulatory changes, as the BRRD did not succeed in removing the credit risk transfer from sovereigns to banks for the largest financial institutions. The BRRD requires a "bail-in" of creditor funds instead of taxpayer money in order to save banks. However, the fact that systemically important banks are so large and important may have led investors to conclude that if they were to end up insolvent, bailing in investor money may not be enough to save the institution, and government support would be needed over and above the bail-in mechanism.

Hypothesis 2C predicts that the feedback loop is stronger for banks that have a credit rating closer to the rating of their government, because of an empirically observed credit rating ceiling (Alsakka et al., 2014). I test the hypothesis by interacting two variables with the change in sovereign CDS spread. Both variables *Rating ceiling* and *Spread ceiling* measure whether the creditworthiness of the bank is higher than that of the sovereign, and on that account the banks' credit spreads may be "bound" by the level of sovereign credit spreads. Results are shown in columns 5 and 6 of Table 5. Interaction with *Rating ceiling* is significant at the 5% level. Banks with a credit rating equal to, or above, their sovereign's credit rating are more affected than others by changes in sovereign's CDS spreads. The effect is also economically clear: a 10% increase in sovereign spreads increase bank spreads by 0.89 percent for banks with a rating at the sovereign bound but only 0.09 percent for other banks. The effect for non-bound' banks stays statistically significant as well.

The alternative dummy variable *Spread ceiling* measures the proximity of sovereign and bank credit qualities using CDS spread levels. Regression results in column 6 confirm findings with the first variable. The interaction is statistically significant at the 1% level and coefficient on the interaction is 0.98 percent, even higher than coefficient on *Rating ceiling.* From Appendix 3 it can be observed that both variables are significant determinants of the sovereign-to-bank risk transfer during the first two periods, but the significance disappears in the third period. I conclude that Hypothesis 2C cannot be rejected and banks which are rated above or at the same level as their government are more affected by changes in the sovereigns' CDS spreads. The same holds when credit quality is measured with the level of the CDS spread itself. These results are in line with Alsakka et al. (2014) who find strong evidence supporting the existence of the

credit rating ceiling and many other studies on the importance of sovereign credit ratings. If the coefficients of different tests in Table 5 are compared with each other, it also seems that empirically the *credit rating channel* is the strongest determinant of the sovereign-to-bank risk transfer with a percentage increase in sovereign spreads leading to an increase of 9.8 basis points for banks whose CDS spread is lower than the sovereign CDS spread.

In addition to H1, I find support for all three sub-hypotheses of H2 on the *asset-holdings channel, guarantee channel* and *credit rating channel.* Significance of the results diminishes for almost all of the variables after the second period, which is in line with previous results in Table 3. Results for both H1 and H2 support my expectations that the introduced regulation has been able to decrease linkages between banks and sovereigns, and there are no sub-groups of banks that would be affected by sovereign credit spreads for the whole study period.

In general, results for the transmission channels are also consistent with previous research by De Bruyckere et al. (2013), Alsakka et al. (2014) and Altavilla et al. (2016), although the research methods of previous studies differ somewhat from my tests. In my tests the empirical evidence for *asset-holdings channel* is actually the weakest of all tested variables. De Bruyckere et al. (2013) found support for the asset holdings channel, guarantee channel and collateral channel by studying excess correlations between bank and sovereign CDS spreads, but their period of study is restricted to years between 2007 and 2012. Also Altavilla et al. (2017) found that a 10 % quarterly change in sovereign spreads translates to a 3.1 % change in bank spreads in GIIPS countries, for those banks that hold large amounts of sovereign bonds, which is a much larger magnitude than in my study. Differences in magnitude may be partly related to my longer dataset, daily-level regressions and unavailability of public micro-level bond holdings data. Either way, the results show that the detrimental effect of domestic bond holdings, at least when it comes to the interdependence of credit spreads, has clearly decreased in the past few years.

Almost all results in Tables 3, 4 and 5 support Hypothesis 1 and show a weakening correlation between bank and sovereign CDS spreads. The tests do not prove that this weakening trend has been caused by the regulatory improvements, but controls for market movements and day and bank fixed effects make it unlikely that the decrease could be caused by a change in macro variables. In addition, proxy variables for expected government support, *Ratings Uplift* and *Systemic Importance,* lose their impact as a channel of sovereign stress after 2016 when the SRM came into force in the monetary union. This gives further support for the success of the banking union. I discuss the policy implications of my findings further in Chapter 5.5

5.2 Credit risk transfer from sovereigns to non-financial CDS spreads

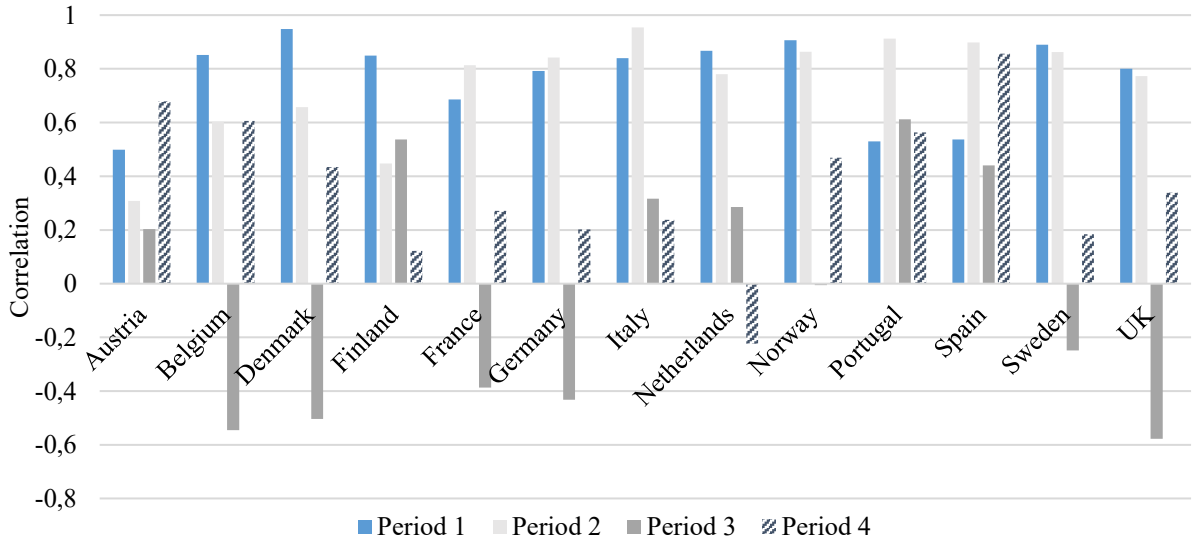
Next, I move to study my second research question on the relation between non-financial companies and sovereigns. I test hypotheses 3 and 4 with three different model specifications for the four sub-periods. I do not expect that the introduced banking regulation should have a meaningful impact on non-financial companies' CDS premiums and I am mainly interested in testing the effects for the total period. Nonetheless, differences between the sub-periods are still of interest, because they can reveal information whether the correlation has been caused by special circumstances or if effects are consistent across time. I am also interested in comparing the results to the bank sample. I first focus on testing the transfer of sovereign risk to non-financial firms and then move on to test the transfer channels hypothesized in H4.

5.2.1 Corporate and sovereign credit spreads

Firstly, Figure 6 presents correlations between sovereign CDS spreads and non-financial sectors' CDS spreads by country in the four periods. Correlations are lower than in the financial sector for some countries, but in general the coefficients range between 0.6 and 0.8 during the first two periods. Again, the figure shows an interesting change in the correlations during third period as the correlation between CDS spreads turns negative during in several countries.

Figure 6: Correlations between non-financial firm and sovereign spreads

This figure shows the pairwise correlations between sovereign CDS spreads and the median CDS spreads for the country's non-financial firms. Period 1 in blue ranges from 1.1.2009 to 11.4.2010, Period 2 in light grey from 12.4.2010 to 11.4.2014, Period 3 in dark grey from 12.4.2014 to 31.12.2015 and Period 4 in dashed from 1.1.2016 until 30.6.2017. Source: Datastream.



However, the correlation pattern for non-financials and sovereigns is a bit less consistent than for the banking sector. There are clear differences between countries and average correlation between sovereign and non-financial credit premiums range from 0.53 in Austria to 0.95 in Portugal. In most countries, correlations seem to be decreasing towards the end of the sample.

Regression results for models (7), (8) and (9) are presented in Table 6. From the results of first two model specifications it can be seen that *Δlog(Sovereign CDS)* is significant at least at the 5% level for the total sample and for all sub-periods except for period 4. A 10 % increase in sovereign CDS spread increases log corporate CDS spreads on average by 7 basis points controlling for firm fixed effects. During period 2 the economic effect doubles to a change of 14 basis points for a 10 % change in sovereign spreads. As with the financial sample, including firm fixed effects and control variables increases the adjusted R^2 of the regressions, but has no significant effect on the magnitude of results.

Specification marked with (3) shows that adding firm's own equity returns does not change the results on the main dependent variable, but the coefficient on *Δlog(EQ)* is highly statistically significant in all periods. Thus, an increase in the firm's equity price is negatively correlated with a change in company's credit spreads. This is an expected result in line with the bank sample and the effect is economically significant as well: a 10 percent increase in the stock price decreases CDS spreads by 0.82 percent, on average. It is interesting to note that the significance of the main dependent variable is actually higher for the non-financial sample than for the bank sample for most sub-periods, although coefficients are lower and the sample is bigger.

Results in Table 6 support H3 and show that CDS spreads of non-financial companies are affected by changes in sovereign CDS premiums. Again, the results are clearly strongest both economically and statistically during period 2 from 2010 to 2014. Consistent with the bank sample, the relation has been diminishing in the last few years and the magnitude of results is lower than for the sample of financials. For this reason, I also conduct the tests at annual level. Results are presented in Appendix 4. The risk transfer to non-financials is significant only during three years (2011, 2012 and 2014) when the regressions are conducted in calendar years, indicating that the relation between non-financials and sovereigns is not as consistent as it is for banks. However, it is interesting to remark that the years when the relation is significant are different for the banks and for the non-financial firms.

Table 6: Sovereign-to-corporate risk transfer

This table reports regression results for fixed effects regressions between where the independent variable is the daily change in the natural logarithm of a non-financial company's CDS spread, Δlog*(Firm CDS)*. *Δlog(Sovereign CDS)* is the daily change in the natural logarithm of the corresponding sovereign's CDS spread, and *Δlog(EQ)* is the daily change in the natural logarithm of the company's equity price. All regressions control for day fixed effects. Regression specifications (2) and (3) include firm fixed effects and their interactions with the daily change in the iTraxx EUR Investment Grade index and daily change in the VSTOXX volatility index. Standard errors (in parentheses) are clustered at the company level. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, correspondingly. Constants are included in the regressions but not shown in the table.

	Total (1/2009 – 6/2017)			Period 1 (1/2009 – 4/2010)			Period 2 (4/2010 – 5/2014)			Period 3 (5/2014 – 12/2015)			Period 4 (1/2016 – 6/2017)		
Δlog (Firm CDS)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Δlog (Sovereign CDS)	0.012*** (0.003)	0.007*** (0.001)	0.007*** (0.002)	0.012** (0.006)	0.011** (0.005)	0.011** (0.005)	0.025*** (0.006)	0.014*** (0.004)	0.013*** (0.004)	0.006** (0.003)	0.004** (0.002)	0.004** (0.002)	0.002 (0.002)	0.002 (0.002)	0.002 (0.002)
Δlog(EQ)			-0.082*** (0.009)			-0.047*** (0.009)			-0.104*** (0.014)			-0.092*** (0.018)			-0.073*** (0.013)
Control variables	NO	YES	YES	NO	YES	YES	NO	YES	YES	NO	YES	YES	NO	YES	YES
Day FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Firm FE	NO	YES	YES	NO	YES	YES	NO	YES	YES	NO	YES	YES	NO	YES	YES
Observations	245,920	245,920	245,920	36,531	36,531	36,531	118,311	118,311	118,311	47,686	47,686	47,686	43,392	43,392	43,392
No of firms	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113
Adjusted R^2	0.349	0.375	0.378	0.302	0.321	0.322	0.370	0.402	0.405	0.285	0.327	0.330	0.409	0.467	0.469

Augustin et al. (2016) document a higher correlation between sovereign and corporate spreads for companies from Eurozone and GIIPS countries. Like with the financial sample before, I add interactions with indicator variables for *GIIPS* and for *Non-GIIPS Eurozone* countries. Results presented in Table 7 show that firms from GIIPS and Eurozone countries are significantly more affected than others. Spreads of firms from GIIPS countries have a stronger correlation with changes in sovereign spreads in all periods except for period 4, where the relation is statistically insignificant for all samples. Firms from other Eurozone countries (excluding GIIPS countries) are also more affected than non-Eurozone firms, although only in the first two periods. I conclude that firms outside Eurozone are not affected by changes in their sovereign's CDS spreads, as coefficient of the main dependent variable becomes insignificant in all periods. Companies from GIIPS countries are most highly affected, which may result either from the fact that the spreads of GIIPS governments were generally higher and the countries were more indebted, or from the fact that the effect was channeled through these countries' more distressed banking sectors to the real economy.

The findings are in line with Augustin et al. (2016), who present two arguments for their results. Firstly, they focus on the bailout of Greece, which the researchers claim increased the probability of future bailouts and consequently increased the riskiness of the Eurozone economies. This short time period may be one reason why GIIPS countries were more affected than others in their study, as market participants updated their beliefs of further bailouts in other peripheral countries. Secondly, they suggest that because countries which adopted the Euro are not able to use monetary policy to increase their competitiveness, the common currency may affect the local companies' competitive environment through price levels.

I am not able to reject H3 and my results support the expected relationship that sovereign CDS spreads affect non-financial corporates' CDS spreads in Europe. However, results for the non-financial sample differ from the bank sample in a few ways. Although effects are statistically significant, they are on average economically smaller than for financials. Also, for the bank sample the effect between sovereigns disappears during the third period, while it stays significant for the non-financial sample until period 4. This finding confirms the credibility of the bank sample results by showing that no specific changes in the CDS markets during the third period should have biased the results for the financials, as this sort of events should be showing in the results with the non-financial sample as well.

Table 7: Sovereign to corporate risk – GIIPS and Eurozone firms

This table reports regression results for fixed effects regression where the independent variable is the daily change in the natural logarithm of a firm's CDS spread, *Δlog(Firm CDS)*. *Δlog(Sovereign CDS)* is the daily change in the natural logarithm of the corresponding sovereign's CDS spread. All regressions control for day and firm fixed effects and firm's own equity returns, and include interactions of firm fixed effects with the daily change in the iTraxx EUR Investment Grade index and daily change in the VSTOXX volatility index. *GIIPS* is an indicator variable that takes the value of one if the bank is domiciled in Ireland, Italy, Portugal or Spain, and *Non-GIIPS Eurozone* takes the value of one if the bank is domiciled in a Eurozone country but not in one of the GIIPS countries. Standard errors (in parentheses) are clustered at the bank level. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, correspondingly. Constants are included in the regressions but not shown in the table.

Δlog(Firm CDS)	Total (1/2009 – 6/2017)	Period 1 (1/2009 – 4/2010)	Period 2 (4/2010 – 5/2014)	Period 3 (5/2014 – 12/2015)	Period 4 (1/2016 – 6/2017)
Δlog(Sovereign CDS)	-0.001 (0.001)	-0.025** (0.010)	-0.003 (0.002)	0.002 (0.002)	0.001 (0.004)
GIIPS * Δlog(Sovereign CDS)	0.136*** (0.018)	0.070*** (0.013)	0.193*** (0.025)	0.087*** (0.026)	0.009 (0.018)
Non-GIIPS Eurozone * Δlog(Sovereign CDS)	0.006*** (0.002)	0.013** (0.005)	0.009** (0.003)	0.000 (0.003)	0.003 (0.002)
Control for equity returns	YES	YES	YES	YES	YES
Control variables	YES	YES	YES	YES	YES
Day FE	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES
Observations	245,920	36,531	118,311	47,686	43,392
No of firms	113	113	113	113	113
Adjusted R^2	0.380	0.323	0.411	0.332	0.469

The results are mostly in line with previous studies. Bedendo and Colla (2015) and Augustin et al. (2016) show that an increase in sovereign credit spreads is associated with an increase in firm credit spreads, but my results are again of a lower in than previous studies. Bedendo and Colla (2015) find that a 10 % increase in sovereign spreads translates into a 0.5 to 0.8 percent increase in non-financials' spreads, and Augustin et al. (2016) find an increase of a 1.1 percent, on average. However, it is important to note the short study periods of the previous studies. Especially Augustin et al. (2016) focus on a very narrow period during the first Greek bailout, which significantly spilled over from sovereign to corporate credit risk. I extend previous literature by showing that the risk transfer is present for a longer period and does not relate solely to stress transmission during crisis periods. Hence, sovereign credit risk affects corporate credit premiums, although the daily effects of changes in government credit risk are small.

5.2.2 Channels of transmission for non-financial firms

Next, I test Hypothesis 4 and its sub-hypotheses by including a set of dummy variables to test the channels of transmission between non-financial companies and sovereigns. Results are presented in Table 8 for the total time period and in Appendix 5 for the sub-periods.

First, I test whether companies that are more dependent on the banking sector and bank loans are more affected by sovereign risk than others. Previous results in Table 6 signaled that the relation between corporates and sovereigns has decreased after the banking union has been set up. One possible reason for the decrease in co-movement could be that the sovereign-to-firm credit risk spillover has effectually been caused by the bank-sovereign feedback loop, which has also disappeared in the past few years. For example, firms' credit risk may have been affected due to a weakening financial sector in the country. To formally test the bank channel, I include variables *Bank dependent* and *Bank based* in the analyses. Results are shown in columns 1 and 2 of Table 8. Interaction between variable *Bank dependent,* which indicates how large a share of firm's debt is bank loans, and the change in sovereign spread is significant at the 5% level. Companies that finance a comparably large fraction of their assets with bank loans are more affected than others by changes in sovereign CDS. In addition, I include variable *Bank based* which is an indicator for the relative size of the country's banking sector compared to its equity market capitalization. Interaction with the alternative variable is also significant at the 5% level is significant in all of the specified sub-periods in Appendix 5. However, including neither of the bank-variables makes the main effect insignificant.

Based on this evidence I cannot reject Hypothesis 4A. The results are consistent with Bedendo and Colla (2015) who find that companies relying more on bank financing are adversely affected by sovereign spread changes. My findings support the original hypothesis and show that firms which fund a larger fraction of their assets with bank loans or operate in countries with relatively large banking sectors are more affected by changes in sovereign spreads. The finding also indicates that the relationship between bank and sovereign spreads could leak out to non-financial spreads, as discussed. In addition, from Appendix 5 it can be seen that the transfer of credit risk from sovereigns to firms continues in the countries with comparably large financial sectors through the whole period from 2009 to 2017. Countries that stay in this group throughout the period include, for example, Austria, Denmark, Netherlands and Sweden.

Table 8: Sovereign to corporate risk – Channels of transmission

This table reports regression results for fixed effects regression where the independent variable is the daily change in the natural logarithm of a bank's CDS spread. *Δlog(Sovereign CDS)* is the daily change in the natural logarithm of the corresponding sovereign's CDS spread. *Bank dependent* equals one if the company's ratio of bank loans to total liabilities is higher than sample median. *Bank based* takes the value of one if the banking assets to equity market capitalization of the country is higher than all countries' median. *Govt control* is equal to one if the local government owns more than 5% of the company's shares. *Strategic importance* is equal to one if the ratio of the company's market capitalization to the total market capitalization of the country's stock exchange is higher than of the 75th percentile of the total sample. *Supported sector* takes the value of one if the firm operates in utilities, telecommunications or transportation. *Rating ceiling* is equal to one if the S&P long-term rating of the bank is equal to, or higher than, the rating of their sovereign. *CDS ceiling* is equal to one if the CDS spread of a bank is lower than that of their sovereign. *Domestic revenue* equals one if the company's ratio of sales from domicile country to total sales is higher than sample median. All regressions control for day and firm fixed effects and include interactions of firm fixed effects with the daily change in the iTraxx EUR Investment Grade index and daily change in the VSTOXX volatility index. Standard errors (in parentheses) are clustered at the firm level. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, correspondingly. Constants are included in the regressions but not shown in the table.

Δlog(Firm CDS)	Bank - dependent	Bank-based	Government control	Strategic importance	Supported sector	Rating ceiling	CDS ceiling	Domestic revenue
Δlog(Sovereign CDS)	0.004*	0.005***	0.004***	0.003**	0.003**	0.006***	0.004***	0.005**
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)
Bank dependent *	0.013**							
Δ log(Sovereign CDS)	(0.005)							
Bank based *		0.019**						
Δ log(Sovereign CDS)		(0.009)						
Government control *			0.015**					
Δ log(Sovereign CDS)			(0.006)					
Strategic importance *				0.024***				
Δ log(Sovereign CDS)				(0.009)				
Supported sector *					0.023**			
Δ log(Sovereign CDS)					(0.009)			
Rating ceiling *						0.073		
Δ log(Sovereign CDS)						(0.045)		
CDS ceiling *							0.058***	
Δ log(Sovereign CDS)							(0.016)	
Domestic revenue *								0.018*
Δ log(Sovereign CDS)								(0.009)
Control for equity return	YES	YES	YES	YES	YES	YES	YES	YES
Control variables	YES	YES	YES	YES	YES	YES	YES	YES
Week FE	YES	YES	YES	YES	YES	YES	YES	YES
Bank FE	YES	YES	YES	YES	YES	YES	YES	YES
Observations	149,452	245,920	245,920	224,756	243,743	217,750	245,920	243,743
Companies	80	113	113	107	112	98	113	83
Adjusted R^2	0.383	0.378	0.378	0.388	0.378	0.382	0.378	0.378

Hypothesis 4B predicts that the link between sovereigns and corporates is stronger for firms that are more likely to benefit from government guarantees. Variable *Government control* that measures government ownership is included in column 3. Interaction with *Government control* is significant at the 5% level and the main dependent variable stays statistically significant after the interaction term is included. However, the coefficient for companies (partly) controlled by the government is higher than for other companies. On average, a 10% daily increase in sovereign spreads increases corporate spreads by 0.04% while the effect is 0.15% for companies with government ownership. Alternatively, I use two variables that measure likelihood of government support in other ways than direct ownership. I expect that companies which are more relevant to their local country in terms of market capitalization are more likely to receive government support. Results for including the variable *Strategic relevance* are presented in column 4. The interaction is highly statistically significant at the 1% level and the coefficient of 0.024 is clearly higher than for the sample in general. Hence, companies that represent a high part of their country's equity market capitalization are more likely to be affected by changes in sovereign creditworthiness. Companies operating in utilities, transportation or telecommunications are also significantly more affected by sovereign spreads than others as the coefficient on the interaction with variable *Supported sector* in column 6 shows.

Results are similar to those found by Bedendo and Colla (2015), who prove that companies which are supported by the state are more affected by changes in sovereign credit risk, and Klein and Stellner (2014) who show that bond yields of government-owned companies are influenced by spreads of sovereign bonds. I prove that government ownership is only one aspect. The results show that firms large by size compared to their home markets or operating in sectors that are often supported by the state, are actually more affected by changes in sovereign CDS spreads than government-owned companies. All in all, results for these three variables support Hypothesis 4B and companies which are more likely supported by local government are more affected by changes in its CDS spreads. Although the variables are defined differently, the results are also in line with the financial sample.

Results for Hypothesis 4C are presented in columns 6 and 7. I include interactions with variables *Rating ceiling* and *Spread ceiling*. Coefficient on *Rating ceiling* is statistically insignificant while interaction with *Spread ceiling* is significant at the 1% level. The results are somewhat mixed: companies with a credit rating above their sovereign's rating are not significantly more affected by changes in sovereign spreads than others, but companies with a

credit spread below their sovereigns' are. Although insignificant, the coefficient on *Rating ceiling* is clearly higher than on *Spread ceiling* and the sample in general. Periodical results in Appendix 4 show that the interaction with *Rating ceiling* is significant in regressions during periods 2 and 3, while *Spread ceiling* is significant for periods 1 and 2. During Period 2 the coefficient on *Rating ceiling* is 0.126, indicating that a ten percent increase in sovereign spread would increase the spread of a highly rated company 1.26%. The results support the rating ceiling hypothesis, although the interaction term is insignificant in the main regression model, consistent with the financial sample where I found strongest evidence for the ratings channel. In very recent studies for example Almeida et al. (2017) and Drago and Gallo (2017) have found empirical evidence that sovereign credit ratings affect corporate borrowing costs.

Finally, I test Hypothesis 4D and the effect for companies that source a high portion of their revenue from the domestic market. Results in column 8 show that interaction with variable that measures the relative proportion of revenues that the firm sources from the domestic markets, *Domestic revenue,* is slightly significant at the 10% level. From Appendix 4 it can be seen that the interaction is significant only during period 2. The results show some support to hypothesis 4D and the expectation that companies focused in the domestic markets are more influenced by sovereign credit risk, but the results are not conclusive.

In general, regressions for different sub-periods in Appendix 4 show the same pattern as Table 6. Almost all variables except for firm's own equity returns lose their explanatory power over changes in corporate credit spreads during period 4, while the relation is clearly highest during the second period. In conclusion, the results support Hypothesis 4 and show that there are factors that make firms more vulnerable to country risk in the long-term although the results become mixed towards the end of the study period. Sub-hypotheses on the *bank channel, guarantee channel* and *credit rating channel* are supported empirically, while the proof for hypothesis on the *domestic demand channel* is weaker. This shows that the effects found by previous studies (Bedendo and Colla, 2015; Augustin et al., 2016) are not only related to short crisis periods. The results are also largely in line with those of the bank sample, supporting both the effect of credit ratings and government guarantees on corporate credit spread changes. In addition, it is a bit unexpected, yet not against hypotheses, that many variables lose their statistical significance in explaining sovereign-to-firm risk transfer during period 3 also in the non-financial sample.

5.3 Corporate to sovereign credit risk transfer

Finally, I investigate the reverse relation from changes in corporate spreads to changes in sovereign spreads to test whether a two-way dynamic between the credit spreads exists. Results for regression model (12) are presented in Table 9. Panel A shows results for regressing sovereign credit spread changes on bank spread changes, Panel B shows results for non-financials' spreads and Panel C shows regressions where both variables *Δlog(BankRisk)* and *Δlog(FirmRisk)* are included in the same model. The regressions control for changes in the local currency exchange rate against the US dollar, changes in the domestic equity market index and in 5-year US Treasury yields, in addition to corporate CDS spreads and market volatility

From Panel 1 it can be seen that changes in bank spreads affect sovereign spreads at the 1% significance level during period 2 with a coefficient of 0.166. In other periods the variable is insignificant. In Panel B, changes in non-financial firms' credit spreads affect sovereign spreads in periods 2 and 3, and significantly also for the total time sample. Coefficients are higher than in the previous tests – for example, a 10% change in the CDS index for non-financials increases log sovereign CDS spreads by 1.94%. In Panel C, the results do not change meaningfully when both variables are included in the regression at the same time. To save space, coefficients for most control variables are not presented, but daily changes in the iTraxx Main CDS index, volatility and US treasury yields are strongly significant determinants of changes in sovereign CDS spread for most countries. This is in line with Longstaff et al. (2011) and Dieckmann and Plank (2012) who find that global variables are important determinants of variation in sovereign spreads.

Results support Hypothesis 5. Sovereign CDS spreads are clearly affected by changes in local banks' and firms' CDS spreads and the results are economically meaningful as well. Furthermore, the results also show support Hypothesis 1 – there is no significant covariation between banks and sovereigns after period 2 and the co-variation decreases between sovereigns and non-financial companies as well.

In contrast to my findings, Banerjee et al. (2016) find that sovereign spreads affect bank spreads in long and short run but bank credit spreads stop affecting sovereign CDS spreads after the first Greek bailout. I find that bank spreads affect sovereign spreads also after the Greek bailout until spring 2014. To my knowledge, no studies have previously documented a long-term risk transfer from the corporate sector to sovereigns or studied how the relation has changed after

Table 9: Credit risk transfer from corporates to sovereigns

This table reports regression results for fixed effects regression where the independent variable is the daily change in the natural logarithm of a sovereign CDS spread, *Δlog(SovereignCDS*). *Δlog(BankRisk)* is the daily logarithmic change in the weighted average bank CDS-spread of banks from country *j*, where each observation is weighted according total assets. *Δlog(FirmRisk)* is the daily logarithmic change in the weighted average non-financial CDS-spread of firms from country *j*, where each observation is weighted according total assets. *Δlog(EquityMarket)* is the daily logarithmic change in local equity market index and *Δlog(FXRate)* is the daily logarithmic change in the exchange rate against US dollar. *Debt-to-GDP* is the ratio of the country's sovereign debt to GDP. All regressions control for day and country fixed effects and include interactions of country fixed effects with the daily change in the iTraxx EUR Investment Grade index, daily change in the VSTOXX volatility index and daily change in 5-year US Treasury yields. Standard errors (in parentheses) are clustered at the country level. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, correspondingly. Constants are included in the regressions but not shown in the table.

Δlog(SovereignCDS)	Total	Period 1	Period 2	Period 3	Period 4
Panel A: Banks to sovereigns					
Δlog(BankRisk)	0.054 (0.039)	0.044 (0.033)	0.166*** (0.039)	-0.083 (0.088)	0.049 (0.034)
Δlog(EquityMarket)	-0.103 (0.117)	0.039 (0.106)	-0.108 (0.100)	-0.357 (0.236)	-0.156 (0.175)
Δlog(FXRate)	-0.648*** (0.072)	-0.027* (0.124)	-0.855** (0.397)	-0.530 (0.787)	-1.236 (0.739)
Debt-to-GDP	0.000 (0.002)	-0.001 (0.0186)	0.005 (0.004)	-0.011 (0.014)	0.014 (0.023)
Observations	23,856	3,473	11,517	4,642	4,224
Countries	11	11	11	11	11
Adjusted R^2	0.262	0.605	0.376	0.035	0.081
Panel B: Non-financials to sovereigns					
Δlog(FirmRisk)	0.147*** (0.047)	0.042 (0.040)	0.194*** (0.058)	0.126* (0.059)	0.159 (0.108)
Δlog(EquityMarket)	-0.169 (0.109)	0.010 (0.088)	-0.243** (0.108)	-0.324* (0.159)	-0.102 (0.162)
Δlog(FXRate)	-0.474** (0.157)	-0.233** (0.099)	-0.609 (0.348)	-0.286 (0.475)	-0.958 (0.611)
Debt-to-GDP	-0.006*** (0.002)	0.007 (0.020)	-0.006** (0.003)	0.009 (0.012)	-0.002 (0.021)
Observations	28,208	4,119	13,611	5,486	4,992
No of countries	13	13	13	13	13
Adjusted R^2	0.276	0.583	0.382	0.054	0.080
Panel C: Non-financials and banks to sovereigns					
Δlog(BankRisk)	0.055 (0.058)	0.051 (0.039)	0.165*** (0.049)	-0.165 (0.174)	0.010 (0.057)
Δlog(FirmRisk)	0.129*** (0.036)	0.008 (0.045)	0.161*** (0.045)	0.115 (0.083)	0.242 (0.149)
Equity market, FX rate, Debt-to-GDP	YES	YES	YES	YES	YES
Observations	21,680	3,150	10,470	4,220	3,840
No of countries	10	10	10	10	10
Adjusted R^2	0.254	0.607	0.378	0.028	0.070
Control variables	YES	YES	YES	YES	YES
Day FE	YES	YES	YES	YES	YES
Country FE	YES	YES	YES	YES	YES

local bailouts of the banking sector have been prohibited in the EU. Furthermore, my results shed light on the corporate-to-sovereign transfer by showing that it is not only the local banking sector, but also the credit risk of non-financial firms' that may affect sovereign creditworthiness. These results cannot be explained only with government guarantees, as compared to banks, normal firms are less likely to be explicitly supported by the state. Although I control for changes in several global and local market variables, some part of the co-movement may be related to unobserved variables in the local economy that affect both corporate and sovereign credit risk.

Finally, I test if GIIPS and Eurozone countries differ from those that do not belong to the monetary union. Results are presented in Table 10. The transmission effects are strongest for GIIPS countries and insignificant for countries outside Eurozone. Non-GIIPS countries in the Eurozone are, however, also significantly affected by changes in corporate spreads. Panel A of Table 10 actually shows that the CDS spreads of banks in the Eurozone significantly affect sovereign spreads in the last sub-period showing some evidence against the hypothesis that the new regulation has broken the bank-sovereign feedback loop. The same relation is not seen with GIIPS countries. In conclusion, results in Table 10 are in line with previous evidence.

From Panel B it can be observed that corporate-to-sovereign feedback loop is not present in countries outside of Eurozone. In the monetary union the relation is significant, both from firms to sovereigns and from sovereigns to firms. This finding is also consistent with Dieckmann and Plank (2012) who find that CDS spreads of countries within the Eurozone exhibit higher sensitivity to the state of the financial sector. Generally, results in all tests which divide the sample into Eurozone and non-Eurozone countries show that only firms and banks within the monetary union are affected by changes in the credit quality of their sovereign.

Table 10: Sovereign credit risk – GIIPS and Eurozone countries

This table reports regression results for fixed effects regression where the independent variable is the daily change in the natural logarithm of a sovereign CDS spread, *Δlog(SovereignCDS)*. *Δlog(BankRisk)* is the daily logarithmic change in the weighted average bank CDS-spread of banks from country *j*, where each observation is weighted according total assets. *Δlog(FirmRisk)* is the daily logarithmic change in the weighted average non-financial CDS-spread of firms from country *j*, where each observation is weighted according total assets. *GIIPS* is an indicator variable that takes the value for countries Ireland, Italy, Portugal or Spain, and *Non-GIIPS Eurozone* for countries in the Eurozone, excluding the GIIPS countries. All regressions control for day and country fixed effects and changes in the local equity market index, foreign exchange rate against the US dollar and the country's debt-to-GDP ratio. All regressions include interactions of country fixed effects with the daily change in the iTraxx EUR Investment Grade index, daily change in the VSTOXX volatility index and daily change in 5-year US Treasury yields, Standard errors (in parentheses) are clustered at the country level. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, correspondingly. Constants are included in the regressions but not shown in the table.

Δlog(SovereignCDS)	Total	Period 1	Period 2	Period 3	Period 4
Panel A: Banks to sovereigns					
Δlog(BankRisk)	-0.020 (0.045)	0.034 (0.043)	0.046 (0.048)	-0.039 (0.138)	-0.088 (0.075)
GIIPS * Δlog(BankRisk)	0.113 (0.063)	0.049 (0.064)	0.249*** (0.069)	0.029 (0.062)	0.078 (0.097)
Non-GIIPS Eurozone * Δlog(BankRisk)	0.020 (0.061)	0.044 (0.032)	0.133*** (0.035)	-0.326** (0.143)	0.153** (0.053)
Observations	23,856	3,473	11,517	4,642	4,224
No of countries	11	11	11	11	11
Adjusted R^2	0.263	0.605	0.377	0.043	0.082
Panel B: Non-financials to sovereigns					
Δlog(FirmRisk)	-0.004 (0.050)	-0.050 (0.031)	0.019 (0.040)	-0.184* (0.097)	0.223 (0.234)
GIIPS * Δlog(FirmRisk)	0.248*** (0.034)	0.130** (0.053)	0.315*** (0.054)	0.298*** (0.048)	0.089 (0.084)
Non-GIIPS Eurozone * Δlog(FirmRisk)	0.117** (0.040)	0.032 (0.043)	0.131** (0.051)	0.067 (0.063)	0.190 (0.137)
Observations	28,208	4,119	13,611	5,486	4,992
No of countries	13	13	13	13	13
Adjusted R^2	0.277	0.584	0.385	0.057	0.080
Control variables	YES	YES	YES	YES	YES
Day FE	YES	YES	YES	YES	YES
Country FE	YES	YES	YES	YES	YES

5.4 Robustness checks

To ensure the robustness of my empirical results, I conduct additional statistical tests. Like discussed previously, daily quotes of CDS spreads may be noisy because contracts on corporate entities can be illiquid. In this study, I decided to follow Acharya et al. (2014) and several others in the main models and use daily data. However, I also test whether the illiquidity of quotes affect my results and conduct the most important tests on changes of CDS spreads at the weekly level. The weekly CDS change is calculated as the logarithmic change of average weekly CDS spread of each firm and country. Results for the main regressions on weekly level are presented in Table 11 for Hypotheses 1, 3, and 5.

The results stay mostly in line with the tests on daily data, although coefficients are distinctly higher. Statistical significance is mostly consistent with the previous results with the exception of a few periods, where coefficients become statistically significant with weekly data. Daily changes in CDS spreads are smaller than weekly changes, on average, and if anything using daily data seems to be downplaying some of the previously documented effects. A 10% weekly increase in sovereign CDS spreads is translated to an increase of 0.61% in bank spreads and a 0.34% increase in non-financials' spreads. The adjusted R^2 of the models also increase with weekly level data, indicating that daily changes in CDS spreads do entail some noise. Additionally, the weekly level regressions indicate that the relation between non-financial firms and sovereigns persists during all periods – also during period 4 which showed no significant evidence with daily-level changes. Interestingly, the relation between banks and sovereigns becomes significant again in period 4 when tests are conducted at the week level. This is contrary to previous findings, where the bank-sovereign relation was insignificant in all tests after the second period. The results with weekly changes hint that the bank-sovereign feedback loop is not necessarily fully broken yet.

I also test whether results of empirical tests change if I use a dynamic panel and include one-day lags of the dependent variable and the main independent variable in the regression models (Bedendo and Colla, 2015). Results for regression models (13) and (14) are presented in Table 12; in Panel A for banks, in Panel B for non-financials and in Panel C for sovereigns.

In Panels A and B, the lag of the change in sovereign spreads is significant in several sub-periods for bank and non-financial samples. This indicates that in addition to current changes, previous changes in sovereign creditworthiness also have an effect on firm spreads.

Table 11: Weekly regressions

This table presents regression results for fixed effects regressions. The dependent variable of each regression is indicated next to the name of the panel. *Δlog(Bank CDS)* is the weekly logarithmic change in a bank's CDS spread, *Δlog(Firm CDS)* is the weekly logarithmic change in a non-financial firm's CDS spread and *Δlog(Sovereign CDS)* is the weekly logarithmic change in a sovereign's CDS spread. *Δlog(BankRisk)* is the weekly logarithmic change in the weighted average bank CDS-spread in country *j*, where each spread is weighted according bank's total assets. *Δlog(FirmRisk)* is the weekly logarithmic change in the weighted average non-financial CDS-spread in country *j*, where each spread is weighted according to firm's total assets. *Δlog(Bank EQ)* and *Δlog(Firm EQ)* are the weekly logarithmic changes in a bank's or non-financial firm's equity price, respectively. All regressions control for week and bank/firm/country fixed effects and interactions of bank/firm/country fixed effects with in the weekly changes isn iTraxx EUR Investment Grade index and VSTOXX volatility index. Panel C regressions also control for weekly changes in the country's equity market index, country's debt-to-GDP ratio, the change in the foreign exchange rate against the US Dollar and interaction of country fixed effects with the weekly change in the 5-year US Treasury yields. Standard errors (in parentheses) are clustered at the country level. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, correspondingly. Constants are included in the regressions but not shown in the table.

	Total (1/2009 – 6/2017)	Period 1 (1/2009 – 4/2010)	Period 2 (4/2010 – 5/2014)	Period 3 (5/2014 – 12/2015)	Period 4 (1/2016 – 6/2017)
Panel A: Bank risk Δlog(Bank CDS)					
Δlog(Sovereign CDS)	0.061***	0.030	0.080***	0.011	0.104***
	(0.014)	(0.030)	(0.016)	(0.025)	(0.030)
Δlog(Bank EQ)	-0.227***	-0.321***	-0.108	-0.133	-0.394
	(0.071)	(0.086)	(0.085)	(0.148)	(0.262)
Observations	13,809	2,029	6,665	2,697	2,418
Adjusted R^2	0.591	0.631	0.650	0.432	0.588
Control variables	YES	YES	YES	YES	YES
Week FE	YES	YES	YES	YES	YES
Bank FE	YES	YES	YES	YES	YES
Panel B: Non-financials Δlog(Firm CDS)					
Δlog(Sovereign CDS)	0.034***	0.029**	0.047***	0.033***	0.015*
	(0.007)	(0.014)	(0.011)	(0.010)	(0.008)
Δlog(Firm EQ)	-0.473***	-0.273***	-0.551***	-0.655***	-0.357***
	(0.064)	(0.074)	(0.115)	(0.167)	(0.083)
Observations	49,935	7,375	24,080	9,744	8,736
Adjusted R^2	0.486	0.464	0.493	0.445	0.551
Control variables	YES	YES	YES	YES	YES
Week FE	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES
Panel C: Sovereigns Δlog(Sovereign CDS)					
Δlog(BankRisk)	0.113**	0.010	0.208**	0.022	0.167**
	(0.048)	(0.049)	(0.068)	(0.065)	(0.065)
Observations	4,889	709	2,365	957	858
Adjusted R^2	0.555	0.800	0.559	0.204	0.423
Δlog(CorpRisk)	0.255***	0.136***	0.338***	0.286**	0.144
	(0.070)	(0.039)	(0.097)	(0.119)	(0.088)
Observations	5,781	841	2,795	1,131	1,014
Adjusted R^2	0.557	0.798	0.552	0.226	0.396
Control variables	YES	YES	YES	YES	YES
Week FE	YES	YES	YES	YES	YES
Country FE	YES	YES	YES	YES	YES

Lags of the dependent variable are also significant for some sub-periods, but the coefficient is mostly negative, showing signs of reversal in daily credit spread changes – yesterday's change in spreads is at least partly reversed by today's change. Furthermore, including lags in the regression models does not change the original results for banks or for non-financials. If anything the coefficient on variable *Δlog(Sovereign CDS)* becomes more significant. Controlling for a dynamic relationship further strengthens the previously discussed findings.

Panel C shows results where the change in sovereign spreads is the dependent variable. The lag of the dependent variable $\Delta log(Sovereign\ CDS)_{(t-1)}$ is significantly negative in most periods. Changes in sovereign spreads show clear reversal from the day before, indicating that daily changes in sovereign spreads may entail noise. The main effects from corporate credit risk to sovereign credit risk stay significant after including the lagged variables for the same periods as before.

Again, it is interesting to note that during the last period from January 2016 onwards, *Δlog(BankRisk)* significantly explains variation in sovereign spreads when lagged variables are included in the regressions. Contrary to previous findings, it seems that bank risk again feeds back to sovereign risk in the period starting from 2016 – indicating that the bank-sovereign feedback loop is not fully broken yet. One reason behind the change in the last period could be fears of Deutsche Bank failure and the turbulence in the bank markets in the beginning of 2016.

5.5 Discussion of results

Next, I briefly discuss my findings combining together results for all of the three samples, my contribution to literature, and implications of the results to investors, policy makers and firms.

My regression results support hypotheses 1 and 3 and show that sovereign credit spreads affect corporate credit spreads of both banks and firms outside the financial sector. Results are in line with previous literature (Acharya et al., 2014; Bedendo and Colla, 2015; Augustin et al., 2016, among others). As expected, the co-movement becomes insignificant for the bank sample after 2014. For other firms the risk transfer from sovereigns has persisted longer, but the statistical significance has also decreased after 2016. The Bank Recovery and Resolution directive, which entered into force in spring 2014, forces bank creditors to take losses before taxpayers and the SRM of the European Banking Union has aimed to break the link between sovereigns and the local banking sector by centralizing the bank resolution to an EU-level.

Table 12: Regressions with a dynamic panel

This table presents regression results for fixed effects regressions. The dependent variable of each regression is indicated next to the name of each panel. *ΔLog(Bank CDS)* is the weekly logarithmic change in a bank's CDS spread, *Δlog(Firm CDS)* is the weekly logarithmic change in a non-financial firm's CDS spread and *Δlog(Sovereign CDS)* is the weekly logarithmic change in a sovereign's CDS spread. *ΔLog(Bank/Firm/Sovereign CDS)$_{(t-1)}$* is a one-day lag of the CDS spread change. *Δlog(BankRisk)* is the weekly logarithmic change in the weighted average bank CDS-spread in country *j*, where each spread is weighted according to bank's total assets. *ΔLog(FirmRisk)* is the weekly logarithmic change in the weighted average non-financial CDS-spread in country *j*, where each spread is weighted according to firm's total assets. *ΔLog(Bank/Firm Risk)(t-1)* is a one-day lag of the weighted CDS spreads. All regressions control for day and bank/firm/country fixed effects and interactions of bank/firm/country fixed effects with in the daily changes in iTraxx EUR Investment Grade index and VSTOXX volatility index. Panel C regressions also control for daily changes in the local equity market index, country's debt-to-GDP ratio, the change in the foreign exchange rate against the US Dollar and interaction of country fixed effects with the daily change in the 5-year US Treasury yields. Standard errors (in parentheses) are clustered at the country level. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, correspondingly. Constants are included in the regressions but not shown in the table.

	Total (1/2009 – 6/2017)	Period 1 (1/2009 – 4/2010)	Period 2 (4/2010 – 5/2014)	Period 3 (5/2014 – 12/2015)	Period 4 (1/2016 – 6/2017)
Panel A: Δlog(Bank CDS)					
Δlog(Sovereign CDS)	0.019***	0.022*	0.039***	-0.003	0.010
	(0.006)	(0.012)	(0.008)	(0.011)	(0.007)
Δlog(Bank CDS)$_{(t-1)}$	-0.053**	-0.005	-0.058**	-0.043	-0.104***
	(0.020)	(00.020)	(0.025)	(0.026)	(0.028)
Δlog(Sovereign CDS)$_{(t-1)}$	0.017***	0.011	0.021***	0.001	0.021***
	(0.004)	(0.010)	(0.007)	(0.005)	(0.006)
Controls and equity returns	YES	YES	YES	YES	YES
Day FE	YES	YES	YES	YES	YES
Bank FE	YES	YES	YES	YES	YES
Observations	67,458	9,935	32,520	13,099	11,904
Adjusted R^2	0.458	0.477	0.513	0.384	0.429
Panel B: Δlog(Firm CDS)					
Δlog(Sovereign CDS)	0.009***	0.012**	0.016***	0.006***	0.003
	(0.002)	(0.006)	(0.004)	(0.002)	(0.002)
Δlog(Firm CDS)$_{(t-1)}$	-0.013	0.008	-0.032**	-0.013	-0.005
	(0.009)	(0.014)	(0.012)	(0.017)	(0.044)
Δlog(Sovereign CDS)$_{(t-1)}$	0.009***	0.013**	0.015***	0.006**	0.005***
	(0.002)	(0.006)	(0.003)	(0.002)	(0.002)
Controls and equity returns	YES	YES	YES	YES	YES
Day FE	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES
Observations	245,807	36,418	118,311	47,686	43,392
Adjusted R^2	0.378	0.322	0.406	0.331	0.470
Panel C: Δlog(Sovereign CDS)					
Δlog(BankRisk)	0.067	0.042	0.172***	-0.061	0.081***
	(0.039)	(0.033)	(0.041)	(0.071)	(0.022)
Δlog(Sovereign CDS)$_{(t-1)}$	-0.246***	-0.044*	-0.149***	-0.345***	-0.325***
	(0.032)	(0.023)	(0.033)	(0.042)	(0.030)
Δlog(BankRisk)$_{(t-1)}$	0.025	-0.007	0.013	0.012	0.028
	(0.020)	(0.034)	(0.030)	(0.037)	(0.032)
Observations	23,845	3,462	11,517	4,642	4,224
Adjusted R^2	0.307	0.606	0.390	0.153	0.178
Δlog(FirmRisk)	0.169***	0.049	0.208***	0.164**	0.199
	(0.051)	(0.045)	(0.059)	(0.062)	(0.121)
Δlog(Sovereign CDS)$_{(t-1)}$	-0.233***	-0.094**	-0.129***	-0.339***	-0.319***
	(0.034)	(0.035)	(0.040)	(0.043)	(0.029)
Δlog(FirmRisk)$_{(t-1)}$	0.042**	0.001	0.044	0.097**	-0.030
	(0.019)	(0.040)	(0.034)	(0.045)	(0.081)
Observations	28,195	4,106	13,611	5,486	4,992
Adjusted R^2	0.316	0.587	0.393	0.165	0.174
Controls	YES	YES	YES	YES	YES
Day FE	YES	YES	YES	YES	YES
Country FE	YES	YES	YES	YES	YES

Based on my empirical results, it seems that both regulatory initiatives have been successful in their aims, and to my knowledge, this study is the first one to document a significant decrease in the sovereign-to-bank risk transfer. A significant relation is found only for firms and sovereigns that are domiciled in the Eurozone.

Previous empirical results of Bedendo and Colla (2015) and Augustin et al. (2016) have documented a similar risk transfer from sovereigns to non-financial companies within a narrow period after the sovereign debt crisis. I confirm the previous findings with a much longer dataset and show that sovereign credit risk is indeed a meaningful determinant of corporate credit spreads also in the long term. Furthermore, I document a two-way dynamic between corporate and sovereign credit spreads and find support for H5: aggregate corporate credit risk, both of banks' and non-financial companies', affects sovereign credit risk in Eurozone countries. Surprisingly, the effect seems to be stronger and more persistent from non-financial corporates than from banks. Bank-to-sovereign effects diminish after period 2014. Results are support the expectation that sovereigns transferred a part of the banking sector's credit risk to their own, after which the expectations of bank failures have decreased (Acharya et al., 2014). Corporate-to-sovereign risk transfer persists for a longer period and is significant for the total study period.

Based on my empirical results, I also argue that some firms are more affected by sovereign spreads than others. For both samples, firms which are more likely to benefit from government support, and firms whose credit risk is close to the credit rating of the sovereign are more affected by changes in sovereign spreads, as I expected. This finding is common for both banks and for non-financials. In addition, banks that hold large amounts of domestic sovereign bonds and non-financial firms that are more dependent on bank loans are more affected than others. These results are also mostly consistent with discussions found in previous literature.

The results are meaningful for several stakeholders. Firstly, investors of both corporate and sovereign debt should acknowledge that country risk may affect the returns of corporate bonds, and significant risks in the private sector may increase the risk of sovereign debt. Particularly those companies that may benefit from government guarantees, have a high credit rating or are otherwise concentrated in the local markets are likely to be influenced by changes in sovereign credit spreads. Hence, even investors that do not hold sovereign bonds may be suspect to the credit risk of European governments through their holdings of corporate debt. Secondly, an improvement (worsening) in the creditworthiness of the home country may decrease (increase) the borrowing costs of local banks and non-financials. From firm managements' point of view,

it is worth to realize that even in the global financial markets country risks may affect the firm's creditworthiness. Where the company is headquartered may in the best (worst) case significantly affect the firms' financial costs.

Thirdly, the results show important remarks to politicians and EU policy makers. For local politicians, results for H5 show that the riskiness of, and guarantees to, local private sector are determinants of sovereign risk. Thus, a strict discipline of public finances may decrease not only decrease the borrowing costs of the government, but also the borrowing costs of local firms, which may foster economic growth in the long term. On the other side, deterioration in government finances reduces the value and credibility of guarantees to the private sector and consequently increases firms' credit risks and makes the likelihood of interventions higher. Thus, riskiness of the private sector meaningfully affects government's borrowing costs.

It is in the interests of politicians, taxpayers and EU policy makers to decrease the loop between corporate and sovereign credit risk in order to stabilize borrowing costs and to break the link between the banking sector and governments. My results prove that the loop has been diminishing in the past years and the markets seem to consider the likelihood of bank or firm bailouts to be much lower than before. This is good news to regulators in the European Union, as it shows that the new regulation on banking sector has at least partly succeeded in its aims. However, some of the results presented in the robustness checks indicate that the feedback-loop between banks and governments is not completely broken. Time will tell whether the risk loop will emerge again if general levels of credit risk increase, or if the new regulation is tested with a resolution of a large and systemic bank. It is outside the scope of this thesis to discuss possible policy enhancements, but for example Navaretti et al. (2016) suggest that assigning a non-zero risk weight that reflects the effective risks of EU government bonds would cut incentives to support local governments. However, this improvement is not unproblematic either. Changing the treatment of sovereign bonds could make sourcing sovereign financing difficult for riskier countries and make the problem of the feedback loop even worse.

Finally, it is important to note that although I document significant relation between of sovereign and corporate spreads, my results do not prove causality between the two sectors. This is the disadvantage of the chosen research methods: correlation between spreads and discussion of drivers behind the feedback loop does not necessarily mean that these factors have actually caused the co-movement in spreads; it only shows which firms have been more affected in the past compared to others. Proving a causal link is left out of the scope of this thesis.

6 Conclusion

In this thesis, I have studied the relation between sovereign and corporate CDS spreads in Europe and how their interdependence has changed after the financial crisis. In particular, I employ a large panel dataset of CDS premiums of sovereigns, banks and non-financial companies from 2009 to 2017 in my tests. My research methods are able to isolate the effects of sovereign (or firm) credit spread changes to firm (sovereign) credit default spreads by controlling for market movements, day and bank fixed effects and the firm's own equity returns in the regressions. I divide the sample to four sub-periods to test for changes in the relationship.

My first research question asked has new banking sector regulation in the European Union been successful in breaking the previously documented relation between bank and sovereign CDS spreads. In line with my hypotheses, I find that there has been a significant relationship between banking sector and sovereign CDS spreads after the financial crisis. This is consistent with the results of Acharya et al. (2014), Alter and Schüler (2012) and Fratzscher and Rieth (2015). However, this relation has weakened to insignificant after new banking sector regulation has been implemented in the European Union. Both the effects from sovereigns to banks, and from banks to sovereigns, have decreased after 2014 when the Bank Recovery and Resolution Directive came into force. Regarding the characteristics of affected banks, those that hold significant amounts of domestic government bonds or have a credit rating close to the credit rating of the sovereign are more affected by changes in sovereign CDS spreads, as well as systemically important financial institutions and banks that are expected to benefit explicit and implicit government guarantees. The findings are in line with my expectations and previous research (De Bruyckere et al. 2013; Alsakka et al., 2014), although many effects are present only for a period from 2011 to 2014. In general, the results are meaningful and shed light on the impact of new regulatory changes. To my knowledge, no studies have before documented the impact of the regulation on the much-studied credit risk feedback loop.

Regarding my second research question, I also find evidence of a two-way dependence between credit spreads of non-financial firms and sovereigns. CDS premiums of non-financial firms are significantly affected by changes in sovereign spreads, and sovereigns are also meaningfully impacted by private sector credit risk. The results are in line with my hypothesis, and shed new light on a sovereign-to-corporate credit risk transfer beyond the banking sector. The findings also bear importance to corporate financing costs by proving that country risk can be a meaningful component in the costs of debt even in financially developed countries. Corporate

issuers in Europe should to take into account that large changes to the credit risk of the country they are domiciled in may affect future borrowing costs of the firm. In addition, politicians should acknowledge that strict fiscal policy can increase not only the government's creditworthiness, but also decrease the credit spreads of local firms. Surprisingly, sovereign CDS premiums are more affected by corporate credit risk than the other way around.

Previous research (Bedendo and Colla, 2015; Augustin et al., 2016) shows that shocks to sovereign credit risk can spill over to corporate credit risk in sovereign debt crisis through firms' dependence on the banking sector, dependence on domestic demand, and decrease in the value of government guarantees to firms. I contribute to previous literature by showing that this relation is not solely linked to years of sovereign distress, but persists over an extended period from 2009 to 2015. I also document that firms' relative dependence on bank loans, the likelihood of receiving government support, and the credit quality of firms are important channels through which sovereign credit risk affects corporate credit premiums. Importantly, both results for the banks and for the non-financials show significant relationship between sovereign risks only for firms from Eurozone countries. Non-Eurozone countries are unaffected in nearly all of tests.

Some tests conducted in the robustness checks -section show indications that the bank-sovereign feedback loop is not fully broken yet, as sovereign credit spreads start to significantly affect bank spreads again in 2016. Therefore, in the future it would be interesting to test whether the general results of my study persist and has the regulation has been able to break the sovereign-bank feedback loop for good, especially after the ECB starts to normalize its unconventional monetary policy. The abnormal monetary policy has kept market rates extremely low in the monetary union, and it would be interesting to see how bank- and sovereign spreads will react to future increases in the level of interest rates. In addition, it would be especially relevant for policy makers to see how credit spreads would react to a new crisis, a significant stress scenario in the markets, or the failure of a systemic financial institution. In addition, although the role of country risk in emerging markets has been studied before, it would be interesting to duplicate my findings with global data because I find significant results only for countries that are part of the Eurozone.

References

Acharya, V., Drechsler, I., and Schnabl, P., 2014. "A Pyrrhic Victory? Bank Bailouts and Sovereign Credit Risk", *Journal of Finance*, 69 (6), 2689 – 2939.

Acharya, V., Eisert, T., Eufinger, C., and Hirsch, C., 2016. "Real Effects of the Sovereign Debt Crisis in Europe: Evidence from Syndicated Loans". Working paper.

Acharya, V., and Steffen, S., 2015. "The "Greatest" Carry Trade Ever? Understanding Eurozone Bank Risks", *Journal of Financial Economics,* 115 (2), 215-236.

Adelino, M., and Ferreira, M. A., 2016. "Bank ratings and lending supply: Evidence from sovereign downgrades", *Review of Financial Studies*, 29 (7), 1709-1746.

Ahmed, J., Anderson, C., and Zarutskie, R., 2015. "Are the borrowing costs for large financial firms unusual?", Finance and Economics Discussion Series 2015-024. Washington: Board of Governors of the Federal Reserve System.

Almeida, H., Cunha, I., Ferreira, M., A., and Restrepo, F., 2017. "The Real Effect of Credit Ratings: The Sovereign Ceiling Channel", *Journal of Finance,* 72 (1), 249 – 290.

Alsakka, R., ap Gwilyn, O., and Wu, T., N., 2014. "The sovereign-bank rating channel and rating agencies' downgrades during the European debt crisis", *Journal of International Money and Finance,* 49, 235-257.

Altavilla, C., Pagano, M., and Simonelli, S., 2017. "Bank Exposures and Sovereign Stress Transmission", *Review of Finance*, 21 (6), 2103–2139.

Alter, A., and Beyer, A., 2014. "The dynamics of spillover effects during the European sovereign debt turmoil", *Journal of Banking & Finance*, 42, 134-153.

Alter, A., and Schüler, Y., S., 2012. "Credit spread interdependencies of European states and banks during the financial crisis", *Journal of Banking & Finance*, 36, 3444 – 3468.

Andreeva, D., and Vlassopoulos, T., 2016. "Home bias in bank sovereign bond purchases and the bank-sovereign nexus", ECB Working Paper No 1977.

Aretzki, R., Candelon, B., and Sy, A. N., 2011. "Sovereign Rating News and Financial Markets Spillovers: Evidence from the European Debt Crisis", IMF Working Paper No 11/68.

Artreta, O., and Hale, G., 2008. "Sovereign debt crises and credit to the private sector", *Journal of International Economics*, 74, 53-69.

Augustin, P., 2013. "The Term Structure of CDS Spreads and Sovereign Credit Risk", Working Paper.

Augustin, P., Boustanifar, H., Breckenfelder, J., and Schnitzler, J., 2016. “Sovereign to Corporate Risk Spillovers”, ECB Working paper No. 1878.

Bai, J., and Wei, S., 2012. “When Is There a Strong Transfer Risk from the Sovereigns to the Corporates? Property Rights Gaps and CDS Spreads”, *Federal Reserve Bank of New York Staff Reports*, no. 579.

Baldacci, E., Gupta, S., and Mati, A., 2011. ”Political and Fiscal Risk Determinants of Sovereign Spreads in Emerging Markets”, *Review of Development Economies,* 15 (2), 251-263.

Bank for International Settlements, 2011. “The impact of sovereign credit risk on bank funding conditions”, *CGFS papers No 43.* Available at: https://mpra.ub.uni-muenchen.de/32581/

Bedendo, M., and Colla, P., 2015. “Sovereign and Corporate Credit Risk: Evidence from the Eurozone”, *Journal of Corporate Finance,* vol. 33, 34 – 52.

Bekooij, J., Frost, J., van der Molen, J., and Krzysztof, M, 2016. ”Hazardous Tango: Sovereign-Bank Interdependencies across Countries and Time”, De Nederlandsche Bank Working Paper No. 541.

Benzoni, L., Collin-Dufresne, P., Goldstein, R., S., and Helwege, J., 2015. “Modeling Credit Contagion via the Updating of Fragile Beliefs”, *The Review of Financial Studies*, 28 (7), 1960–2008.

Blanco, R., Brennan, S., and Warsh, I., W., 2005. “An Empirical Analysis of the Dynamic Relation between Investment-Grade Bonds and Credit Default Swaps”, *Journal of Finance,* 60 (5), 2233-2281.

Borensztein, E., Cowan, K., and Valenzuela P., 2013. "Sovereign ceilings “lite”? The impact of sovereign ratings on corporate ratings", *Journal of Banking & Finance*, 37 (11), 4014-4024.

Collin-Dufresne, P., Goldstein, R., S., and Martin, J., S., 2001. “The determinants of credit spread changes”, *Journal of Finance*, 56, 2177-2207.

De Bruyckere, V., Gerhardt, M., Schepens, G., and Venner, R., V., 2013. “Bank/sovereign risk spillovers in the European debt crisis”, *Journal of Banking & Finance,* 37 (12), 4793-4809.

Demirgüç-Kunt, A., and. Huizinga, H., 2013. “Are banks too big to fail or too big to save? International evidence from equity prices and CDS spreads”, *Journal of Banking & Finance,* 37 (3), 875-894.

Dieckmann, S., and Plank, T., 2012. "Default risk of advanced economies: an empirical analysis of credit default swaps during the Financial Crisis", *Review of Finance*, 16, 903 – 934.

Dombrovskis, V., "Speech by Vice-President Dombrovskis on European Financial Integration" in Brussels, 19.5.2017. Available at: https://ec.europa.eu/commission/commissioners/2014-2019/dombrovskis/announcements/speech-vice-president-dombrovskis-european-financial-integration_en

Drago, D., and Gallo, R., 2017. "The impact of sovereign rating changes on European syndicated loan spreads: The role of the rating-based regulation", *Journal of International Money and Finance*, 73, 213-231.

Dötz, N., and Fischer, C., 2010. "What Can EMU Countries' Sovereign Bond Spreads Tell Us About Market Perceptions of Default Probabilities During the Recent Financial Crisis?", *Bundesbank Series 1 Discussion Paper No. 2010,11.*

Ejsing, J., Lemke, W., 2011. "Janus-headed salvation: Sovereign and bank credit risk premia during 2008-2009", *Economic Letters,* 110 (1), 28-31.

Erce, A., 2015. "Bank and Sovereign Risk Feedback Loops", Federal Reserve Bank of Dallas Working Paper.

European Commission, "Bank recovery and resolution". Available at: https://ec.europa.eu/info/business-economy-euro/banking-and-finance/financial-supervision-and-risk-management/managing-risks-banks-and-financial-institutions/bank-recovery-and-resolution_en

European Banking Authority, EU-Wide Transparency Exercises. Available at: https://www.eba.europa.eu/risk-analysis-and-data/eu-wide-transparency-exercise/2017

Fratzscher, M., and Rieth, M., 2015. "Monetary policy, bank bailouts and the sovereign-bank risk nexus in the Euro area", DIW Berlin Discussion Paper.

Gennaioli, N., Martin, A., and Rossi, S., 2014. "Sovereign default, domestic banks and financial institutions", *Journal of Finance,* 69 (2), 819-866.

IMF, 2017. "Global Financial Stability Report: Getting the Policy Mix Right", *World Economic and financial surveys,* April 2017. Available at: https://www.imf.org/en/Publications/GFSR/Issues/2017/03/30/global-financial-stability-report-april-2017

Kallestrup, R., Lando, D., and Murgoci, A., 2016. "Financial sector linkages and the dynamics of bank and sovereign credit spreads", *Journal of Empirical Finance*, 38, 374-393.

Klein, C., and Stellner, C., 2014. "Does sovereign risk matter? New evidence from Eurozone corporate bond ratings and zero-volatility spreads", *Review of Financial Economics,* 23 (2), 64-74.

Lee, J., Naranjo, A., and Sirmans, S., 2016. "Exodus from sovereign risk: Global asset and information networks in the pricing of corporate credit risk", *Journal of Finance,* 71 (4), 1813-1856.

Longstaff, F., A., Mithal, S., and Neis, E., 2005. "Corporate Yield Spreads: Default Risk or Liquidity? New Evidence from the Credit Default Swap Market", *Journal of Finance,* 60 (5), 2213 – 2253.

Longstaff, F., A., Pan, J., Pedersen, L., H., and Singleton, K., J., 2011. "How sovereign is sovereign credit risk?", *American Economic Journal: Macroeconomics,* 3.2, 75-103.

Löffler, G., 2005. "Avoiding the rating bounce: why rating agencies are slow to react to new information", *Journal of Economic Behavior & Organization*, 56 (3), 365-381.

Merler, S., and Pisani-Ferry, J., 2012. "Hazardous tango: sovereign-bank interdependence and financial stability in the euro area", *Financial Stability Review*, 16, 201-210.

Moody's Investor Services, February 2010. "Narrowing the gap – a clarification of Moody's approach to local versus foreign currency government bond ratings". Available at: https://www.moodys.com/researchdocumentcontentpage.aspx?docid=PBC_118820

Moody's Investor Services, September 2014. "Proposed bank rating methodology". Available at: https://www.moodys.com/microsites/gbrm2014/RFC.pdf

Navaretti, B., Calzolari, G., and Pozzolo, A., 2016. "Diabolic Loop or Incomplete Union? Sovereign and Banking Risk", *European Economy, 4.6.2016.* Available at: http://european-economy.eu/2016-1/diabolic-loop-or-incomplete-union-sovereign-and-banking-risk/

Neuberg, R., Glasserman, P., Kay, B., and Rajan, S., 2016. "The Market-implied Probability of European Government Intervention in Distressed Banks", Working paper.

Nickell, S., 1981. "Biases in Dynamic Models with Fixed Effects", *Econometrica,* 49 (6), 1417-1426.

O'Hara, M., and Shaw, W., 1990. "Deposit Insurance and Wealth Effects: The Value of Being "Too Big to Fail"", *Journal of Finance,* 45 (5), 1587-1600.

Ongena, S., Popov, A., and Van Horen, N., 2016. "The invisible hand of the government: "Moral suasion" during the European sovereign debt crisis", ECB Working Paper No. 1937.

Palladini, G, and Portes, R., 2011. “Sovereign CDS and bond pricing dynamics in the Euro-area”, NBER Working Paper No. 17586.

Pan, J., and. Singleton, K. J., 2008. “Default and recovery implicit in the term structure of sovereign CDS spreads”, *Journal of Finance*, 63 (5), 2345-2384.

Reuters, 19.3.2012. “Greek CDS payout auction sees bond price at 21.75 cents”. Available at: https://www.reuters.com/article/markets-greece-cds/greek-cds-payout-auction-sees-bond-price-at-21-75-cents-idUSL6E8EJ13820120319

Reuters, 30.7.2014. “Chronology: Argentina's turbulent history of economic crises”. Available at: https://www.reuters.com/article/us-argentina-debt-chronology/chronology-argentinas-turbulent-history-of-economic-crises-idUSKBN0FZ23N20140730

S&P Global, 21.6.2016. “Undoing The Doom Loop: A Look At The Links Between European Banks And Sovereign Debt”. Available at: https://www.globalcreditportal.com/ratingsdirect/renderArticle.do?articleId=1659892&SctArtId=391948&from=CM&nsl_code=LIME&sourceObjectId=9676336&sourceRevId=1&fee_ind=N&exp_date=20260621-21:18:49

Vergote, O., 2016. “Credit risk spillover between financials and sovereigns in the euro area during 2007-2015”, ECB Working paper No 1898.

VOX News, 4.10.2016. “Germany's largest bank is facing a huge fine, prompting fear of a new financial crisis”. Available at: https://www.vox.com/new-money/2016/10/4/13124402/deutsche-bank-problems-explained.

Appendices

Appendix 1: Variable definitions

Variable	Calculation	Data source
Δlog(Bank CDS)	Daily change in natural logarithm of bank's CDS spread	Datastream
Δlog(Firm CDS)	Daily change in natural logarithm of non-financial's CDS spread	Datastream
Δlog(Sovereign CDS)	Daily change in natural logarithm of sovereign's CDS spread	Datastream
Δlog(BankRisk)	Daily change in natural logarithm of a country-specific index of bank CDS spreads. The daily spread of the index is calculated as the weighted average of the country's banks, with total assets relative to other banks as weights.	Datastrean, Thomson One
Δlog(EQ)	Daily change in natural logarithm of bank's or non-financial firm's equity price	Datastream
Δlog(EquityMarket)	Daily change in natural logarithm of a country's equity index	Datastream
Δlog(FirmRisk)	Daily change in natural logarithm of a country-specific index of non-financial firms' CDS spreads. The daily spread of the index is calculated as the weighted average of the country's firms with total assets relative to other non-financial firms as weights.	Datastrean, Thomson One
Δlog(FXRate)	Daily change in the natural logarithm of the foreign exchange rate against US dollar	Bloomberg
Bank dependent	1 if the ratio of bank debt to total liabilities of a non-financial firm is higher than the sample median, 0 otherwise. Re-measured annually.	Orbis
Bank-based	1 if the country's ratio of total banking sector assets to total equity market capitalization is higher than the all-country median, 0 otherwise. Re-measured annually.	Bloomberg, ECB
Debt-to-GDP	Country's government debt to GDP ratio, measured quarterly	OECD
Domestic demand	1 if the ratio of revenue a non-financial firm sources from the domestic country compared to its total revenue is higher than the sample median at the end of 2016, 0 otherwise	Orbis
Domestic exposure	1 for banks if the ratio of domestic sovereign bond holdings to total assets is higher than the bank-sample median, 0 otherwise. Re-measured bi-annually.	ECB Stress tests, Thomson One
GIIPS	1 for firms from Ireland, Italy, Portugal or Spain, 0 otherwise	Datastream
Government control	1 for non-financial firms where the domestic government holds more than 5% of firms outstanding shares at the end of 2016, 0 otherwise	Orbis
Home share	1 for banks if the ratio of domestic sovereign bond holdings to total government bond holdings is higher than the bank-sample median, 0 otherwise. Re-measured bi-annually.	ECB Stress tests
Non-GIIPS Eurozone	1 for firms from Eurozone, but not from Ireland, Italy, Portugal or Spain, 0 otherwise	Datastream
Rating ceiling	1 if the S&P long term issuer credit rating of the bank or firm is higher than, or equal to the sovereign's issuer rating, 0 otherwise	Thomson One
Ratings uplift	1 if the Moody's assigned Issuer Credit Rating of a bank is higher than Moody's Baseline Credit Assessment (BCA) rating, 0 otherwise. The difference indicates government support.	Bloomberg
Spread ceiling	1 if the CDS spread the bank or firm is higher than, or equal to the sovereign's CDS spread, 0 otherwise	Datastream
Strategic importance	1 if the ratio of non-financial firm's market capitalization to the total market capitalization of the domicile country is higher than the 75th percentile of the sample, 0 otherwise. Re-measured annually.	Bloomberg
Supported sector	1 if the non-financial firm operates in sectors classified as telecommunications, utilities or transportation, 0 otherwise	Thomson
Systemic importance	1 if the bank is deemed to be a Global Systemically Important Bank (G-SIB) by the Financial Stability Board, 0 otherwise.	ECB Stress tests

Appendix 2: Annual regressions – sovereigns to banks

This table reports regression results for fixed effects regression, where the independent variable is the daily change in the natural logarithm of a bank's CDS spread. *Δlog (Sovereign CDS)* is the daily change in the natural logarithm of the corresponding sovereign's CDS spread and *Δlog(EQ)* is the daily change in the natural logarithm of the bank's equity price. All regressions control for day and bank fixed effects and include interactions of bank fixed effects with the logarithm of daily change in the iTraxx EUR Investment Grade index and daily change in the VSTOXX volatility index. Standard errors (in parentheses) are clustered at the bank level. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, correspondingly. Constants are included in the regressions but not shown in the table.

Δlog(Bank CDS)	2009	2010	2011	2012	2013	2014	2015	2016	2017
Δlog(Sovereign CDS)	0.027* (0.013)	0.044** (0.018)	0.045*** (0.016)	0.015** (0.007)	0.016*** (0.004)	0.014 (0.010)	-0.004 (0.014)	0.010 (0.009)	-0.013 (0.010)
Δlog(EQ)	-0.043*** (0.013)	-0.051** (0.023)	-0.060*** (0.019)	0.011 (0.016)	-0.034*** (0.012)	-0.087*** (0.018)	-0.017 (0.018)	-0.063*** (0.017)	-0.134** (0.064)
Control variables	YES	YES	YES	YES	YES	YES	YES	YES	YES
Day FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	7,858	7,936	7,985	7,983	7,940	7,930	7,953	7,967	3,937
Adjusted R^2	0.452	0.613	0.445	0.517	0.536	0.308	0.536	0.484	0.299

Appendix 3: Periodic regressions on the sovereign-bank transmission channels

This table reports regression results for fixed effects regression where the independent variable is the daily change in the natural logarithm of a bank's CDS spread. *Δlog (Sovereign CDS)* is the daily change in the natural logarithm of the corresponding sovereign's CDS spread. *Domestic exposure* is equal to one if the ratio of domestic bond holdings to total assets of the bank is higher than the median of the sample in a half-a-year period. *Home bias* is equal to one if the ratio of domestic bond holdings to total sovereign bond holdings is higher than the median of the sample in a half-a-year period. *Systemic importance* is equal to one if the bank is deemed a G-SIB. *Ratings uplift* is equal to one if the Moody's BCA rating is lower than Moody's issuer rating when ratings are assigned numerical scores. *Rating ceiling* is equal to one if the S&P long-term rating of the bank is equal to, or higher than, the rating of their sovereign. *CDS ceiling* is equal to one if the CDS spread of a bank is lower than that of their sovereign. All regressions control for day and bank fixed effects and include interactions of firm fixed effects with the daily change in the iTraxx EUR Investment Grade index and daily change in the VSTOXX volatility index. Standard errors (in parentheses) are clustered at the bank level. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, correspondingly. Constants are included in the regressions but not shown in the table.

Δlog(Bank CDS)	Period 1	Period 2	Period 3	Period 4	Period 1	Period 2	Period 3	Period 4	Period 1	Period 2	Period 3	Period 4
Δlog(Sovereign CDS)	0.001	0.029***	0.004	-0.001	-0.010	0.027**	-0.003	-0.003	-0.006	0.022**	-0.025	0.002
	(0.018)	(0.009)	(0.006)	(0.006)	(0.022)	(0.010)	(0.015)	(0.005)	(0.018)	(0.011)	(0.020)	(0.010)
Domestic exposure *	0.006	0.061**	-0.032	0.014								
Δ log(Sovereign CDS)	(0.029)	(0.023)	(0.041)	(0.019)								
Home share *					0.014	0.057***	-0.004	0.014				
Δ log(Sovereign CDS)					(0.025)	(0.018)	(0.012)	(0.014)				
Systemic Importance *									0.064***	0.059***	0.020**	0.003
Δ log(Sovereign CDS)									(0.022)	(0.018)	(0.010)	(0.008)
Observations	1,904	29,046	12,513	9,727	1,972	29,361	12,513	9,727	9,966	32,520	13,099	11,904
Adjusted R^2	0.593	0.539	0.396	0.504	0.589	0.533	0.396	0.504	0.478	0.511	0.384	0.422
Δlog(Sovereign CDS)	0.044	0.011	-0.009	-0.000	0.013	0.027***	-0.008	-0.001	0.011	0.034***	-0.004	0.003
	(0.058)	(0.021)	(0.033)	(0.013)	(0.014)	(0.005)	(0.013)	(0.006)	(0.012)	(0.007)	(0.012)	(0.006)
Ratings uplift *	0.021*	0.038***	-0.002	-0.000								
Δ log(Sovereign CDS)	(0.011)	(0.009)	(0.007)	(0.006)								
Rating ceiling *					0.070*	0.147***	0.072	0.035				
Δ log(Sovereign CDS)					(0.036)	(0.045)	(0.051)	(0.033)				
Spread ceiling *									0.093**	0.118***	0.037	0.007
Δ log(Sovereign CDS)									(0.045)	(0.024)	(0.058)	(0.046)
Observations	9,318	30,423	12,254	11,136	9,386	31,381	12,254	11,136	9,966	32,520	13,099	11,904
Adjusted R^2	0.487	0.558	0.397	0.458	0.493	0.555	0.398	0.494	0.478	0.511	0.383	0.422
Control for equity returns	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Control variables	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Day FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bank FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Appendix 4: Annual regressions – sovereigns to non-financials

This table reports regression results for fixed effects regression, where the independent variable is the daily change in the natural logarithm of a firm's CDS spread. *Δlog (Sovereign CDS)* is the daily change in the natural logarithm of the corresponding sovereign's CDS spread and *Δlog(EQ)* is the daily change in the natural logarithm of the bank's equity price. All regressions control for day and firm fixed effects and include interactions of firm fixed effects with the logarithm of daily change in the iTraxx EUR Investment Grade index and daily change in the VSTOXX volatility index. Standard errors (in parentheses) are clustered at the bank level. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, correspondingly. Constants are included in the regressions but not shown in the table.

Δlog(Firm CDS)	2009	2010	2011	2012	2013	2014	2015	2016	2017
Δlog(Sovereign CDS)	0.003 (0.006)	0.023*** (0.006)	0.028*** (0.008)	-0.000 (0.004)	0.000 (0.002)	0.009*** (0.003)	0.001 (0.002)	0.001 (0.002)	0.002 (0.002)
Δlog(EQ)	-0.046*** (0.011)	-0.098*** (0.035)	-0.099*** (0.017)	-0.125*** (0.027)	-0.075*** (0.015)	-0.099*** (0.019)	-0.087*** (0.023)	-0.069*** (0.015)	-0.082*** (0.025)
Control variables	YES	YES	YES	YES	YES	YES	YES	YES	YES
Day FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	28,847	29,154	29,041	28,928	28,815	28,815	28,928	29,041	14,351
Adjusted R^2	0.308	0.500	0.423	0.353	0.361	0.300	0.334	0.478	0.435

Appendix 5: Periodic regressions on sovereign-corporate transmission channels

This table reports regression results for fixed effects regression where the independent variable is the daily change in the natural logarithm of a bank's CDS spread. *Δlog(Sovereign CDS)* is the daily change in the natural logarithm of the corresponding sovereign's CDS spread. *Bank dependent* equals one if the company's ratio of bank loans to total liabilities is higher than sample median. *Bank based* takes the value of one if the banking assets to equity market capitalization of the country is higher than all countries' median. *Govt control* is equal to one if the local government owns more than 5% of the company's shares. *Strategic importance* is equal to one if the ratio of the company's market capitalization to the total market capitalization of the country's stock exchange is higher than of the 75th percentile of the total sample. *Supported sector* takes the value of one if the firm operates in utilities, telecommunications or transportation. *Rating ceiling* is equal to one if the S&P long-term rating of the bank is equal to, or higher than, the rating of their sovereign. *CDS ceiling* is equal to one if the CDS spread of a bank is lower than that of their sovereign. *Domestic demand* equals one if the company's ratio of sales from domicile country to total sales is higher than sample median. All regressions control for day and firm fixed effects and include interactions of firm fixed effects with the daily change in the iTraxx EUR Investment Grade index and daily change in the VSTOXX volatility index. Standard errors (in parentheses) are clustered at the firm level. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, correspondingly. Constants are included in the regressions but not shown in the table.

log (Firm CDS)	Period 1	Period 2	Period 3	Period 4	Period 1	Period 2	Period 3	Period 4	Period 1	Period 2	Period 3	Period 4	Period 1	Period 2	Period 3	Period 4
Δlog(Sovereign CDS)	0.013	0.004	0.002	0.004	0.007	0.011***	0.002	0.001	0.010	0.006**	0.003*	0.002	0.008	0.006**	0.000	-0.000
	(0.009)	(0.005)	(0.003)	(0.003)	(0.006)	(0.004)	(0.002)	(0.002)	(0.006)	(0.003)	(0.002)	(0.002)	(0.006)	(0.003)	(0.002)	(0.002)
Bank dependent *	0.014	0.021**	0.010**	0.003												
Δ log(Sovereign CDS)	(0.011)	(0.010)	(0.004)	(0.005)												
Bank-based *					0.024**	0.022**	0.017**	0.022**								
Δ log(Sovereign CDS)					(0.012)	(0.010)	(0.009)	(0.010)								
Government control *									0.013	0.036***	0.007	0.001				
Δ log(Sovereign CDS)									(0.009)	(0.013)	(0.005)	(0.003)				
Strategic importance *													0.020**	0.044**	0.023**	0.010
Δ log(Sovereign CDS)													(0.010)	(0.018)	(0.010)	(0.006)
Observations	23,328	72,904	28,260	24,960	36,531	118,311	47,686	43,392	36,531	118,311	47,686	43,392	32,967	107,995	43,888	39,936
Adjusted R^2	0.320	0.409	0.363	0.465	0.322	0.406	0.330	0.470	0.322	0.406	0.330	0.469	0.319	0.412	0.360	0.489
Δlog(Sovereign CDS)	0.008	0.005*	0.003	0.001	0.011*	0.012***	0.002	0.002	0.007	0.007**	0.003*	0.002	0.008	0.009**	0.004	0.001
	(0.006)	(0.002)	(0.002)	(0.002)	(0.006)	(0.004)	(0.002)	(0.002)	(0.005)	(0.003)	(0.002)	(0.002)	(0.006)	(0.004)	(0.002)	(0.004)
*Supported sector**	0.018	0.044***	0.009	0.007*												
Δ log(Soveregn CDS)	(0.011)	(0.016)	(0.006)	(0.004)												
Rating ceiling *					0.108	0.126**	0.088***	0.006								
Δ log(Sovereign CDS)					(0.105)	(0.059)	(0.026)	(0.016)								
Spread ceiling *									0.038**	0.076***	0.037	-0.010				
Δ log(Sovereign CDS)									(0.015)	(0.018)	(0.022)	(0.011)				
Domestic demand *													0.024*	0.034**	0.005	0.004
Δ log(Sovereign CDS)													(0.013)	(0.016)	(0.006)	(0.005)
Observations	36,207	117,264	47,264	43,008	32,063	103,843	41,778	37,889	36,531	118,311	47,686	43,392	36,207	117,264	47,264	43,008
Adjusted R^2	0.321	0.406	0.330	0.472	0.327	0.407	0.337	0.477	0.322	0.407	0.331	0.469	0.322	0.408	0.335	0.471
Control for EQ returns	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Control variables	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Day FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES