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Essays on Firms Financing and Sovereign Debt Pricing

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Abstract

This thesis aims to provide new insights on the functioning of financial markets. In particular, I focus on European markets with the final objective of uncovering important evidences for the implementation of policies aimed to improve the resiliency of the financial system to economic crises.

In the thesis, I tackle two important issues present in the financial literature. In chapters II and III I study the effects of the credit cycle on firm's choice of debt structure whereas in Chapter IV I investigate the relative pricing of sovereign credit risk by studying the relationship between sovereign CDS spreads and sovereign yields, for European countries, during and after the sovereign debt crisis.

Chapter II is dedicated to the study of firm's choice of funding and its relationship with the evolution of the credit cycle. Using a sample of U.S. and European firms, I document the existence of a credit substitution channel between loans and bonds that reduces the adverse effect of a shrink in credit supply. Moreover, I also report estimates on the degree of substitution. In particular, I investigate on the ability of firms to fully substitute between the two forms of debt, and I find that firms in Eurozone countries can only partially substitute bank debt with market debt.

In Chapter III I extend the findings of the previous chapter providing evidences on the the existence of an asymmetric effect when including in the analysis also lenders' characteristics. Main lenders' financial soundness, and the practice of relationship lending, contribute to reduce the necessity for firms of modifying their debt structure when the credit cycle is at a through.

in Chapter IV I document that a distress puzzle at the sovereign level emerges during the crisis period for the Eurozone countries, and I offer empirical evidence on the theoretical relationship between CDS spreads and bond yields, before and after the ECB intervention. I estimate a contingent claim model for sovereign credit risk, and shed light on the relationship between risk and return for sovereign securities. Further, I test the profitability of arbitrage strategies that exploit deviations from the equilibrium condition. Finally, I observe that after the launch of the Outright

Monetary Transaction (OMT) Programme, by the European Central Bank, the relative mispricing of the sovereign credit risk has strongly reduced

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I. Introduction to the thesis

In the thesis, I tackle two important issues present in the financial literature. In chapters II and III I study the effects of the credit cycle on firm's choice of debt structure. Using a sample of U.S. and European firms, I document the existence of a credit substitution channel between loans and bonds that reduces the adverse effect of a shrink in credit supply. Moreover, I also report estimates on the degree of substitution. In particular, I investigate on the ability of firms to fully substitute between the two forms of debt. In chapter III I study how external factors related to lenders' characteristics affect the substitution channel and in turns firms' choices. In the last part of the thesis I switch the focus on sovereigns. In chapter IV I investigate the relative pricing of the sovereign credit risk by studying the relationship between sovereign CDS spreads and sovereign yields, for European countries, during and after the sovereign debt crisis.

Chapter II is dedicated to the study of firm's choice of funding and its relationship with the evolution of the credit cycle. Large amount of literature has been dedicated to banks and their role of financial intermediation capable of reducing transaction costs and asymmetric information problems that plague the financial market. Banks extend credit to households and firms that otherwise would have been rationed. By extending credit to the real economy, banks boost consumption and investments, which are two of the main component that form the GDP. Thanks to their ability of mitigating agency costs, financial intermediaries have always been a key source of funding for firms –especially for small and medium sized ones. Some of the most influential authors to discuss the importance of intermediaries as possible solution to inefficiencies of financial markets were Diamond (1984), Dewatripont, Tirole, et al. (1994) and Freixas and Rochet (1997). Nevertheless, many economists saw the coexistence of financial markets and financial intermediaries as a temporary condition that would cease with the improvement of financial markets efficiency over time. According to this school of thought, the more efficient financial markets should have replaced financial intermediaries because investors prefer to use markets for smoothing their consumption by transferring savings across time and not paying any intermediation fee. While the assertion is partly true, we did not observe –until the financial crisis- a shrinkage of banks; if something the banking system enlarged to the point in which few large banks were dominating the entire banking industry.

Two elements played a role in the persistent importance of the banking system. The first is the enlargement of the core business of banks. As markets became more efficient a conspicuous part of the pool of potential borrowers moved to the relatively cheaper bonds' market. As a response, banks modified their business model to enlarge their scope by offering additional fee-paying financial services. On the other hand, not all the financial markets developed at the same pace across the world (not even across developed countries). On this issue Allen and Santomero (2001) reports that the size of the banking industry did not shrink overall; thus supporting the hypothesis that bank credit is not fully substitutable with market debt and that financial intermediaries still maintain a key role in the financial system.

The role of banks in the economy lead researchers to investigate the relationship between the availability of bank credit and the economic cycle. From a regulators point of view providing evidences of a causal relationship going from the bank credit supply to the economic cycle (and in particular that a shortage of bank funding is detrimental for the economic recovery) have important implications for the implementation of policies aimed to improve the resiliency of the financial system to economic crises. As discussed, the inefficiencies of the market leave space to financial intermediaries' activity. Nonetheless, bank debt and market debt are substitutable only to a certain extent. In countries like U.S. where the competition of financial markets is strong, the banks had to be entrepreneurial and change their approach to the intermediation business. An example is the development of the syndicated loans market that has been a major achievement for financial intermediaries in U.S., and more recently in Europe. Nevertheless in Europe, and in countries like Japan, banks still play a leading role as intertemporal smoother thus making the core commercial banking business still profitable. In addition to this argument the traditional business of banks is still of high value as a mean of transmitting central bank's monetary policy; conventional and most of the unconventional ones as well.[1]

In Chapter III I extend the findings of the previous chapter by considering additional external factors that influence the credit cycle. In particular, I document the existence of an asymmetric effect when including in the analysis also lender characteristics. Main lenders' financial soundness, and the practice of relationship lending, contribute to reduce the necessity for firms of modifying their debt structure when the credit cycle is at a through[2].

Another observed empirical fact is that while capital markets are stable, bank credit supply is very volatile resulting in a less reliable source of funding for periods in which funds are most in demand. The highly volatile and pro-cyclical bank credit supply can eventually lead to a severe economic recession. To overcome this issue, and to obtain more stable funding, firms often create links with one or more banks by repeatedly interacting with them overtime. The link formed between the lending bank and the borrowing firm has been denominated in the literature "relationship lending". The existence of relationship lending allows firms to maintain a cheaper and more secure source of funding through reduced transaction costs, and a much reduced information asymmetry.

It is now clear that from an economic theory perspective, scholars accept that the bank's credit cycle directly affects the real economy. A reduction in credit supply could in fact exacerbate the effects of an economic downturn. The empirical observation of these theoretical predictions open the doors to several interesting macro-prudential implications. The objectives of the regulators should be to provide buffers to the economy such that when the crisis hit economic agents are not affected too severely.

[1]The Fed in 2008 revived a provision in Section 13(3) of the Federal Reserve Act. Under this provision, the Fed was allowed to extend credit to non-bank financial firms (thus not directly supervised by the central bank). Despite more risky in principle the loans turn in a profit of around $30 billion for the Fed.

[2]The notion of main lender and relationship lender will be defined in Chapter III

The correct functioning of the capital markets is of fundamental importance for the substitution channel to work, and regulators should take continuous effort to improve the efficiency of the financial structure. However, since the development of capital markets is not uniform even across developed countries, we do observe failures in the effectiveness of the substitution channel. This is the case in Europe, where the banking system is dominant compared to financial markets. The solution that many firms adopt is to release soft information to some lenders that allows them to obtain cheap funds when the costs of borrowing are high, thus providing an alternative to the bond market substitution. While relationship lending is a well-known solution to get funding for the more opaque small and medium enterprises, with the development of the syndicated loans market a strong firm-bank link proved to be valuable also for bigger corporations that could raise large amounts from a syndicate whose lead arranger is informed. A syndicated loan is much more similar to a bond compared to a bilateral loan while retaining most of the advantages of a loan in terms of renegotiation.

From a corporate finance perspective, the link with a bank allows firms to have a stable source of funding which is particularly important in periods with tight credit but also concedes monopoly rents to the superiorly informed bank. Firms face a trade-off between the stability of bank's funding and the amount of information they would like to release to the bank. In other words, firms will have to choose the right amount of bank credit to circumvent the market power that the informed bank acquires. The link between the bank credit and economic activity therefore should be even stronger than previously hypothesized if it is found that a long-term relationship with a bank reduce the adverse effect of a crisis for the firm. This has also implications from a macroeconomic point of view. The presence of relationship lending could modify the way the monetary policy affects real activity through the lending channel especially when there is a credit crunch.

Finally, in Chapter IV I show that after the launch of the Outright Monetary Transaction (OMT) Programme, by the European Central Bank, the relative mispricing of the sovereign credit risk has strongly reduced. I disentangle the effects of the ECB intervention on the sovereign credit risk market in different ways. I offer empirical evidence on the theoretical relationship between CDS spreads and bond yields, before and after the ECB intervention, across Eurozone and No Eurozone countries. Then, I estimate a contingent claim model for sovereign credit risk, and shed light on the relationship between risk and return for sovereign securities. Further, I test the profitability of arbitrage strategies that exploit deviations from the equilibrium condition.

The positive relationship between risk and expected return is one of the milestones in financial theory. Investors choose to buy risky assets by looking at risk-adjusted returns. The higher is the risk associated to a given investment, the higher must be the expected return. Hull, Predescu, and White (2004) find that conditional on the absence of frictions in the market, a portfolio including CDS and bond, issued by the reference entity, generates cash flows equal to a riskless bond in all states of the world. Hence, the CDS premium should be equal to the excess risky yield over the risk-free rate.

Compared to the related literature in Palladini and Portes (2011), Arce, Mayordomo, and Pena (2013), and Fontana and Scheicher (2016) the investigation extend the analysis to the period following the ECB intervention, including also countries outside the Eurozone, with the aim of highlighting the differential effects of the unconventional monetary policy.

The empirical contradiction of the positive relationship between risk and expected return is known in the financial literature as *distress puzzle*.

The distress puzzle is different from a temporary mispricing condition as documented for both corporate (Longstaff, Mithal, and Neis (2005), Blanco, Brennen, and Marsh (2005)), and sovereign securities (Palladini and Portes (2011), Arce et al. (2013), Fontana and Scheicher (2016)). These papers argue that CDS spreads are faster in price discovery, thus reacting quicker to changes in credit condition. As a consequence, the relationship CDS spread - bond spread does not hold in the short-term. However, they show that CDS spreads and bond yields exhibit strong co-movements in a long-term perspective.

Chapter IV documents that a distress puzzle at the sovereign level emerges during the crisis period for the Eurozone countries. The mispricing is not temporary and cannot be arbitraged away by investors. Indeed, I observe that the mispricing is ruled out only after the launch of the OMT programme.

II. Loan to Bond Substitution: An Empirical Analysis on the Functioning of the Substitution Channel for Eurozone Firms

1. Introduction

Theoretical literature on the credit cycle strongly supports the hypothesis that bank lending is pro-cyclical and that credit supply significantly affects real economy.

Plenty of literature investigated the link between bank lending and the business cycle both from a theoretical and from an empirical point of view. Unfortunately, verifying empirically the theoretical predictions has proved hard. In fact, while credit shrinks unambiguously during crises, it is not clear if this reduction is driven by a reduction in supply or in demand. A shift in demand is not as interesting to study as a shift in supply. A decline in demand for credit implies that there are no good investment opportunities for potential borrowers to invest on, thus the reduction in credit is not hindering economic growth. On the opposite, an inward shift in supply means that despite potential borrowers apply for bank loans, large part of them is rejected by the bank. The reduction in credit supplied by banks prevents borrowers from investing in good projects, and in turn affects negatively the real economy. Crucial to the evolution of credit supply are also central banks' policies. During the most recent financial crisis, the ECB pledged to massively inject liquidity in the economy, but it soon realised that the liquidity programs were not working as expected because banks were just storing the extra-liquidity in the central bank deposit facility. ECB then tweaked its policy to make liquidity available to banks only conditional on banks lending out money to the real economy thus recognising the importance of the lending channel of monetary policy for economic growth. [3]

The issue of discriminating between the reduction in credit supply and demand has been tackled in the empirical literature by several authors. Different methodologies have been proposed to identify loan supply movements. Leary (2009) uses a quasi-natural experiment setup that focus on two particular events in 1961 and in 1966 that he believes determined

[3] The targeted longer-term refinancing operations (TLTROs) are an example of this kind of facility enacted by ECB. TLTROs are targeted operations, as the amount that banks can borrow is linked to their loans to non-financial corporations and households.

some changes in bank funding constraints; Kashyap, Lamont, and Stein (1994), and more recently Becker and Ivashina (2014) have tackled this very interesting question using the demand for credit from individual firms and excluding altogether observations in which no credit was demanded.

Following the strategy first introduced by Kashyap et al. (1994) to overcome the identification issue, I will test the hypothesis of the existence of a loan-to-bond substitution channel for Eurozone firms by including in the sample only firm-quarters in which firms actually demand credit either in the form of loan or bond. This empirical strategy exploits observed changes in the composition of firms' source of funding over the business cycle to identify inward shifts in the supply of loans, and consequently an increase in bond financing.

To the best of my knowledge, no evidences have been presented on the existence of the loan to bond substitution channel and its functioning related to the credit cycle for Eurozone firms. This chapter extends the existing literature along two dimensions: by providing evidences on the substitution channel for Eurozone firms, and by investigating further in the issue to shed light on the degree of substitutability between loans and bonds.

The first contribution extends the previous evidences on the loan-to-bond substitution channel to Eurozone firms. The different structure of the financial system between U.S. and Europe as documented in Langfield and Pagano (2016), and the different pace of the development of other credit market such as the syndicated loan market, limit the generalisation of Becker and Ivashina (2014) outside U.S.. An analysis that specifically targets firms operating in the Euro area is required to draw conclusions on the effect of the substitution channel in Europe given the structural differences between the two financial systems.

Using data from Dealscan for syndicated loans, and from Thomson One banker for bonds I carry out the analysis on the existence and the direction of the loan-to-bond substitution channel using different macroeconomic measures of aggregate credit conditions. The lending variables of interest can be thought as proxies for the credit conditions in each macro-area analysed (i.e. US and Eurozone), and are collected for Eurozone firms either directly from the ECB statistical warehouse website or computed using accounting data from Compustat global. Data for U.S. firms are compiled from the Fed of st Louis website, Compustat North America, and the Call reports of big banks.

Previous empirical literature uses a simple indicator as dependent variable. The choice of the indicator presents two main problems. First, firm-quarters in which both loans and bonds are issued cannot be identified, and thus must be dropped from the sample. Second, the indicator variable cannot capture a partial substitution. My approach uses amounts to tackle the two problems above. The dependent variable in this analysis instead of being a simple indicator is a ratio of the total amount raised through loans in a given firm-quarter - expressed in US Dollars - to the total amount of funds borrowed in the quarter. This way to define the dependent variable allows retaining in the sample also firm-quarters in which both bank loans and bonds are included, and that would have been excluded if a dichotomous dependent variable were chosen. The variable will behave exactly as an indicator variable if in a given quarter a firm only issues bonds or only issues loans. However, when a firm raise funding from both bonds and bank loans in the same quarter, we would observe a number included between 0 and 1.

As second contribution to the literature, I introduce a regression specification that is capable of identifying the degree of substitution between loans and bonds for the firms in the sample. The higher the substitutability between bank loans and corporate bonds, the milder will be the adverse effect on the economy of a decline in funds loaned by banks. The well-functioning of this effect opposes to the cyclicality of the credit supply and help faster economic recovery.

Assuming the well-established result on the existence of the substitution channel, further investigation is required to clarify whether the total amount that was obtained in period of high credit supply is entirely substituted by bonds when credit condition deteriorates. To test this hypothesis I use the total amount of funds raised by firms in each quarter, and check whether this amount changes significantly with credit conditions. If firms are able to fully substitute their bank loans with bonds we should not observe any effect on the total amount of debt raised by firms. A signed coefficient (where the sign depends on the explanatory variable used in the regression specification) would be an indication that firms can only partially substitute bank debt with bonds, and therefore they can raise less funds thus possibly foregoing profitable investment opportunities.

At this point one might argue that the use of amounts might be suspicious because amounts are influenced by firms' investment opportunities, which during crises can be much reduced. Indeed, during crises, by using the amounts we could observe partial substitution just because the firms do not have enough investment opportunities to require additional debt. I address these concerns by further filtering the data. In particular, I apply two alternative filters that should leave in the sample only firms with stable demand for funds. The first filter restricts the sample to firms whose standard deviation of assets from the mean over the time series is small. This filter ensure that only firms with stable demand for funding to finance their assets are included in the sample. The second filter retain in the sample only firms in sectors less affected by the business cycle and more likely to have longer-term investment projects thus needing constant funding.

This chapter contributes to the literature by enhancing the understanding of the link between bank debt and market debt in the Eurozone. This implication is particularly important for small firms that usually rely heavily on bank loans, and are likely to be excluded from the credit market during crises. [4] Inefficiencies arise whenever those firms for which the switch between the two forms of financing is curtailed are firms with positive NPV projects. In other words when the firms are profitable is inefficient to scale them back, and eventually shut them down.

In this analysis I find that firms based in the Eurozone are able to substitute between loans and bonds as a response to changing credit conditions; yet the substitution is only partial, and firms will end up raising less funds than needed. Despite the bank-centric feature

[4] I must be careful in generalising given that borrower in the syndicated loan market are often large firms

of the European financial market that encourages firms to rely a lot on bank loans, we still observe substitution to bonds; although the direction of the substitution in some specification contrasts the findings in the literature. Firms in the Eurozone choose to substitute from loans to bonds especially in periods in which the banking sector is in distress or periods related to policies implemented by the central bank to enhance credit. Comparing the results with those obtained for U.S. firms (here provided as benchmark) requires an in-depth analysis on the role of the banking system versus the financial market in Europe and U.S.. The policy implications of having results different from those observed in the U.S. might be very relevant. The divergence in the results might indicate that policies enacted by the Fed in U.S. might not be the best fit for European system, and thus ECB should tackle similar problems differently. The expansive central bank monetary policies, that in principle should have affected positively also bank lending, did not work as expected along this transmission channel because of the tendency of banks to hoard the extra liquidity received from the ECB in order to be prepared to face sudden shortages in liquidity.

A possible solution to resolve the discrepancies would be to implement structural reforms of the financial system to close the gap in efficiency between the U.S. and the European capital markets with the final objective of harmonising regulation where possible.

The rest of the chapter is organized as follows: Section 2 is a review of the related literature, Section 3 describes the data and explain the empirical strategy of the analysis, Sections 4 presents the results of the empirical analysis both for the main specification and for the partial substitution analysis, Section 5 reports the robustness checks, and Section 6 concludes the chapter.

2. Literature Review

Empirical observation of the credit cycle shows that the demand and supply of credit are often misaligned. The cyclical nature of credit supply does not always match the credit demand that despite being cyclical it has been shown to vary less than the supply. According to the Austrian theory of the business cycle, it is believed that bank credit is a main determinant of the business cycle. The outcome from the theory is that when the credit supply is excessive, and the price of bank debt is too low, we observe an investment boom whereas tight credit and high prices determine economic recession. During a credit boom the risk of inefficiently financing bad projects rise sensibly. Only a finite number of good projects are available in the economy. Excessive supply leads the bank to fund also bad projects that turn out in a loss for the bank, and might kick start the descending phase of the cycle. The Austrian theory seems consistent with events occurring during the financial crisis in 2007. Before the crisis, interest rates were too low and banks were funding non-profitable projects. With the advent of the crisis, firms were demanding credit in excess with respect to the supply. For an equilibrium argument, the high demand transposed in an interest rates hike, and at the same time bank credit supply tightened considerably.

While it is clear that the level of credit supply is correlated with the business cycle, the extensive theoretical literature produced on the link between credit supply and business cycle has proved hard to test empirically over the years. Substantial body of empirical work that relates loans to macroeconomic conditions and the monetary policy has been produced in the early 90s' with influential works of Romer and Romer (1994) and Bernanke and Blinder (1992). Nevertheless, the idea that the lending channel and the money channel were two separate mechanisms for the transmission of monetary policy is even older, and dates back to Tobin and Brainard (1963). All of the papers mentioned examine how different indicators respond to a shift in monetary policy, and they consistently find that a contraction in the monetary policy leads to a fall in bank lending. However, these papers were lacking a clear identification strategy to conclude causation.

Kashyap et al. (1994) brought new empirical evidences using a novel identification strategy of the lending channel as a way to transmit monetary policy. Previous research focus on how bank assets and liabilities responded to policy impulse. The latter strategy clearly suffers from endogeneity problems. Indeed, a negative response in the assets and liabilities might be the result of a decline in firm's output that leads to a drop in demand for credit. Kashyap et al. (1994) methodology utilizes data on commercial papers and bank loans to untangle credit demand and credit supply. The objective of the paper is to identify the effect of a monetary contraction on the supply of bank credit. Kashyap et al. (1994) do so by observing that if a firm stop borrowing from banks following a reduced demand for credit -due to the lack of investment opportunities- one should expect that also the demand for other sources of financing, such as commercial papers, would decline or at least would not increase. If instead the tightening monetary policy affects negatively the supply of bank credit, and not the demand, we should observe an increase in commercial paper issuance as long as firms are able to substitute the two forms of financing relatively easily.

Leary (2009) focus on the relevance of credit supply and capital market frictions in determining the structure of liabilities for firms. Conversely to Modigliani and Miller (1958) he claims that the structure of firm's liabilities is not relevant. Leary (2009) uses the fact that the supply of funds is not infinitely elastic, and thus supply conditions matters in the structure of the liabilities of a firm. Leary (2009) focus on two changes in bank funding constraint that happened in 1961 and in 1966 to study the effect on firms' financial structure. The first event is the development of the market for certificates of deposit that emerged in 1961. Leary (2009) believes that this event is an indicator for loosening funding constraint. The second event is the credit crunch of 1966 in U.S. in which the tight funding constraints were a consequence of government policies that restrained credit. The finding of Leary (2009) provides support to the hypothesis that the credit supply and the segmentation of the market for corporate bonds significantly affects the firm's capital structure choice, and in turns affects firm's value. He observes that following an expansion in the availability of bank loans, bank dependent firms saw their leverage ratios increasing consistently more than the leverage ratio of firms with access to the public debt market. [5] Leary (2009) exploits this differential in

[5]Large firms are less likely to be affected as they are less sensitive to credit supply shrinkages Holmstrom

sensitivity to credit supply shocks to study the effect of supply frictions on capital structure. The paper is relevant in providing evidences on the relationship between firms' financing decisions and the costs segmenting the debt market (e.g. transaction costs and asymmetric information). Firms, by choosing their relatively cheaper source of financing in response to an imbalance between credit demand and credit supply can enhance their value, whereas the effects of debt market segmentation keep some firms - with certain specific characteristics - with few alternatives to bank loans thus depressing their value. Despite the interesting results, Leary (2009) presents a problem in the identification strategy. There is reason to believe that the two events used to carry out the analysis might be related to changes in credit supply, it is more difficult to believe that a coefficient associated to this event is free of endogeneity problems.

Peek and Rosengren (2000) using the quasi-natural experiment set-up provided by the Japanese banking crisis, focus on how a loan supply shocks might affect real economic activity in U.S.. They claim that the shock affecting Japanese banks at the time of the crisis could have had a direct impact on construction activities in U.S. real estate market due to the depth of penetration of Japanese banks in the U.S. credit market. They conclude that the shock to the loan supply as identified by the Japanese banking crisis ultimately had real effects on the economic activity in U.S.. According to Peek and Rosengren (2000), previous studies on credit cycle -even when able to isolate the effect of a shock to the supply of credit- were not able to identify the effect this shock has on real economy. Their finding, in contrast with previous literature, suggests that when the bank loan supply is low, firms have hard time in substituting bank debt and this eventually result in lower investments, which hinder real economic activity. [6]

Related to this body of literature is also Chava and Purnanandam (2011). Their findings suggest that adverse shocks to the credit supplied by banks, result in negative performances

and Tirole (1997)

[6] Literature on the relationship between credit cycles and real activity usually finds that firms have some flexibility over the possible source of financing

of bank's related borrowers. Indeed, firms that relied heavily on banks' capital, suffered larger losses -according to a set of indicators provided- when the supply of bank loans shrunk compared to those firms that had access to the public debt market. In line with Peek and Rosengren (2000) they find that firms were not able to extensively substitute their source of financing even when profitable (see results in Holmstrom and Tirole (1997)). Chava and Purnanandam (2011) empirical strategy uses the Russian crisis of 1998 as indicator for a shock in the U.S. supply of loans. In order to provide a more reliable identification of the loan supply shock, they compared banks that were affected by the shock because of their substantial exposure with Russia, and banks that were not. They find that banks affected by the crisis reduced consistently their lending and increased interest rates compared to non-affected banks.

Becker and Ivashina (2014) provides a more recent empirical paper on the credit cycle. Resorting to the methodology presented first in Kashyap et al. (1994) they try to quantify fluctuations in the bank loan supply by studying firms' substitution between loans and bonds. Using publicly traded bonds data instead of commercial papers as in Kashyap et al. (1994) they isolate the effect of a loan supply contraction by including in their dataset only firms with positive external funding demand (either bond or bank loan) and interpret a substitution from loan financing to bond financing as a contraction in bank-credit supply. In the paper, they provide evidences of substitution when lending standards and monetary policy are tight, when aggregate lending is low, and in case of poor bank performance.

Another piece of evidence relevant for the understanding of the thesis is provided in Langfield and Pagano (2016). In their paper they provide data about the disproportionately strong bank based financial structure in Europe that grew at a pace much faster than European countries own economies and of most of the other banking system, whereas the capital market did not developed accordingly. The data provided in their paper picture the European banking system as the world's largest one with a total asset value in 2013 equal to 334% of EU GDP in contrast with the Japanese banking system (196% of Japan's GDP) and the U.S. one (88% of US GDP). Their findings support the conclusions of the first part of this thesis dedicated to the debt structure. Untapped public debt market is leaving banks as the main liquidity providers for firms especially in period of downturns. When banks experience a shortage of funds, the underdevelopment of the corporate bond market exacerbate the effect of a crisis.

Beside the risk-sharing reason, many factors drive the firm's optimal choice between a bank based and a market based financial system. Banks are able to collect private information that enables them to discriminate better between insolvent firms - which should be shut down - and firms who are simply experiencing liquidity shortfalls and that should be financed anyways. This though comes at the cost of releasing soft information to the bank, thus granting an information advantage over other banks and reducing competitiveness. Langfield and Pagano (2016) propose solutions to rebalance the European financial system. While recognizing that recent reforms on supervision and bank resolution are a step toward a more efficient financial structure overall, they suggest that security markets across Europe should be integrated forming a capital market union with low transaction costs, greater standardisation, and greater liquidity of corporate bonds and asset backed securities markets.

While many authors tend to accept the hypothesis that both bank credit demand and supply is pro cyclical, theoretical literature often finds the opposite. Diamond (1991) develop a theory of individual and aggregate loan demand in which firms with average credit ratings in normal periods tend to rely more on bank credit. However, in periods of high interest rates also borrowers with the highest credit rating choose to borrow from banks. Diamond (1991) make the distinction between non-monitored funding identified as market debt and monitored funding which is identified as bank loan. The reason to identify the two forms of financing as market debt and bank debt respectively come from the fact that monitoring of private information is most efficiently delegated to a financial intermediary, while having many smaller investors as in the case of the corporate bonds market makes monitoring difficult. Diamond (1991) finding relates to the reputation cost of defaulting, which is much higher for highly rated firms. For this class of firms monitoring is unnecessary compared to firms with lower rating for which the reputation cost of defaulting is relatively low and monitoring is necessary to avoid defaults. According to this theory in periods of high interest rates also higher rated borrowers need monitoring; consequently a higher fraction of bank loans are issued with respect to periods with lower interest rate. Moreover, the need for monitoring of highly rated firms in periods of high interest rates makes the average quality of new loans higher.

In line with Diamond (1991), Rajan (1992) affirms that the cost of bank financing is not fixed or firm dependent but is the result of several factors. In his model, he argues that if there is a convenient lending contract, as it could be the financing obtained by the relationship lender, then the firm should borrow everything from this bank. However, we do observe that firms differentiate their source of funding even in such cases.

Rajan (1992) and Bolton and Freixas (2006) developed models of financial markets and corporate finance in which different sources of funding coexist in equilibrium. Rajan (1992) finds that a loan from the relationship lender would give to the bank bargaining power over firm's profit once the project has begun. Therefore, the firm optimal choice of funding attempt to circumscribe such power for the banks. Rajan (1992) paper supports the hypothesis of loan to bond substitution in the idea that changing credit conditions modify the relative costs between different forms of financing thus requiring a rebalancing of the firm's debt structure.

Chemmanur and Fulghieri (1994) also develop a model of choice between bank lending and publicly traded debt. The intuition of their model is that banks are interested in building up a reputation for making efficient renegotiation versus liquidation decisions and this provides them with larger incentive to invest resources in collecting private information from borrowers with respect to the sparse corporate bond investors. Chemmanur and Fulghieri (1994) proves that in equilibrium bank loans minimize inefficient liquidation, and will be preferred from firms with higher probability of financial distress; more profitable firms will prefer bond financing. Crisis periods tend to lower the profitability of firms thus making funding more expensive. Firms in a long-lasting relationship with one or more banks might find convenient to substitute some of their corporate bond financing with bank financing. The intuition is that banks, by collecting information about their relationship borrowers over time, are able to distinguish fundamentals of opaque firms better then external investors. Hence, these banks might help the relationship borrower in harsh times by lending more funds, and allowing for the possibility of an efficient renegotiation. Such renegotiation would be precluded or very difficult to obtain if the firm should deal with dispersed bondholders thus leading to an inefficient liquidation.

The results in this chapter raise a further research question. My hypothesis is that in countries experiencing a bank biased financial system the effect of individual lender's characteristics could be stronger than the substitution effect documented. I address the question in chapter III where lenders' data are interacted with the aggregate borrowing conditions in the regression equation.

3. Data and Methodology

A. Data

For the analysis in this chapter I collect firm level data from several databases. For the accounting data of European firms, I use Compustat global. Compustat's balance sheet data are available at quarterly frequency and they are used to control for firms' specific time varying characteristics in the regression specifications.

To construct the dependent variable I download data on loans and bonds from two different databases. From Reuters' Dealscan I obtain detailed firm level data on syndicated loans whereas data for bonds are downloaded from the Thomson One Banker.

The six macro level lending variables that I use as exogenous regressors to proxy overall credit conditions in the Euro area are the following: 1) Lending standards, 2) Lending growth, 3) Non-performing Loans, 4) Loan allowances, 5) Bank stock returns and 6) Monetary policy.

I collect data for constructing the lending standards, lending growth and monetary policy variable from the ECB statistical warehouse website. Non-performing loans and loan allowances are both expressed as fraction of total loans and are computed as averages of big banks accounting information. Lending standards is a time-series of data obtained from the ECB lending survey. The value of the variable of interest is the answer to the question that ECB pose to loan officers of Eurozone banks about whether in the previous quarter they think their bank credit standards towards firms have been tightened, remained the same or have been relaxed. The final figure is obtained as the difference between the percentage of loan officers who declare that lending standards are tighter, and those who declare that they are looser, in each quarter, compared to the previous one. Any number greater than zero means that credit standards in the quarter are tighter than credit standards in the previous quarter; negative numbers indicate an overall relaxation of the lending standards. The second variable is lending growth which is the growth rate of loans in the euro area to non-financial corporations as reported by MFIs to the ECB.[7] Non-performing loans is constructed as the average of the top 10 Euopean banks' non-performing loans over total loans. This is an accounting-based variable and reflects expected losses on loans granted from banks. In addition, loan allowances is accounting based and it is the average of the top 10 European banks allowances for loan losses over total loans. Data for non-performing loans and loan allowances are collected from Compustat. A higher value for the loan allowances variable means that overall the banking sector is provisioning for a higher amount of non-performing loans and therefore can indicate a period of stress for the banking sector. Stock returns is the average of stock returns of the 10 largest banks by volume of loans in the sample. Finally, the monetary policy variable is constructed as deviations of the interest rate from the rate implied by the Taylor rule calculated as in Taylor (1993). Since not all

[7]Data are available on the ECB statistical warehouse website

the variables needed to compute the Taylor rule are available for the Euro area I used the methodology presented in Maddaloni and Peydró (2011) of using the residual of a regression of GDP over inflation and interest rate to proxy the deviations from the Taylor rule. A high value of the monetary policy variable means that the actual rate is farther from the equilibrium rate implied by the Taylor rule and can be interpreted as the monetary policy being tight.

For the U.S. benchmark analysis, firms' accounting data are collected from Compustat North America while data for the macro lending variables are collected from the Fed of St. Louis website and from the Call Reports for big banks. For U.S. firms the sample spans the quarters from 1990:Q2 to 2015:Q2 and includes several crises and economic boom periods. For Eurozone firms the estimation window goes from 2002:Q1 to 2015:Q2. The reason for a shorter window is the necessity of collecting broader level macroeconomic data, which in most cases are available as aggregate data at the Eurozone level only since 2002. Nonetheless, the short window includes periods of growth as well as period of crisis with significant central bank's interventions, and thus provide the necessary variation to perform the analysis.

B. Methodology

As part of the strategy to identify the credit supply effect on the debt structure, I apply several filters to the sample. Excluding from the sample firm-quarters where neither bonds nor loans are granted to the firm ensures that observing less loans necessarily means more bonds are issued which in turn rules out the hypothesis that observing less loans is due to lack of credit demand rather than a shrinkage in supply. Therefore, firms that are not filtered out from the sample, and switch from one source of financing to the other, are choosing according to the relative cost of the two sources of funding. A second filter I applied drops observations with missing accounting data. The reason to apply this filter is that we need to include control variables in the regression specification to ensure the conditional exogeneity of the variable of interest. Of the remaining firm-quarters in the sample I also exclude short maturity loans as revolving lines and commercial papers, and to avoid misinterpretation of the outcomes, financial firms with primary sic code between 6000 and 7000 are also excluded from the analysis.

In the main specification, the dependent variable is constructed as a ratio of the amount of loans obtained by a firm in a given quarter over the total combined amount of loans and bonds raised by the firm in the quarter. The dependent variable defined in this way includes observations in which firms only issue loans, only issue bonds, and observation in which firms issue both loans and bonds. When the dependent variable equals zero then only bonds are issued, when it is equal to one the firm raises only bank loans, while any number between zero and one is indicating a mix of loan financing and bond financing in a given quarter. This design also captures partial substitutions when a portion of the amount previously raised with loans or bonds it is then raised with the other form of debt [8]. In each specification of the regression equation, the dependent variable is regressed on a specific lending variable in the set of macro-variables described above. Fixed effects at the firm level are also included to capture the effect of firm specific characteristics that do not change over time. The regression equation is the following:

$$LB_{it} = \alpha + \mu_i + \beta A_t + \delta X_{it} + \varepsilon_i$$

Where the dependent variable is labelled LB_{it} and is defined as described above. LB_{it} varies across firms and time. μ_i captures the firm fixed effects and is imposing a different intercept for each firm. Using fixed effects at firm level is central for the identification strategy of the analysis. Indeed the inclusion of fixed effects demean the model, thus the resulting demeaned dependent variable will always be zero in three occasions. First, a firm that over the years analysed in the sample only issue bonds, a firm that only raise funding through bank loans, and a firm that only appears in the sample once. Observations of

[8] Although the design is not able to capture the degree of partial substitution

the dependant variable for absolute non-switchers and firms that only appear once have no predictive power because of the use of firm fixed effect. The design of the empirical model implies that I can only observe the effectiveness of the channel if firms actually switch from one form of financing to the other consistently with changes in the independent variables. A_t represents the time varying lending variable chosen in each specification from the set of six possible explanatory lending variables capturing the effect of aggregate lending conditions. X_{it} is a set of firms' control variables that change across firms and time.

A possible weakness of the analysis is that time fixed effects cannot be included in the regression equation otherwise they would absorb the effect of the lending variable of interest that only changes over time. Therefore, especially for the monetary policy variable, the risk arise that the estimated coefficient could be capturing the effect of time that cannot be controlled for in this specification. The reason why the monetary policy variable should be particularly affected is related to the fact that changing in the monetary policy stance is mainly implemented as a response to a crisis. In order to provide more robustness to the coefficient estimated for the monetary policy variable and more generally to the effect of aggregate borrowing conditions on the firm's choice between loan and bond financing, I introduce an instrumental variable that should remove the possible endogeneity issue. The instrument is the lagged value of the 3 months euribor futures' prices, where the price of the future is quoted as 100 minus the 3-months euribor spot rate. Since there is no reason to believe that the lagged price of such futures could influence the amounts loaned today if not through the monetary policy variable and its determinants, I am confident that this is a suitable instrument for the analysis.

The filters applied ensure that only firms that have been able to borrow from the bond market relatively recently populate the sample. All of the firms that have not been issuing bonds in the last 5 years are excluded from the sample in the main specification, meaning that firms in the sample all have access to the corporate bonds market and will switch their financing source only according to their relative costs. In the robustness checks of section 5 the filter on past issuance of bonds is tweaked to check that the estimates obtained do not crucially depend on the choice of the filter. The coefficients in the robustness section are consistent with those obtained in the main specification.

In the section dedicated to the investigation on the degree of substitution, I study whether firms were able to fully substitute their source of funding or they were, at least partially, credit rationed. To capture the partial substitution effect the empirical design must be changed to include a different dependent variable. I choose the log of total amount raised in each quarter as dependent variable. Using LB as dependent variable can only tell us that there was substitution but not if the substitution has been partial or full. In this section I use the full sample of European and US firms and I include a dummy called Eurozone to identify firms in countries belonging to the Eurozone. The variable of interest is the interaction between Eurozone and the lending variable. The interaction variable tells us how much, firms in the Eurozone, are able to substitute between the two sources of funding compared to their U.S. counterpart. The empirical model would be transformed in the following way:

$$Log\,amount = \alpha + \mu_i + \beta_0 A_t + \beta_1 Eurozone_i + \beta_2 (A_{it} * Eurozone_i) + \delta X_{it} + \varepsilon_i$$

Where $Log\,amount$ is the dependent variable as described above, A_t is the lending variable that proxies aggregate credit conditions, $Eurozone_i$ is a dummy variable equal to 1 if the firm belongs to a country in the Eurozone and is 0 otherwise, and X_{it} is a set of control variables. $A_{it} * Eurozone_i$ is the variable of interest. I also provide alternative estimates by restricting the sample to a specific set of firms that are more likely to ask funds even during periods of market turmoil.

4. Empirical Analysis

In this chapter, I provide evidences on the existence and functioning of the substitution channel in Europe and on how it works compared to the US one. In particular, I determine that the direction of the substitution effect is not the one expected from empirical literature, and I give theoretical explanation on how these supposedly unexpected results have a logic explanation related to the fact that previous analyses only considered US firms while this analysis focus on Eurozone firms. Therefore, the different capital market conditions, and the relative predominance of the banking system over the market, might have generated a different reaction of firms to changing aggregate borrowing conditions as proxied by the six alternative lending variables considered.

A. Data Description

Table I contains descriptive statistics of Eurozone firms' variables. The sample of Eurozone firms in this chapter spans years from 2002 to 2015. The reason to use such a relatively short sample is the lack of data about the macroeconomic lending variables for each single country before the introduction of the ECB; hence each observation is included in the sample only if the firm belongs to a country which is already in the monetary union in that quarter.

The starting dataset is a panel of 9,154 non-financial corporations based in the euro area and repeatedly observed over the time window spanning from 2002 to 2015. The total number of firm-quarter observations is 54,428. Excluding from the sample all firm-quarter observations in which no form of credit is issued or the maturity is too short (e.g. bonds with maturity shorter than one year, revolving lines and other form of short term loans) I am left with 7,775 firms for a total of 28,196 firm-quarter observations. Of this subsample, 19,088 observations are bank loans with mean size €281 million and median equal to €87.4 million and 9,108 are corporate bonds issued. The mean size of bonds is €783 million and the median is €375 million. The number of loans is more than double that of the bonds;

Table I. Descriptive statistics

The table reports descriptive statistics for the sample of Eurozone firms. All the amounts are in millions of US Dollars unless differently specified in the table. The last two rows refer to the average amount of loans granted and bonds issued respectively.

	Bonds only		Loans only		Bonds and Loans	
Variable (in millions)	Mean	Median	Mean	Median	Mean	Median
Assets	55,172.84	46,716.45	25,204.73	2,387.75	48,048.19	21,509
Long term debt	8,480.394	6,537.5	7.694.199	409.85	11,025.08	4,724
Plant and Equipment	16,798.96	9,203.2	7,285.234	348.351	17,414	4,524
Leverage%	23%	18%	25%	24%	26%	24%
ROA%	3%	2.4%	3.1%	2.8%	2.9%	2.7%
Market to Book	2,047,475	1,224,674	900,101.3	1,613,030	2,024,219	1,511,495
Loans			€281	€87.4		
Bonds	€783	€375				

however, the size of each bonds' issuance is on average much higher than the size of a bank loan. I interpret it as the fact that usually bigger firms, who require larger amounts to finance their assets, are more likely to be able to raise funding in the public debt market at competitive prices compared to smaller firms. After merging the dataset with accounting data from Compustat, I am left with 2,406 firm-quarter observations of Eurozone firms; 1,360 of which are loans and 1,046 are bonds.

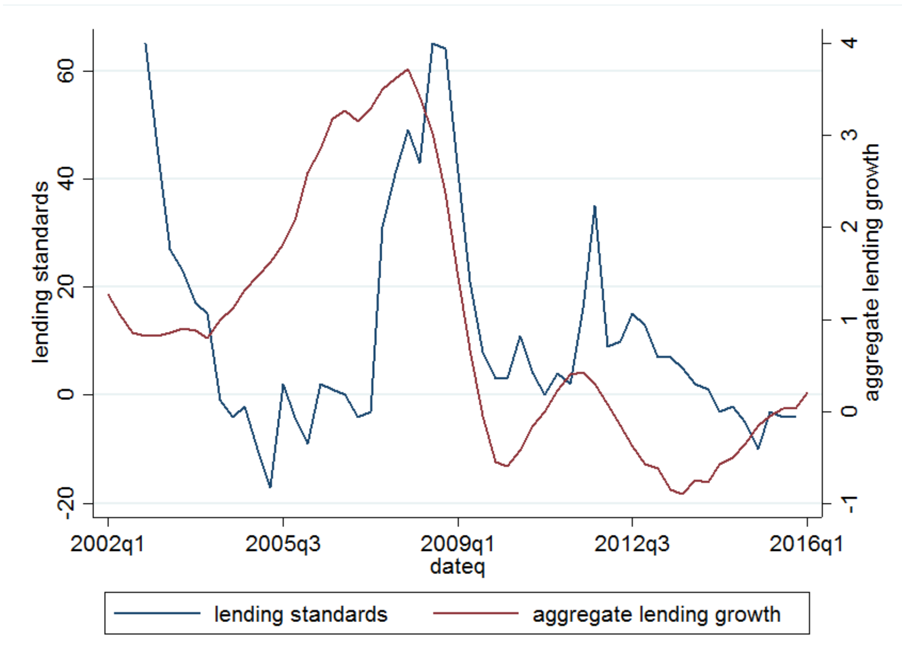
Table II. Lending Variables Correlation (Eurozone)

This table reports the covariance matrix of of the six lending variable relative to the Eurozone chosen for the analysis. The variables included are the most related to bank lending in the set of available variables. The star indicates that the correlation is significantly different from zero.

	Loan allowances	Lending growth	Lending standards	NPL's
Loan allowances	1			
Lending growth	-0.42	1		
Lending standards	-0.128	0.3274*	1	
NPL's	0.3624*	-0.7881*	-0.2244	1

In Table II the correlation matrix for the lending variables shows few unexpected signs. In principle, I expect the lending growth variable to be negatively correlated with all of the other lending variables. Lending growth is indeed negatively correlated to loan allowances and non-performing loans but it is positively and significantly correlated to the lending standards as it is shown in Figure 1. This might indicate that the lending standards variable represents the tightness of the screening that banks perform on new borrowers while they still grant credit to borrowers they already know.

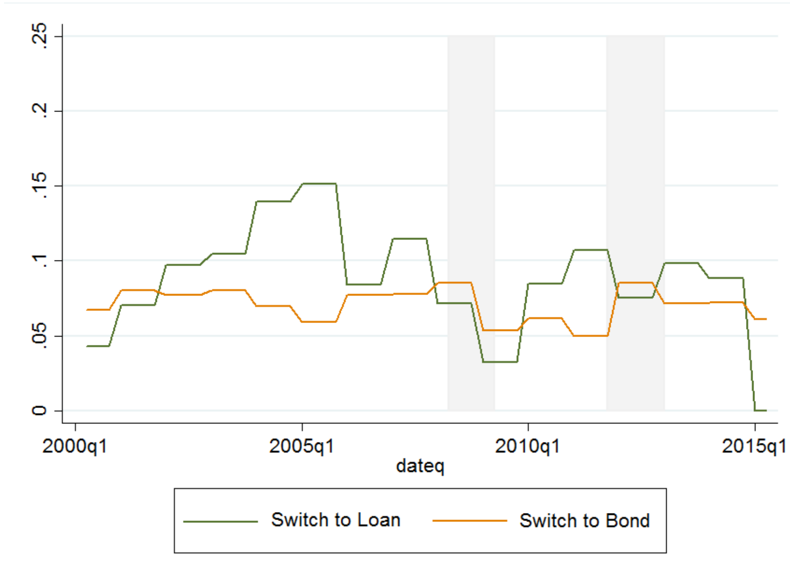
Figure 1. Lending standards - Lending growth



The figure shows the dynamic overtime of two of the six lending variable considered. Lending standards (blue line) is an integer representing the number of loan officers that consider the lending standards of their bank tighter compared to the previous quarter minus the number of those loan officers that considered them looser and it's value is reported on the left of the graph. Aggregate lending growth (red line) is reported on the right of the graph and is a percentage. The variable aggregate lending growth reports the growth in lending compared to the previous quarter.

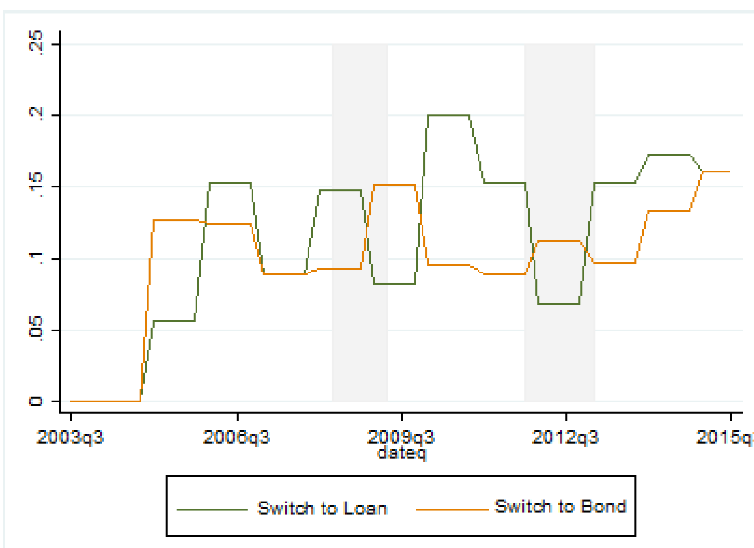
For the US sample, there is an average of around 5% of firms that will issue a new loan and no bonds the year after they issued a loan. The corporate bond market instead is more stable both in U.S. and in the Eurozone. Therefore, of firms issuing bonds in a given year, on average 38% will issue a bond also the following year. Switchers behave similarly in Eurozone and U.S.. In Figures 2 and 3 data for switchers (both from loan to bond and bond to loan) are plotted for each year. In both regions the majority of firms tend to switch to loan in normal times but do the opposite during crises.

Figure 2. Switchers in U.S.



This figure plot the percentage of switchers from bond to loan (green line) and from loan to bond (yellow line) among U.S. firms in each quarter

Figure 3. Switchers in Eurozone



This figure plot the percentage of switchers from bond to loan (green line) and from loan to bond (yellow line) among Eurozone firms in each quarter

Looking at descriptive data it is clear that firms tend to be non-switchers; meaning that the source of financing for each firm is mostly the same over the years spanned by the sample both for firms that usually get bank loans and for firms that issue bonds. In particular, among firms getting a loan in a specific year, on average 13% will obtain another loan in the following year the persistence is even stronger for regular bond issuer. Among firms that issue bonds in a given year, on average 29% of them will issue new bonds the following year. Among switchers, the predominant direction is the switch from bond to loan. Nevertheless, there are years in which the opposite switch from loan to bond prevails and it is interesting to notice that those years are characterised by economic policy's related events that broadly affected the Eurozone. The first year in which we observe consistent loan to bond substitution is the 2009. The year 2009 marks the beginning of the Eurozone crisis. In the early months of 2009, the average lending rate to non-financial corporations was close to the highest level ever reached since the creation of the Eurozone and -though at a lower rate- credit standards were still tightening. This combination of factors reduced the cost of issuing bonds for many firms with access to the public debt market relative to the cost of bank loans. Over the year 2009, the average lending rate decreased considerably possibly rebalancing the relative costs of loans and bonds. The second year to consider is the 2012. In year 2012, the lending rates were stable but the credit standards were again tightening at faster pace. Tightening credit standards coupled with the intervention of the ECB, which introduced the Outright Monetary Transaction Programme (OMT), and with the tendency of banks to hoard liquidity instead of lending out funds, determined another wave of switching from loan to bonds that we observe in the data. [9] [10] Finally we observe 2015 to be a year with a consistent number of firms switching from loans to bonds (despite for 2015 this number is not too far higher than the number of firms switching from bond to loan). In 2015 despite the slowly decreasing average lending rates and the looser credit standards compared to the previous year, more firms choose bonds over loans when the previous year they chose

[9] See Acharya, Gale, and Yorulmazer (2011) for references on liquidities holdups

[10] Interventions by the Eurosystem in public and private debt securities markets in the Euro area to ensure depth and liquidity in those market segments that are dysfunctional.

bank loans as source of funding. This is likely to be due by the ECB finally introducing the expanded asset purchase programme (commonly known as quantitative easing). The QE works through several transmission channel and allows the ECB to purchase a large quantity of assets held by non-bank financial institution, in this way the ECB encourages them to rebalance their portfolios into riskier assets, such as corporate bonds or stocks. This in turn will make public debt more available and cheaper to firms.

In Table III I report the correlation matrix of the lending variables in US. Also for US we observe that lending growth is negatively correlated with loan allowances and non-performing loans; however it is interesting to see that lending standards is not significatively correlated to lending growth. From the analysis of Table III I can hypothesise that lending standards are not an important proxy for the credit supply and therefore would not be able to highlight the substitution effect in the US.

Table III. Lending Variables Correlation (U.S.)

This table reports the covariance matrix of of the six lending variable relative to U.S. firms chosen for the analysis. The variables included are the most related to bank lending in the set of available variables. The star indicates that the correlation is significantly different from zero.

	Lenidng growth	Lending standards	NPL's	Loan allowances
Loan allowances	1			
Lending growth	-0.5201*	1		
Lending standards	-0.0467	0.0212	1	
NPL's	0.8446*	-0.5751*	0.0282	1

B. U.S Extension

Table IV presents a simple extension to Becker and Ivashina (2014) where I introduce the amounts in the dependent variable. More precisely the dependent variable is the ratio of the amount of bank loans received for a given firm-quarter - expressed in US Dollars - over the total amount of bonds issued and loans received in the same firm-quarter. The use of amounts allows the inclusion in the sample of firms that receive both bank finance and market finance in the same quarter and that were excluded in the original specification for identification problems. The model is estimated by ordinary least squares (OLS), errors are clustered at quarterly level, and firm-level fixed effects are included. It is immediate to notice that the number of observations drops from around 11,000 to 7,300 when amounts are introduced. Panel A of Table IV presents the coefficients obtained by replicating Becker and Ivashina (2014) regression specification but extending the sample to the first quarter of 2015. The estimation in the extended sample gives coefficients consistent with theoretical and empirical literature and thus seem to be robust to different time period specification.

All of the lending variables confirm the strong pro-cyclical effect in the debt financing mix for the firms in the sample. In column (1) the macro-lending variable "lending standards" is the average of the banks' loan officers' opinion on credit standards reported to the FED. The coefficient should negatively correlate to the availability of bank debt. The coefficient is indeed negative and significant but the magnitude is much smaller than the one reported in Panel A of Table IV where the indicator is used as dependent variable. The point estimate implies that the loan to total amount ratio decreases by only 0.016 percentage points for a one standard deviation increase in the lending standards. The coefficient in column (1) is indicating that when lending standards tighten firms switch to bond financing. Nonetheless, despite the coefficient is positive, it is significant only at 10% level, and the effect on the dependent variable for a one standard deviation increase is not large in magnitude. The effect is even lower than the one implied by the coefficient in Panel A. The magnitude and the significance of the coefficient is not surprising as it was evident also in the previous empirical literature that the changing credit standards is not a powerful predictor of the firm willingness to switch from bank loan to bond and vice-versa. The rest of the estimation is in line with results in the literature with firm-level fixed effects explaining large part of the variation thus validating the hypothesis of the importance of compositional effects in the financing decision. The estimated coefficients in column (1) might suggest that these effects are even larger than those implied by previous results. The coefficient of the lending variable is not very significant and is small in magnitude while the coefficient for the log-asset is relatively big and it is strongly significant. The results shows that probably being in a certain class of firms with some specific characteristics (e.g. high level of log-assets) is more relevant than the current level of credit standards for receiving additional bank credit with respect to periods in which bank's credit standards are looser. This is also consistent with Kashyap and Stein (2000), which finds that weaker firms suffer more than others when banks restraint credit supply.

In the specification in column (2) the explanatory variable of interest is "lending growth" that is predicted to be positively correlated with the availability of bank financing. The coefficient is indeed positive and strongly significant. The effect of lending growth is larger in magnitude than the one reported in Panel A. In column (3) the explanatory variable of interest is the ratio of non–performing loans to total loans for banks. This measure is more objective than the previous two as it is obtained from accounting data and not from opinions surveyed by the FED as it was in the previous two estimation exercises. The regression coefficient in column (3) predicts a positive and significant effect for the lending variable of interest (non-performing loans). This column predicts a drop in bank loans of five percentage points for a one standard deviation increase in the aggregate level of non-performing loans. The coefficient estimated is consistent with the negative relationship between non-performing loans and bank lending reported in the theory. In column (4) loan allowances over total loans is the main explanatory variable. "Loan allowances" is again an accounting-based variable and reflects expected losses on loans granted from banks. The coefficient for the regression of loan allowances on bank lending is negative and is strongly significant. The explanation is that an increase in banks' loan allowances indicates that banks expect a larger fraction of loans to be delinquent and implies a drop in bank-supplied credit. The effect of the loan allowances on the dependent variable is also very strong in magnitude and it predicts a reduction in loans granted by the bank when the loan allowances increase.

In column (5), the coefficient is positive and significant. Estimation in column (5) uses the returns of a bank-stock index that is a measure of banks' performances as macro variable of interest. The returns on the bank stock index correlates negatively to the loan to total amount ratio meaning that a one standard deviation increase in the banks' performance, as measured by the index, will increase the amount of finance raised from the bank relatively to the total combined amount of debt raised from banks and market by 3.1 percentage points. In the last column, the macro-lending variable is called monetary policy and is a measure of the deviations of the policy rate from the Taylor rule. The coefficient is confirmed to be negative and significant meaning that a restrictive monetary policy stance reduces bank debt availability for firms. Someone may argue about whether the deviations from the Taylor rule is still a good measure of the monetary policy stance in recent years as the introduction of unconventional monetary policy complemented the policy rate tool with other powerful instruments adopted by central banks such as forward guidance and quantitative easing. Nonetheless, the results for U.S. firms prove to be robust when the sample is split to separate the years before the introduction of non-conventional monetary policies from years following the implementation of the first LSAP programme by the FED.

The firm-specific control variables show that bigger firms (in terms of log-asset) are more likely to receive bank financing than smaller firms. This might seem in contrast with the findings in the literature that bank loans are more important for weaker firms; however, there are many reasons to believe that larger firms are more likely to receive credit from banks than weaker firms. This could be due to the higher share of collateral that bigger firms can pledge or from the fact that the syndicated loans market is more accessible to big firms or some other reasons. On the other hand, better performing firms identified as firms with positive stock returns or firms paying dividends, are more likely to issue bonds in all the specification considered in Table IV.

Table IV. U.S. Benchmark

Each observation corresponds to firm-quarters in which new debt is issued (either loans or bonds). The key coefficient of interest are the coefficients of the lending variables representing aggregate credit conditions. In Panel A Benchmark results of a regression of the dependent variable $Loan_{it}$ on the lending variable and the firms' characteristics are reported. $Loan_{it}$ is defined as an indicator variable which equals 1 if a loan has been issued by a firm in a given quarter and is zero if a bond was issued in a given quarter. In Panel B the main results for the U.S. subsample are reported. The dependent variable is LB_{it} which is the ratio of the amount of loans raised by a firm in a given quarter divided the total amount raised by the firm in that quarter.LB_{it} equals 0 if a firm issue loans only, equals 1 if the firm issues bonds and is a number between 0 and 1 if a firm issued both forms of finance in a given quarter. All the regression equations are estimated with OLS for the period 1990:Q2 - 2015:Q2 and include firm-fixed effects.

Panel A: Benchmark results

	Dependent Variable: $Loan_{it}$					
	(1)	(2)	(3)	(4)	(5)	(6)
Lending variables	Lending standards	Lending growth	NPL's	Loan allowances	bank stock index	Monetary policy
Benchmark	-0.00106***	0.317***	-1.857***	-6.211***	0.0817***	-2.027***
Constant	Y	Y	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y	Y	Y
Observations	10,670	10,698	9,905	9,905	10,544	10,698

Panel B: U.S. Main specification

	Dependent Variable: LB_{it}					
	(1)	(2)	(3)	(4)	(5)	(6)
Lending variables:						
Lending standards	0.000687*					
	(0.000352)					
Lending growth		0.401***				
		(0.0818)				
NPL's			-2.459***			
			(0.384)			
Loan allowances				-8.037***		
				(1.033)		
Bank stock index					0.108***	
					(0.0281)	
Monetary policy						-2.114***
						(0.483)
Firm's characteristics:						
Lag log assets	0.0728***	0.0686***	0.0834***	0.0634**	0.0800***	0.0580**
	(0.0270)	(0.0257)	(0.0272)	(0.0277)	(0.0267)	(0.0267)
Lag log ppe	-0.0582**	-0.0570**	-0.0614**	-0.0552**	-0.0571**	-0.0516*
	(0.0266)	(0.0259)	(0.0274)	(0.0277)	(0.0270)	(0.0265)
ROA	-0.152	-0.205	-0.330	-0.296	-0.234	-0.203
	(0.291)	(0.286)	(0.300)	(0.297)	(0.295)	(0.283)
Market to book assets	-0.00282	-0.0121	-0.0155	-0.0193	-0.00661	-0.00377
	(0.0127)	(0.0118)	(0.0124)	(0.0124)	(0.0127)	(0.0126)
Lag return	-0.0348**	-0.0246*	-0.0219	-0.0240	-0.0273*	-0.0348**
	(0.0141)	(0.0146)	(0.0145)	(0.0145)	(0.0145)	(0.0137)
Lag leverage	0.0353	0.0471	0.0724	0.0740	0.0604	0.0375
	(0.0664)	(0.0661)	(0.0657)	(0.0658)	(0.0639)	(0.0659)
Dividend	-0.0970***	-0.0982***	-0.0893***	-0.0846***	-0.0777***	-0.0891***
	(0.0264)	(0.0265)	(0.0281)	(0.0278)	(0.0273)	(0.0260)
Constant	0.128	0.158*	0.144	0.365***	-0.161	0.181*
	(0.103)	(0.0937)	(0.0937)	(0.0955)	(0.109)	(0.0984)
Firm FE	Y	Y	Y	Y	Y	Y
Observations	7,297	7,318	6,900	6,900	7,230	7,318
R-squared	0.477	0.480	0.485	0.488	0.479	0.480

Robust standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

C. *Eurozone firms*

In this section I present the results for the sample of Euro area firms. The firms included in the regression analysis in Table V are from Eurozone countries only. Indeed, including more European countries outside Eurozone in the sample would have come at the cost of not having consistent measures for the lending variables. This specification allows to use data that are mostly collected from the ECB statistical warehouse. Otherwise, we should have used synthetic measures to build the lending variable. The dependent variable is once again the loan-to-total-amount ratio. The coefficient of the lending variable in column (1) of Table V already brings to our attention the different response to changes in credit standards for (the average) Eurozone firms as opposed to the US case. The point estimate for the "lending standards" variable has positive sign and it is significant, meaning that when lending standards are strict we observe a positive change in the dependent variable compared to periods in which the standards are looser. It is important to notice that the estimated coefficient has a sign opposite to the one found in the previous subsection. Tighter credit standards command a switch from loan financing to bond financing for U.S. firms. Conversely, for Eurozone firms, when the lending standards tighten by one standard deviation the dependent variable increases by 0.1 percentage points. The result that might seem counterintuitive in the first place brings up other considerations about the sample composition and the role of financial market versus the private banks' credit market in Europe.

The first consideration concerns the sample selection. One may think that the result is driven by the fact that having only syndicated loans in the sample implies that only certain firms with similar characteristics are represented and those firms are likely to be more collateralized than those not obtaining syndicated loans. Banks -especially in period of crisis- might want to reallocate the amount previously lent to smaller firms (not included in the sample) to other firms that were already obtaining bank loans thus not increasing their costs, and consequently driving the estimate upward (flight to quality). This behaviour from banks would push the coefficient in a direction opposite to the one observed in the US case just because of sample selection. This clearly does not mean that the total amount of debt increased but simply that the fraction of bank loans in the total new debt is now higher. The above explanation should not be the reason of the unexpected sign on the coefficient for lending standards. Comparing averages of firms' characteristics in the Eurozone and the US sample I find the differences not statistically significant; hence it is unlikely that this effect is driving the result, otherwise it should have done so also for US firms.

A second consideration concerns the role of the public debt market. This market in Europe can be considered underdeveloped when compared to the US counterpart. The financial system in Europe is more bank-centric. In the U.S. system firms could switch from banks to the efficient capital market relatively easily, whereas in Europe firms usually rely on relationship lenders as one of the main source of financing (see Bolton, Freixas, Gambacorta, and Mistrulli (2016)). Relationship lending helps to compensate the inefficiencies of European capital markets that exclude from public funding firms that should be able to raise funds, and force firms to turn to bank loans in order to finance their assets. In periods of tighter credit standards some firms might be perceived as too risky by the few investors present in the European bond market which will demand too high yields. The choice to start a relationship lending over pursuing a transaction based lending make the relative cost of relationship lender funds cheaper than the cost of bonds thus mandating a higher percentage of bank debt in the total stock of funding raised in period of financial distress. Bolton et al. (2016) suggests that the relationship lender should charge higher rates in boom period because of higher monitoring costs. However when the crisis hits relationship lender can lend at more favourable rates to known profitable firms compared to transaction lenders. The positive coefficient that I find hints at the presence of relationship lending. Relationship lender can offer lower prices than the capital market to firms that relinquish soft information over the years. The observed positive coefficient for the lending variable in column (1) means that during crises (or period of tight credit in general) firms that find the cost of issuing public debt too high will turn to banks (probably to the relationship lender) to substitute the amounts they cannot raise any more with bonds. If the theory holds true, the bank should be able to extract higher rent from the firm, and this is likely to be reflected in the pricing of future loans. The hypothesis of relationship lending shall be studied in chapter 3.

The signs of the coefficients in columns (2), (3), (4) follow those in the previous section. This is because the macro lending variables used in these specifications are related to the overall banking sector health status which clearly does not depend on specific features of the Eurozone credit market or the strength of relationship lending. In column (2) the coefficient for lending growth is positive as expected. As the aggregate lending measure for small, medium, and large firms grows, also the amount of loans grows more than the amount of bonds issued. In the Eurozone for a one standard deviation drop in aggregate lending, the amount lent by banks with respect to the total funds raised drops by 2.9 percentage points. It is worth to notice that the lending variable collected from the ECB includes small and medium firms as well as big firms, while the sample available for this research is composed mainly of big firms with access to the syndicated loan market. Therefore, the lending variable measures the effect of aggregate credit conditions on the availability of bank credit to the firms in the sample, and it is not just a direct link between credit granted and credit obtained by big firms. In column (3), the loan allowances lending variable is positively correlated with the dependent variable meaning that an increase in loan allowances lead to an increase in the amounts of bond issued with respect to bank loan supply. Column (4) -also keeping with the expectations- predicts a positive coefficient for the non-performing loans variable. When the non-performing loans in the European banking system go up, banks are less likely to lend, and firms tend to switch to bond financing. When non-performing loans increase by one standard deviation the loans to total amount variable decreases by 5.2 percentage points. In column (5) the lending variable is the average returns of the 10 largest bank in the sample in terms of loans. The sign of the coefficient is positive meaning that the better the banks performs the more they are willing to lend. Nonetheless, it seems that the coefficient is not significant indicating that probably this variable does not really affect the supply of credit of the banks, and in turn the probability of switching to bond financing. Banks' returns are probably driven by external factors more than fundamentals. In column (6) the lending variable is the monetary policy stance. While for the U.S. analysis the data available from the FED allow to build a variable representing the deviations from the Taylor rule, there is no available data of potential GDP for the Eurozone. To overcome the issue I adopt the methodology presented in Maddaloni and Peydró (2011) of using the residuals of a regression of GDP over inflation and interest rate to proxy deviations from the Taylor rule.

The estimation in column (6) returns a positive and significant coefficient. This is signalling that when the monetary policy stance is loose firms will be likely to switch from bank financing to bond financing. When the monetary policy tightens by one standard deviation, the amount of loans over the total amount raised by the firms goes up by 1 percentage point.

With the advent of the financial crisis the expansive monetary policy - consisting in the injection of extra-liquidity in the financial system - undertaken by the ECB, played a role in keeping bond yields to low levels for more transparent firms or for those with good fundamentals. For the above-mentioned firms the policy reduced the cost of issuing bonds relative to bank borrowing, thus leading these firms to exchange some of the bank financing with extra bond financing. The evidence of this effect might be seen as evidence of the effectiveness of the monetary policies operated by the ECB, and the usefulness of the loan to bond substitution channel in transmitting countercyclical policies to fight crises

Table V. Main Specification Eurozone

This table reports results for the subsample of Eurozone's firms. The empirical specification is the same as in Panel B of Table IV. The key coefficient of interest are the coefficients of the lending variables representing aggregate credit conditions and the dependent variable is LB_{it} which is the ratio of the amount of loans raised by a firm in a given quarter divided the total amount raised by the firm in that quarter.LB_{it} equals 0 if a firm issue loans only, equals 1 if the firm issues bonds and is a number between 0 and 1 if a firm issued both forms of finance in a given quarter. All the regression equations are estimated with OLS for the period 2002:Q1 - 2015:Q2 and include firm-fixed effects.

	Dependent Variable: LB_{it}					
	(1)	(2)	(3)	(4)	(5)	(6)
Lending variables:						
Lending standards	0.00498***					
	(0.000797)					
Lending growth		0.0508***				
		(0.0145)				
NPL's			-0.0880**			
			(0.0408)			
Loan allowances				-0.224***		
				(0.0725)		
Bank stock index					0.087	
					(0.079)	
Monetary policy						0.0619***
						(0.0145)
Firm's characteristics						
Lag log assets	0.133	0.281**	0.265**	0.257**	0.128	0.256**
	(0.105)	(0.107)	(0.121)	(0.119)	(0.106)	(0.108)
Lag log ppe	-0.0176	-0.0271	-0.0244	-0.0296	-0.00279	-0.0227
	(0.0434)	(0.0443)	(0.0436)	(0.0441)	(0.044)	(0.0434)
ROA	0.224	0.766	0.781	0.725	0.587	0.595
	(1.116)	(1.119)	(1.093)	(1.098)	(1.061)	(1.139)
Market to book assets	7.46E-08	5.85E-08	8.05E-08	6.79E-08	8.15E-08	5.22E-08
	(6.31E-08)	(7.07E-08)	(6.85E-08)	(6.76E-08)	(6.61E-08)	(6.94E-08)
Lag return	-0.00835	-0.0406*	-0.0382	-0.0272	-0.0289	-0.0368
	(0.0232)	(0.0226)	(0.023)	(0.021)	(0.0225)	(0.0228)
Lag leverage	-0.0237	0.0252	0.0121	0.0466	-0.037	-0.084
	(0.384)	(0.315)	(0.322)	(0.312)	(0.316)	(0.317)
Dividend	-0.00815	-0.0246	-0.0142	-0.0464	-0.00104	-0.0252
	(0.0304)	(0.0351)	(0.035)	(0.0341)	(0.0366)	(0.0353)
Constant	-0.996	-2.380**	-2.590**	-2.961**	-1.038	-2.059**
	(1.002)	(0.984)	(1.2)	(1.246)	(0.974)	(0.99)
Firm fixed effects	Y	Y	Y	Y	Y	Y
Observations	704	711	711	711	711	683
R-squared	0.469	0.455	0.447	0.454	0.441	0.462

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

D. Instrumental Variable

As mentioned in the previous subsection, the unexpected coefficient in the regression specification including monetary policy as main explanatory variable may lead someone to argue that there is endogeneity in the model and that this endogeneity is possibly generated by a third variable omitted from the empirical model. I argue that the coefficient is pointing in the right direction, and the sign is consistent with the objective of expansive central bank monetary policies. In order to provide support to the hypothesis, in this section I introduce an instrumental variable that addresses possible endogeneity problems related to the use of the deviations from the Taylor rule as explanatory variable. The candidate instrument is the lagged price of the 3 months euribor futures. The panel format of the data allows to use the lagged value of the instrument as a second candidate instrument, the overidentified model can then be tested using the Hansen-J overidentification test under the null of having at least one of the instrument not correlated with the residuals of the main regression. Clearly, the exclusion restriction should be evaluated also from a theoretical point of view. I believe that it is fair to assume that the lagged price of the 3 months euribor futures does not affect the supply of credit today if not through the interest rate today. I use the two candidate variables to instrument the monetary policy variable in an overidentified instrumental variable regression analysis. The model is estimated with both two stage least squares estimator (2SLS) and two step efficient GMM (GMM).

The results of the instrumental variable estimations using 2SLS and GMM are reported in Panel B of Table VI. To provide additional robustness to the instrumental variable estimation in columns (3) and (4) the same regressions as in columns (1) and (2) are performed using different lags of the original instrument. To check whether the instrument is appropriate, in Panel A I report the summary results from the first stage regressions and for the Hansen-J overidentification test. According to the F-statistic of the first stage the instruments chosen are relevant in explaining the instrumented monetary policy variable for all the specification presented. The Hansen-J test of overidentification results in a p-value of 0.3377 for the first set of instruments and 0.4180 for the second set of instruments. Both statistics are far from the critical values thus I do not reject the null hypothesis of the test. The outcome of the overidentification test supports the instrument validity hypothesis. The coefficient for the monetary policy variable in Panel B is again positive and significant at 1% level in both columns, and the magnitudes are very close to each other indicating the robustness of the result. From the point estimate in column (1) and column(2) a one standard deviation decrease in the monetary policy variable results in a 1 percentage point decrease in the loan to total amount variable. The result is replicating the one obtained in the previous section for the monetary policy variable indicating that an expansive monetary policy allowed some firms to switch from bank financing to bond financing. In columns (3) and (4) I use two additional lags to the price of euribor futures to rule out the possibility that also the results in Table VI are driven by time related factors that affect the amount of loans directly. The point estimates in columns (3) and (4) indicates that the substitution from bonds to loans when the level of the monetary policy variable is high, could be more pronounced than expected. According to the coefficients in columns (3) and (4) a one standard deviation increase in the monetary policy variable results approximately in a 1.2 percentage point increase in loans

Table VI. Instrumental Variable

This table reports results for the instrumental variable (IV) regression. The instruments are the price of euribor futures contracts taken at different lags and the potentially endogenous regressor is the monetary policy variable. The dependent variable is LB_{it} which is the ratio of the amount of loans raised by a firm in a given quarter divided by the total amount raised by the firm in that quarter.LB_{it} equals 0 if a firm issue loans only, equals 1 if the firm issues bonds and is a number between 0 and 1 if a firm issued both forms of finance in a given quarter. In both panels columns (1) and (2) refer to the specification in which the excluded instruments are the first and the second lag of the price of euribor future whilst in columns (3) and (4) the excluded instruments are the third and fourth lag of the price of euribor futures. In Panel A test statistics of the first stage regression and the Hansen-J test are reported for all the specification. Panel B presents results of the IV regressions using both 2SLS and GMM methodologies.

Panel A: Summary results for first-stage regressions

Specification:	(1) - (2)		(3) - (4)	
Weak identification test (H0: Instrument is weak):	F(2, 522)	P-val	F(2, 513)	P-val
Monetary policy	4023.33	0.000	271.87	0.000
Hansen J statistic (H0: Overidentification restrictions are valid):	Chi-sq(1)	P-val	Chi-sq(1)	P-val
	0.919	0.3377	0.656	0.4180

Panel B: Instrumental variable regression

	Dependent Variable: LB_{it}			
	(1)	(2)	(3)	(4)
Lending variable:				
Monetary policy	0.0621***	0.0621***	0.0792***	0.0783***
	(0.0158)	(0.0158)	(0.0183)	(0.0183)
Firm's characteristics				
Lag log assets	0.257**	0.252**	0.280**	0.272**
	(0.105)	(0.105)	(0.110)	(0.110)
Lag log ppe	-0.0208	-0.0198	-0.0247	-0.0259
	(0.0411)	(0.0411)	(0.0419)	(0.0418)
ROA	0.823	0.927	0.873	0.795
	(1.182)	(1.177)	(1.189)	(1.186)
Market to book assets	4.81e-08	4.07e-08	4.14e-08	4.23e-08
	(6.93e-08)	(6.88e-08)	(7.04e-08)	(7.04e-08)
Lag returns	-0.0374*	-0.0350*	-0.0365*	-0.0382*
	(0.0208)	(0.0207)	(0.0212)	(0.0211)
Lag leverage	0.0741	0.0672	0.111	0.124
	(0.422)	(0.422)	(0.426)	(0.426)
Dividend	-0.0235	-0.0223	-0.0271	-0.0294
	(0.0335)	(0.0335)	(0.0340)	(0.0339)
Estimation method	2SLS	GMM	2SLS	GMM
Firm FE	Y	Y	Y	Y
Observations	631	631	620	620
R-squared	0.045	0.045	0.041	0.041

Robust standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

E. Partial substitution

In this section I investigate the degree of substitution between loans and bonds both in US and Europe. In previous sections I document the presence of the substitution channel in both U.S. and Eurozone credit markets. Nonetheless the specification used does not allow to say anything on the degree of substitution. Indeed firms might have been able to substitute their bank loans with bond financing but not in full, meaning that the total amount of debt raised is lower due to an overall liquidity shortage in the credit market which restricts the supply.

In Table VII and Table VIII I check for the degree of substitutability between loans and bonds by regressing the logarithm of the total amount raised in a firm-quarter against a lending variable, some control variables, and an interaction of the lending variable with the eurozone dummy to discriminate whether the outcome of the partial substitution analysis differs for firms based in the U.S. and those in the Eurozone. All the regression equations are estimated using OLS with errors clustered at quarterly level. Firm's level fixed effects and time fixed effects are also included in all the specifications.

Table VII presents results for the partial substitution analysis relative to the popoulation of firms retained in the sample after applying baseline filters. In order to provide a more robust analysis of the partial substitution effect in Panels A and Panel B of Table VIII I filter the sample to include only firms which supposedly have more stable demand for funding as they are less affected by the business cycle, and have longer investment project horizons.

In Panel A I filter out from the sample firms whose average deviation from the median amount of assets is above the average deviation for the median firm. In this way I should be able to keep in the sample only firms that do not scale down their assets' size when credit conditions deteriorates, and therefore have a constant demand of credit to finance their assets. With the same logic in Panel B I filter the sample by industry according to firms' SIC code. In this specification I include only firms with SIC code between 4000 and 4999 which includes firms in the telecommunications, utilities and health industry. In every panel, each column refers to one of the six lending variables I described in the Data section.

Table VII. Partial Substitution 1/2

This table reports results of the partial substitution analysis performed using the baseline sample of firms . The key coefficients of interest are those associated to the interaction variable. In each column the interaction is the product of the aggregate lending variable considered with the eurozone dummy. The dependent variable *Log amount* is the logarithm of the total amount of credit raised by a firm in a given quarter expressed in US Dollars. All the regression equations are estimated with OLS for the whole sample period and include both firm-fixed effects and quarterly calendar effects.

	Dependent Variable: *Log amount*					
	(1)	(2)	(3)	(4)	(5)	(6)
Lending variables:						
(EZ*Lending Variable)	-0.00112	0.0843*	-24.93*	-17.65**	0.472	0.0207
	(0.00511)	(0.0502)	(12.69)	(8.064)	(0.663)	(0.0853)
Lending standards	-0.00577*					
	(0.00295)					
Lending growth		-0.00433				
		(0.00921)				
NPL's			3.093			
			(3.742)			
Loan allowances				8.731		
				(8.309)		
Returns					-0.726***	
					(0.247)	
Monetary policy						0.0820*
						(0.0426)
Control Variables	Y	Y	Y	Y	Y	Y
Observations	8,416	8,444	7,806	7,803	8,004	8,422
R-squared	0.680	0.676	0.674	0.675	0.679	0.676

Robust standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

The coefficients of interest in Table VII are those associated to the interaction variable, and they are overall pointing in the direction of partial substitution with few exceptions. The figures in columns (2), (3), and (4) document weak evidence of partial substitution in Europe as is shown by the coefficient of the interaction variable. In column (2) the coefficient of the interaction variable between lending growth and the eurozone dummy is positive and significant at 10% level indicating that when lending growth declines, also the total amount raised from firms in Eurozone declines compared to the amounts raised from firms based outside the Eurozone. Looking at column (2) in the next two panels of

Table VII, the coefficient of the interaction variable rise in magnitude and in significance providing support to the hypothesis of partial substitution. Results in columns (3) and (4) point in the same direction of those reported in column (2). The coefficients estimated in both columns are negative and significant indicating that firms in the Eurozone were only partially substituting loans with bonds when non-performing loans, and loan allowances were high. Figures in Panels A and B of Table VIII confirm the results. The coefficients of the interaction variables in columns (3) and (4) of Panel A and Panel B are negative and strongly significant thus providing a robust evidence of imperfect substitutability, meaning that the degree of substitutability between sources of funding for firms in Europe has been revealed to be lower compared to that of U.S. firms.

Table VIII. Partial Substitution 2/2

This table reports results of the partial substitution analysis performed on specific subsamples. Panel A includes only firms whose assets do not deviate consistently from the median assets. In Panel B the filter exclude all the firms operating in industries with SIC codes not included between 4000 and 4999. The key coefficients of interest in both panels are those associated to the interaction variable. In each column the interaction is the product of the aggregate lending variable considered with the eurozone dummy. The dependent variable *Log amount* is the logarithm of the total amount of credit raised by a firm in a given quarter expressed in US Dollars. All the regression equations are estimated with OLS for the whole sample period and include both firm-fixed effects and quarterly calendar effects.

Panel A: by Deviations from Median

	Dependent Variable: *Log amount*					
	(1)	(2)	(3)	(4)	(5)	(6)
Lending variables:						
(EZ*Lending Variable)	0.00162	0.104*	-24.81*	-21.88***	1.010	0.0690
	(0.00459)	(0.0544)	(14.88)	(8.223)	(0.881)	(0.0848)
Lending standards	-0.00416					
	(0.00335)					
Lending growth		0.000988				
		(0.0141)				
NPL's			6.172			
			(4.156)			
Loan allowances				15.90		
				(9.935)		
Returns					-1.026***	
					(0.308)	
Monetary policy						0.0917
						(0.0605)
Control Variables	Y	Y	Y	Y	Y	Y
Observations	4,044	4,069	3,714	3,714	3,773	4,054
R-squared	0.747	0.742	0.743	0.743	0.751	0.742

Panel B: by Industry

	Dependent Variable: *Log amount*					
	(1)	(2)	(3)	(4)	(5)	(6)
Lending variables:						
(EZ*Lending Variable)	0.00582	0.182**	-57.85***	-44.28***	0.409	0.117
	(0.00701)	(0.0914)	(21.76)	(14.94)	(0.829)	(0.142)
Lending standards	-0.00791**					
	(0.00373)					
Lending growth		0.0133				
		(0.0124)				
NPL's			7.234			
			(9.074)			
Loan allowances				19.19		
				(21.11)		
Returns					-1.136***	
					(0.378)	
Monetary policy						0.159**
						(0.0614)
Control Variables	Y	Y	Y	Y	Y	Y
Observations	1,885	1,894	1,718	1,718	1,768	1,893
R-squared	0.716	0.715	0.719	0.720	0.724	0.712

Robust standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

5. Robustness

In section 4 I provided evidences on the existence and the direction of the loan to bond switching channel, and on the degree of substitutability between loans and bonds. In this section I perform a robustness analysis to support the main findings of the chapter. In the robustness analysis I consider the response of different subsamples constructed from firms' individual characteristics to changes in aggregate borrowing conditions.

In Table IX I split the sample by firm leverage and by firms' total assets. As already mentioned, literature provides us with evidences that firms with certain characteristics suffer more when bank supply is weak. [11] To examine this possibility I repeat the empirical exercise for the bottom and the top quartiles of the observed leverage and total assets distributions. From the analysis of the coefficients obtained I conclude that a change in the lending variables affects differently firms with opposite characteristics. The coefficients

[11] See Domac and Ferri (1999)

for firms in the bottom quartile of the total assets distribution indicates that small enough firms appear to be constrained and not able to use the switching channel documented in any direction. Conversely, firms in the top quartile will switch their source of funding between loan and bond as documented from the findings in Table IX.

Table IX. Robustness 1/2

Table IX uses the same specification of Table V but for different subsamples of Eurozone's firms. Each coefficient reported is the result of an OLS regression which includes firm-fixed effects, and controls for firms' characteristics. The dependent variable is the ratio of loan amount over total amount raised in a given quarter by a firm (LB_{it}).The estimation period is 2002:Q1 - 2015:Q2, all errors are clustered by quarter.

	Dependent Variable: LB_{it}					
	(1)	(2)	(3)	(4)	(5)	(6)
Lending variables:	Lending standards	Lending growth	NPL's	Loan allowances	Returns	Monetary policy
Bottom quartile:						
Leverage	0.00343**	0.0836***	0.167**	- -0.289**	-0.174	0.0883***
	(0.00153)	(0.0252)	(0.0702)	(0.110)	(0.118)	(0.0267)
Asset	0.00320	0.0649	-0.121	-0.354	0.187	0.0744
	(0.00319)	(0.0507)	(0.124)	(0.265)	(0.556)	(0.0497)
Top quartile:						
Leverage	0.00496***	0.0446*	-0.0916	-0.260**	0.141	0.0634**
	(0.00166)	(0.0222)	(0.0595)	(0.108)	(0.103)	(0.0252)
Asset	0.00550***	0.0548**	-0.0948*	-0.199*	0.185***	0.0716***
	(0.00136)	(0.0203)	(0.0562)	(0.102)	(0.0345)	(0.0229)

*** p<0.01, ** p<0.05, * p<0.1

The story is different when I look at leverage. In the bottom quartile firms with low leverage are supposed to have a more flexible capital structure and therefore -as expected- the coefficients of the lending variables is significant (despite only at 5% for loan allowances and non-performing loans) and with the same sign found in the main specification. Nonetheless, also highly leveraged firms in the top quartile seem to be able to switch from loan to bond if needed. The effect is significant and points in the same direction for firms in the bottom quartile as well as for firms in the top quartile. This evidence, in keeping with theoretical and empirical literature in Bolton et al. (2016), could support the hypothesis that lender's specific characteristics are also relevant when firms choose their debt structure. The idea is that solid lenders or relationship lenders are willing to lend additional funds to their borrowers -even when already highly leveraged- if they consider the firm capable of producing enough income in the future to repay existing debt.

Relax conditioning filters In the baseline results, the sample used to estimate the empirical model is conditioned to include only firms that issued bonds in the previous 5 years. It is reasonable to believe that firms not filtered out from the sample are those that have access to the public debt market. Nevertheless, applying the filter does not necessarily drop firms without access to the bond market with absolute certainty. In order to provide further evidence of robustness, in Table X I tweak the filter on past issuance to check whether the results are driven from the choice of the filter and that different filters will return significantly different point estimates.

The alternatives to the 5 years filter I use are the following: 1) 4 years filter that includes all firms that issued bonds in the previous 4 years, 2) 2 years filter that includes firms issuing bonds in the previous 2 years, and 3) the complete removal of the bonds' conditioning filter.

The first two filters are more restrictive than the original one. A narrow filter makes harder to argue that firms in the sample do not have access to the corporate bonds market. A robust estimate obtained using narrower filters should rule out the possibility that the estimates are driven by the absence of public debt market access rather then being the outcome of independent firm's decision of switching between bond and loans financing. The third alternative removes the filter altogether. Removing the filter should have an ambiguous effect on the coefficient estimates. Absent the filter, we are including in the sample switcher firms that for some reason did not issue any bond in the last 5 years (it is possible since bonds usually have long maturities) but do have access to the market. The inclusion of these firms in the estimation sample should make the magnitude of the coefficients estimated larger. On the other hand, without the filter, also non-switcher that do not have market access at all are included in the sample thus biasing the estimate downward. The last group of firms should ideally be excluded from the analysis as they are not identifying the effect studied. The rationale for filtering only for past bond issuance and not for loans as well is that all firms that have access to the public debt market should have access to bank debt as well.

From Table X the point estimates obtained by applying the three alternative filters to the data are strongly significant (except for the lending variable "returns"), have the same sign of the benchmark coefficients, and are very close in magnitude in most cases. In the last row of Table X the estimation is performed on the sample that is not filtered for past bond issuance. The coefficients are slightly lower in magnitude with the exception of the coefficient estimated for the non-performing loans variable that is sensibly lower.

Table X. Robustness 2/2

Table X reports the coefficients of the lending variables estimated using different filters. The first row reports the baseline results of Table V obtained using the standard filter that excludes observation for firms that did not issue bonds in the previous 5 years. The dependent variable is LB_{it}, each column corresponds to a specification in which the lending variable is alternatively: 1) Lending standards, 2) Lending growth, 3)Non-performing loans, 4) Loan allowances, 5) Average returns and 6) Monetary policy. Each coefficient reported is the result of an OLS regression which includes firm-fixed effects and controls for firms' characteristics. The dependent variable is the ratio of loan amount over total amount raised in a given quarter by a firm (LB_{it}).The estimation period is 2002:Q1 - 2015:Q2, all errors are clustered by quarter.

	Dependent Variable: LB_{it}					
	(1)	(2)	(3)	(4)	(5)	(6)
Lending variables:	Lending standards	Lending growth	NPL's	Loan allowances	Returns	Monetary policy
Baseline	0.00498***	0.0508***	-0.0880**	-0.224***	0.0870	0.0619***
4 Years filter	0.00483***	0.0499***	-0.0868**	-0.220***	0.0889	0.0603***
2 Years filter	0.00450***	0.0520***	-0.0902**	-0.197***	0.111	0.0579***
No filter	0.00434***	0.0448***	-0.103***	-0.216***	0.0306	0.0512***

*** p<0.01, ** p<0.05, * p<0.1

Given the evidences provided in the main regression on how firms with market access consistently switch between loans and bonds in order to adjust to the changing relative cost debt when banks' non-performing loans are high; I hypothesize that non-switcher firms that despite currently lacking debt market access issued bonds sometimes in the past, are still borrowing from banks. [12]

If the hypothesis on the relationship lending holds true it is possible that a firm despite losing market access will not be credit rationed from the banking sector because it will substitute transaction loans with relationship loans, and therefore it will not be removed

[12]Non switcher firms cannot be excluded from the sample when the filter is removed

from the sample. The presence of these firms in the sample should bias the coefficient estimate towards zero and this is exactly what is observed in column (3) of Table X.

6. Discussion

The most recent crisis that severely affected the U.S. economy and then spread to Europe has called a lot of attention from researchers. The literature produced about the crisis is extensive and touch many fields of economics providing many different points of view. A large part of the literature has been dedicated to the credit cycle and its interaction with the business cycle. Theoretical literature finds that changes in credit supply is an important factor in explaining the credit cycle. Empirical analysis has tried to reconcile theory with the data. Recently Becker and Ivashina (2014) tried to expand the scope of the empirical analysis to provide out of sample forecastability which in the previous literature was low or totally absent. Nonetheless, the limitation of Becker and Ivashina (2014) still resides in the external validity. The paper only focus on U.S. firms which face different market conditions with respect to their European counterpart. In addition, the interaction with banks tends to follow different dynamics in U.S. and in Europe. In the Eurozone the ECB intervened to make the liquidity readily available to banks. The additional liquidity provided however was not lent out by banks who preferred to hoard it as a buffer in case of future crises.

This analysis fill the gap in the empirical literature by providing evidences on how the change in credit supply has affected Euro area firms' financing decisions. The analysis relates the changes in credit conditions with the choice of the firm of using either term loans or issuing corporate bonds to fund their investments. The two options can be considered close substitutes for large enough firm -especially when considering the syndicated loan market-thus the choice of switching from one source to the other must be the by-product of a change in the relative cost of the two financing instruments.

The first interesting descriptive result to notice is that many firms tend not to switch their source of financing (that could be either a bank loan or a corporate bond issuance), and especially those firms who usually issue bonds continue to do so. This behaviour indicates that despite the lower efficiency of the European capital markets compared to the US one, firms that gain the access of the corporate bond market usually do not pull out easily thus making the bond market fairly stable. In contrast, the loan market is very volatile hence providing the bigger variation to the change in relative price.

The identification strategy in this chapter allows to untangle the demand and supply of credit that is fundamental in the analysis. Large part of the sample available is characterized by a crisis. Crises are period in which not only supply of credit fall but usually the lack of investment opportunities lowers the demand of credit as well. By including in the sample only firms that get some form of credit (either a term loan or a bond) in each quarter, I make sure that by observing a lower amount of loans I am not capturing a drop in the demand for funds of the firms but just a change in relative cost of credit obtained from banks and from the corporate bond market.

In this chapter I find evidence that poor conditions in the banking sector negatively affects the supply of loans, and provides ground to advocate for the importance of the substitution channel in relaxing the adverse effects of a downturn. In this analysis I find that for variables less related to the actual "health" of the banking sector and more related to the mechanism underlying the choice of granting loans to firms (e.g. the measure of lending standards and the monetary policy stance), the substitution channel might work differently in Eurozone compared to the U.S.. Periods of tight lending standards are not necessarily related to a reduction in credit supply but could be the outcome of a different allocation of funds among bank borrowers. In particular, banks with well-established relationships with borrowers might prefer -in crisis periods- to reallocate their loans towards firms they know better, and offering relatively cheaper rates compared to transaction based lending. The design and the firm level dataset of the analysis exclude possible alternative explanations for what is observed.

One of the most recurrent endogeneity problem that might affect the analysis of the credit cycle is the existence of compositional effects that could bias the result. The introduction of firm level fixed effects ensure that these firm specific compositional effects are controlled for as long as they are not time varying. The set of firm-specific variables, controls for firm's time varying characteristics that capture the same compositional effects.

In this chapter, by isolating the credit supply, I am able to single out the loan to bond substitution channel for Euro area firms and to uncover some of the factors related to its functioning. Moreover, I document the existence of a different degree of substitutability between loans and bonds for Eurozone firms compared to U.S. firms. The lower substitutability observed in Europe does not allow some firms to raise the desired amount from the credit market, therefore making the recovery from recession much slower than it could have been with perfect substitutability. This work provides insights on the relevance of an efficient public debt market to reduce the adverse effect of a crisis. In particular, how firms which are profitable, and have investment opportunities available, –thus a positive credit demand- should be able to get funding even when the banks reduce the supply. Nonetheless, further analysis is needed to validate the hypothesis put forward in this chapter that lender's characteristics - and especially the existence of relationship lenders - affect the choice of the debt structure.

III. Lender's Characteristics and Relationship Lending for Unconstrained Firms

1. Introduction

The analysis in the previous chapter aims to answer the question about the existence and the functioning of the loan to bond substitution channel in the Eurozone. Nonetheless, further investigation is required to shed light on the causal effect that other external factors might have on the direction of the substitution. I believe that the way the substitution channel works depends endogenously from the structure of the financial system that is not harmonized across countries. In this chapter I focus on how the different role that the banking industry acquired within the financial system and across countries, might influence the way firms choose their liability structure. More specifically, the empirical analysis in this chapter tests two different but related hypothesis.

The first hypothesis to test relates the firm's choice between bank loans and bonds not only to aggregate credit conditions but also to individual characteristics of informed lenders. In other words I test whether the health status (intended as the financial soundness) of a firm's main lender does affect its financing choice by exacerbating the adverse effect of credit supply shrinkage during economic downturns or, on the opposite, how it can reduce these negative effects when lender's financial fundamentals are particularly strong. In this chapter the main lender identifies -as in Sufi (2007)- a bank that is the lead arranger of a syndicated loan, and thus is considered informed relative to the rest of the banks.

The second hypothesis to test is the relationship lending hypothesis. In the subsection dedicated to relationship lending I test whether this could be assumed a determinant of the firms' strong bank bias when choosing the capital structure.

Here I would like to stress out the importance of banks and financial intermediaries as central for the real economy. Banks provide loans to firms and households but they also screen and monitor the borrowers. These latter characteristics allow banks to collect information that are not publicly available and thus not factored in the investment decision of corporate bond market participants. The screening and monitoring activity that banks perform is costly, and these costs are reflected in the price of the loan. Firms choose their financing mix such that they can keep the advantage of easier renegotiation that banks concede compared to the probability of renegotiating debt with a pool of sparse investors but at the same time they try to circumscribe bank's ability to appropriate rents.[13] Among banks, a firm can choose if they should seek to build a long-term relationship or to engage in simple transaction lending. Firms will choose an optimal combination between the cheaper transaction lending and the more expensive relationship lending according to the additional benefit that they can obtain by establishing a relationship with a bank.

This chapter contributes to the literature on the credit cycle by providing new evidences on how individual lender characteristics affect firms' choice of funding when aggregate credit condition deteriorates. In the empirical section, I test two types of lender characteristics. The former characteristic I test is the health status of the lender measured by the combined Tier1-Tier2 risk adjusted capital ratio. I also provide estimates for the more restrictive Tier1 capital ratio and for the level of bank's loan allowances in the robustness section. In the second part of the empirical analysis, I test the differential effect on the demand for bank funds that firms experience when writing a loan contract with a relationship bank rather than a transaction bank. The second part of the chapter can be intended as an empirical test of the predictions in Bolton and Freixas (2006) which considers the firms' optimal choice of financing between corporate bonds and relationship loans.

From the investigation reported in this chapter, I find new evidences on the relevance of individual bank characteristics in the choice of firms' debt structure. The analysis finds that borrowing frequently from the same lender will have effect on the debt structure of firms when aggregate credit conditions are poor. In other words, borrowing from a financially troubled bank will exacerbate the adverse effect of a reduction in credit supply, and make the use of the substitution channel even more necessary for associated firms. On the opposite, firms entertaining a long lasting relationship with a safe bank will resort less to the bond

[13] See Rajan (1992)

market as they are often able to obtain additional credit from their main lender without paying disproportionately high fees or interest rates.

In the second half of the chapter, I find that when the habitual lender of a firm is a relationship lender the firm will not switch to the bond market as much as expected; instead it resorts to additional relationship funds which are available also in recession periods for firms with positive NPV investment projects. It is interesting to notice how this second hypothesis is a more restrictive specification of the first one. In fact, relationship lenders are often associated to higher capital ratio, as they need to maintain a higher capital buffer to roll over the debt of illiquid but profitable firms during crises. Nonetheless, given that the analysis on the relationship lender does not require lenders' accounting data, we will have a larger sample when testing the second hypothesis.

This chapter proceeds as follows: in Section 2 I review the related literature, Section 3 describes the data and the methodology, in Section 4 I report the results of the empirical investigation while Section 5 is dedicated to the robustness checks. Finally, section 6 concludes the chapter.

2. Literature review

Literature on the influence of lenders' characteristics on the credit cycle has largely developed in the 90s. Hancock and Wilcox (1998) present evidences on the link between bank size, bank credit, and the business cycle. The paper analyses the response of real activity in small firms to a shock in bank capital. They show that small banks reduce their loans considerably more than large banks as a response to a negative shock on bank's capital. The decline in loans of small banks is related to a greater reduction in economic activity especially for small firms that are more likely to be credit rationed.

Also Sufi (2007) studies how specific lender characteristics influence bank lending. In his paper, he focus on information asymmetry between borrowers and lenders in the syndicated loan market. Sufi (2007) finds that information asymmetry influences the syndicate structure and its composition. In particular, he finds that when information asymmetry between the borrower and lenders is severe, participant lenders are closer to the borrower, both geographically, and in terms of previous lending relationships. The informed lead bank and the borrower reputation mitigate information asymmetry problems.

Relationship lending is one of the most investigated feature of the banking system. The literature on relationship banking can be separated in two waves.

The first wave of models is well represented by Sharpe (1990) and describes relationship lending as a contract between firms and banks in which a bank acquires information about the borrower in an early stage and then will exploit those information in a later stage to extract monopoly rents. The first wave aims to find evidences that firms with a closer bank relationship are able to raise more funds than firms using arm's length bank finance.[14]. These models provide a description of the relationship lending between banks and firms but they do not introduce trade-offs that might arise when the firm has a choice between relationship lending and transaction lending.

In the second wave of models the interest shifted from the analysis of the effects of relationship lending on firms' ability of raising funds to the estimation of the value of this form of lending compared to arm's length loans. The analyses focus on the insurance, monitoring, and screening abilities of relationship bank. These banks can provide insurance on future access to credit for firms (Berger and Udell (1995); Berlin and Mester (1999)), they can reduce the agency problem through monitoring (Holmstrom and Tirole (1997), Boot and Thakor (2000)), they can more efficiently screen loan applicants thanks to their superior information, and can offer continuation lending specifically tailored for each specific firm.

The rationale for the second wave of papers is that given the cyclicality of bank credit supply, there is not much reason to borrow from a relationship lender in periods of economic

[14] See Petersen and Rajan (1994) and Berger and Udell (1995)

boom when the credit is in high supply. The cost of collecting additional information for the relationship bank is reflected in higher prices in periods of economic growth; therefore, it is interesting to study whether the closer bank-borrower relationship is of particular importance in periods characterized by financial system disruption or by an aggregate shock to the firms' industry. The idea is that in periods characterized by financial instability, in which firms' profits are falling independently of their quality, we should observe banks to cut lending to all firms proportionately except for firms with whom they have long-standing relationships. The question is interesting as relationship banking is a common practice and it involves both advantages and costs for a firm to set up such a link.

Many authors provide theoretical models and empirical evidences to corroborate the hypothesis of relationship lending raised in this thesis. Bolton et al. (2016) create a model of relationship lending against transaction lending and show that relationship lenders, because of the soft information collection, incur in higher costs and thus charge higher lending rates in normal times relative to transaction lending which is based exclusively on hard information and collaterals. Nonetheless, the information collected overtime allows the relationship bank to continue lending to profitable firms when crises hit. Bolton et al. (2016) provides empirical evidences employing data from the Italian credit registry to show that relationship lending increases the resilience of the economy during crises, and showing that Italian banks continued to lend to their relationship borrower even after the 2008 Lehman Brothers bankruptcy. In the paper a firm-bank link is defined as "relationship" if the bank headquarter (or branch) and the firm headquarter are located in the same province.

In the same spirit of Bolton and Scharfstein (1996), Beck, Degryse, De Haas, and Van Horen (2014) study how transaction lending affects firms' funding over the business cycle compared to relationship lending . They use data from the EBRD Banking Environment and Performance Survey (BEPS) and merge this information with firm-level survey information and with data on the geographic location of bank branches across 21 countries in Eastern Europe and the Caucasus.[15] The dataset available to Beck et al. (2014) allows the identification of the differential effect that relationship lending has over transaction lending on firms' financing across the business cycle.

The presence of relationship lending give credit to the case for bailing out banks during crises as documented by Diamond and Rajan (2005). During a downturn many firms with good quality projects will eventually shut down in absence of relationship lending due to the financial constraints that arise.[16] In fact, banks tend to shift their credit supply towards safer (usually bigger) firms. This "flight to quality" has been documented by Domaç and Ferri (1999) who provides evidences of this shift in loan funds recipients from smaller riskier firms to bigger and safer ones during the Asian crisis.

3. Data and Methodology

A. Data

Following the previous chapter, I use firm level data aggregated at quarterly frequency. Observations with missing accounting data are excluded, leaving in the sample only firm-quarters with valid accounting data for both U.S. and Eurozone firms. The accounting variables are collected from Compustat North America for U.S. firms and Compustat Global for the Eurozone firms. Data on loans and bonds are the same used in the previous chapter obtained from Reuters' Dealscan and Thomson One Banker respectively. I also use Orbis banks' focus database to obtain bank addresses to match banks and firms according to their proximity. [17]

The dependent variable is LB_{it} which is the total amount of loans obtained by a firm in a quarter weighted by the total amount raised. The dependent variable obtained allows to include in the sample all the observations in which both loans and bonds are issued from a

[15] The BEPS is a survey on the use of lending techniques gathered from face-to-face interviews with 397 bank CEOs.

[16] See Gertler and Gilchrist (1994)

[17] Formerly Bankscope

given firm in a given quarter. Data on the lending variables are used to proxy borrowing conditions. The lending variables are the following: 1) Lending standards, 2) Lending growth, 3) Non-performing loans, 4) Loan allowances, and 5) Monetary policy.

Data on lending standards are collected for U.S, U.K. and Eurozone firms from the Fed, the BoE, and the ECB respectively. The availability of data that can be obtained for the Eurozone through the bank lending survey is subordinated to the date of the first issue of the ECB's bank lending survey in 2002. In order not to have an unbalanced sample with observation anterior to the 2002 only belonging to non-Eurozone firms, I truncate the sample to obtain a shorter time window starting in 2002 and ending in 2015. Data on credit standards are compiled from central banks' surveys. "Lending growth" is a variable reporting data on the flow of funds available for U.S., UK and Eurozone which can be downloaded from the Fed of St. Louis website, the BoE website and the ECB website respectively. Monetary policy is defined as deviation from the Taylor rule in all of the three macro area considered in the analysis. Deviations are calculated using Taylor (1993) for U.S. and Maddaloni and Peydró (2011) for UK and Eurozone. Finally, non-performing loans and loan allowances are constructed as an average of big banks accounting data and they are both expressed as a fraction of total loans.

In this chapter, data are not filtered for the past issuance of bonds as it was the case in the previous chapter; both short-term and longer-term loans are included. The rationale for not filtering the data is that I want to include in the sample also observations for firms who choose to tap the bond market only rarely because the terms of the loan deal they can get from the bank are in general more convenient. While this approach is reasonable given the long maturity of corporate bonds, in the section dedicated to robustness checks I replicate the analysis in the main specification using filtered data to dispel doubt that the results are driven from the choice of the filters. I find that even with a narrow filter on bond issuance the results remain qualitatively the same. The coefficients in the robustness section are consistent with those in the main specification and in some cases the evidences are even more robust.

B. *Methodology*

In section 4 I perform two separate empirical analysis. In the first subsection I focus on the effect of firm's main lender fundamentals on the supply of bank loans. I identify the main lender for a firm as the syndicated loan lead arranger that appear the most in the credit history of a firm. I also proxy the fundamentals of the main lender using measures of capital ratio and loan allowances. If there is more than one lead arranger suitable to be classified as main lender, I create a synthetic main lender by taking the average of their fundamentals data.

The coefficient of interest is the one associated to the interaction of the aggregate lending variable with the lender specific variable (ML). In the main specification the ML variable is the combined Tier 1 - Tier 2 Capital ratio. In section 5 I use two alternative measures of main lender health status to check the robustness of the results. The variable ML changes across firms and over time thus allowing the inclusion of calendar fixed effects in the robustness section. The main regression equation in the first part of the empirical analysis is the following:

$$LB_{it} = \alpha + \mu_i + \beta_1(ML_{it} * A_{ct}) + \beta_2 ML_{it} + \beta_3 A_{ct} + \gamma Eurozone_{ct} + \delta X_{it} + \varepsilon_{it}$$

Where LB_{it} is the dependent variable, A_{ct} is the aggregate lending variable, and $(ML_{it} * A_{ct})$ is the explanatory variable of interest. The rest of the variables included in the specification ensure the conditional exogeneity of the model. μ_i are firm fixed effects, $Eurozone$ is a dummy controlling for countries within the eurozone, and X_{it} is a matrix of firm specific controls.

In the second part of the empirical section I focus specifically on relationship lenders rather than the more general concept of main lender. The identification of relationship banks is more challenging than the simple main lender identification strategy provided in Sufi (2007); in fact, whether a loan is granted to a firm as a result of relationship lending or transaction lending is not directly observable. In empirical tests of the relationship lending hypothesis scholars have used several different methodologies to proxy the strength of the relationship. Most of the empirical literature choose the time since the bank and the borrower initiated the first deal to measure the strength of the relationship. Intuitively, the longest the relationship the more information a bank is able to collect from the firm and thus can tailor the loan contracts to the specific borrower. While this measure seems appropriate, one must be careful when using it. In fact when using the duration of the relationship to proxy the lending relationship it is necessary to include in the analysis also the age of the firm since the two variables are highly correlated. [18]

The length of the relationship proxies the private information that the lender has been able to collect from the firm over the years, whereas age reflects public information on the reputation and survival of the firm. Moreover the duration proxy gives low weight to relatively new relationships which might be important in terms of expectations of future deals with the same borrower.

Sharpe (1990) uses an alternative measure of relationship lending. In his analysis the strength of the relationship is proxied by the number of simultaneous lending relationship that a firm entertain with banks. In the extreme case of an exclusive relationship, the informed bank obtain a monopoly on the information relative to the firm and this in turn promotes closer link between the firm and the bank. Although the use of such proxy is backed by theory, Elsas (2005) points out that "exclusivity of a bank relationship is neither a necessary nor a sufficient condition for relationship lending.

Alessandrini, Presbitero, and Zazzaro (2009) use yet another measure of relationship

[18] Berger and Udell (1995) and Cole and Walraven (1998) find that the length of the relationship and the age of the firms are highly correlated

lending. In their paper they proxy the strength of the relationship with the distance between the bank and the firm headquarter. The rationale behind the use of the distance measure is that the farther the firm and bank are to each other the more difficult become for the bank to collect soft information thus making more difficult the evaluation of the loan application, and in turn weakening the relationship lending. The scope of the relationship has been also used as a proxy but it is unclear whether is necessary for a bank to provide multiple services to firms in order to be considered a relationship lender. Indeed, while a firm purchasing over the course of its life additional services besides the standard deposit and loans business from the same bank is clearly releasing more information creating a de facto relationship with the bank, it is not rare the case in which firms create strong lending relationship with the bank even in absence of additional financial services.

In this chapter, a firm-bank link is considered to be a long-term relationship if the bank branch or headquarter is in the same city as the borrower headquarter and the two interact through loan contracts multiple times over the years. This approach put together two of the main approach of the literature. The one considering the length of the relationship and the one that considers the proximity between the bank and the lender. The idea is that the combination of the two should help mitigating the objections raised for each measure individually. My identification strategy to isolate the effect of relationship lending is threefold. In the first step I construct the relationship lending variable as described. The length of the relationship measure will give a low weight to newly formed relationship between bank and firms, whilst the proximity of the bank and the firm headquarters could be meaningless if they interact only once. Therefore, I assign a relationship lender to a firm only if the headquarter (or branch) of the bank and the firm are in the same city, and they interact multiple times in different years. At this point someone may raise the issue of a possible endogeneity problem that the correlation between the strength of the bank-firm relationship and the availability of credit is due to variables capturing the effect of informational differences rather than the actual effect of having a relationship bank. To make sure I am capturing the effect that relationship lending has on the probability of obtaining a loan, I add two further steps to the identification strategy.

The second part of the identification strategy is related to the way the dependent variable LB_{it} is designed. Firm-quarters that are not excluded from the initial sample are all relative to firms receiving financing either in the form of bond or loan. If the relationship lending variable (RL_{it}) were to capture a general information problem, then we should observe a non-significant point estimate for the key coefficient of interest since this general information problem should be reflected in a lower availability of all sources of funding for the specific firm and not simply a reduction in bank loans.

Finally, the last piece of the identification strategy is the empirical specification. Using a sort of difference-in-differences approach on a panel of firm-quarters from different countries, I make sure that any fixed difference between firms with a bank relationship and firms without a bank relationship are automatically netted out from the differencing, as well as any compositional effect due to firm specific characteristics is absorbed by the firm-fixed effects. The regression equation underlying the model is the following:

$$LB_{it} = \alpha + \mu_i + \beta_1 A_{ct} + \beta_2 RL_{it} + \gamma(RL_{it} * A_{ct}) + \delta_1 X_{it} + \delta_2 Trend_{it} + \varepsilon_{it}$$

Where LB_{it} is the ratio of the loan amount raised by a firm in a given quarter and the total amount raised by the firm in the quarter. A value equal to 0 indicates that the firm only raised funds in the bond market, a ratio equal to one indicates that firms only get a bank loan in the quarter, a value between 0 and 1 indicates a combination of bank and market finance. RL_{it} is the measure of relationship lending described above. RL_{it} varies across firms and time according to the evolution of firm-bank relationships. The relationship lending variable switches from 0 to 1 at the time the second banking relationship is formed, meaning that the variable will always be lagged by one period. The lending variables A_{ct} represent the aggregate lending condition in the economy and are collected for U.S., U.K. and Eurozone separately. X_{it} is a matrix of firms' control variables and $Trend_{it}$ is a firm specific time trend to take into account the correlation between the age of the firms and the number of interactions between the borrower and the lender. Firm's controls included are: "lag log assets, lag log property plant and equipment, ROA, market to book assets, lagged returns, and a dummy indicating whether the firm paid dividend in a given quarter.

Finally, the interaction of RL_{it} and the lending variable is associated to the key coefficient of interest. A positive coefficient would imply that when credit is tight firms with close bank relationships manage to raise even more funds from banks compared to those firm who use transaction banking to finance their activities. This could be the result of the flight to quality prediction. In Dell'Ariccia and Marquez (2006) model, banks experiencing a negative shock, shift the composition of their borrower pool towards firms for which they have an informational advantage compared to other lenders. In other words, during an economic downturn, firms with a strong bank relationship should experience a smaller reduction in lending compared to other firms.[19] The evidences provided in the empirical analysis are consistent with the theoretical prediction of Dell'Ariccia and Marquez (2006).

4. Empirical Analysis

The sample analyzed in this section spans the years from 2002 to 2015 and is a panel of firm level data collected at quarterly frequencies. The dependent variable is the loan-to-total-amount ratio as described in the methodology section. The choice of the dependent variable is part of the identification strategy in this chapter. All the coefficients in Table II and Table III are estimated using OLS with standard errors clustered at quarterly level. The regression equation also includes firms fixed effects to account for compositional effects.

Table I contains descriptive statistics of the sample used. I report data on the amounts and number of loans and bonds before and after the beginning of the 2007 financial crisis. It is immediate to notice that the amounts of both loans and bonds increase consistently after

[19] The downside of relationship lending should be reflected in higher costs for borrowing over the entire length of the relationship due to the monopoly rent acquired by the bank through informations.

Table I. Descriptive Statistics

This table reports the descriptive statistics for the sample of firms included for the analysis in this section. Note that relationship lender and main lender may coincide for some firms.

	Bonds	Loans
Number	6,944	6,232
Before 2007	4,278	3,793
After 2007	2,666	2,439
Mean(millions)	507	637
Before 2007(millions)	273	372
After 2007(millions)	880	1,050
Median(millions)	250	170
Before 2007(millions)	150	100
After 2007(millions)	500	300

	Total	Main lenders	Relationship
Lenders	5286	50	81

Main Lender's variables	Mean	Median	Std. Dev
Tier 1 Capital ratio	9.721392	8.6	2.777887
Combined Capital ratio	13.18969	12.43	2.450871
Loan allowances	8.522282	8.83	1.362317

2007. However the total number of loans and bonds decrease. The descriptive result, in line with the findings in this thesis, can be interpreted as a flight to quality from the investors side. In fact, from the description of the data, it appears that investors (banks and private investors in the bond market) after 2007 preferred to lend more to a smaller number of firms they deemed safe, thus cutting funding to lower quality firms. The rest of Table I reports statistics on the number of lenders and the description of the variables used in the main lender analysis.

A. Main lender

For this part of the analysis I assigned a main lender to each firm and collected balance sheet data to proxy the "health" status of the lender. The main lender has been selected as the syndicated loan's lead arranger that appears the most times in the credit history of the firm. If there is more than one candidate, I create a synthetic lender by taking the average of their balance sheet data. In Table II I report the figures resulting from the first empirical exercise.

The variable representing the main lender status that I choose in this specification is the combined risk-adjusted capital ratio. In the robustness section I try the more restrictive Tier 1 capital ratio and the lagged value of the log loan allowances over total loans granted by the bank to proxy main lender's fundamentals, and I find the results to be consistent with those obtained in the main specification.

In column (1) the coefficient of the interaction variable is not significant. This indicates that when the bank credit standards tightens the capital ratio of the bank, which in this analysis I use as proxy for bank's fundamentals, does not affect bank lending to firms [20] Hence the lending standards variable does not seem to influence the debt structure choice of unconstrained firms.

The first interesting result is reported in column (2). In this specification the lending variable is aggregate lending growth. The coefficients for the lending variable level is positive and significant at 1% level as expected; nonetheless, when the variable is interacted with ML the coefficient is not significant, indicating that the status of the main lender does not seem to have an effect when lending grows. The coefficients of the level variables non-performing loans and loan allowances in columns (3) and (4) respectively are consistent with the findings in the previous chapter of this thesis. An increase in non-performing loans or in loan allowances cause a switch of the source of funding from bank loans to bonds. The coefficient of the interaction variable in both specification is also negative and strongly significant suggesting that the characteristics of the main lender do affect the choice of the debt structure. In particular the two coefficients show that when aggregate credit conditions are poor, the fundamentals of the main lender affect the firm's choice between bank loans and

[20] Note that here even if the firm is known by the lender, we are not assuming a relationship lender link between them.

bonds. Firms with a non-financially sound main lender will switch more to bond financing compared to other firms.

In the last column the deviations from the Taylor rule are taken as proxy of the monetary policy stance. The monetary policy variable does not interact with the main lender status, hence the non significant coefficient for the interaction variable. The coefficient of the level variable is again consistent with the findings of the previous chapter signalling that when the monetary policy stance is loose firms will be likely to switch from bank financing to bond financing.

Table II. Main Lender

The table reports the results of the main specification using main lender characteristics interacted with the five lending variables considered: 1) Lending standards, 2) Lending growth, 3)Non-performing loans, 4) Loan allowances and 5) Monetary policy. The dependent variable is LB_{it} which is the ratio of the amount of loans raised by a firm in a given quarter divided by the total amount raised by the firm in that quarter. LB_{it} equals 0 if a firm issue loans only, equals 1 if the firm issues bonds and is a number between 0 and 1 if a firm issued both forms of finance in a given quarter. The variable ML is the time series of quarterly combined Tier 1-Tier 2 capital ratio for each main lender associated to a firm. The interaction term is the product of the ML variable with the lending variable used in the specification. Each coefficient reported results from an OLS regression which includes firm-fixed effects and controls for firms' characteristics. The estimation period is 2002:Q1 - 2015:Q2, all errors are clustered quarterly.

	Dependent Variable: LB_{it}				
	(1)	(2)	(3)	(4)	(5)
Lending variables:					
(ML*Lending variable)	-0.000225	-0.00101	0.943***	1.839***	-0.00365
	(0.000161)	(0.00180)	(0.291)	(0.616)	(0.00470)
Lending standards	0.00274				
	(0.000217)				
Lending growth		0.0175			
		(0.0239)			
NPL's			-15.48***		
			(4.288)		
Loan allowances				-27.18***	
				(8.694)	
Monetary policy					0.0834
					(0.0648)
Eurozone	0.211**	0.243***	0.391***	0.449***	0.231***
	(0.103)	(0.0836)	(0.0993)	(0.0908)	(0.0864)
ML	-0.0236***	-0.0221***	-0.0328***	-0.0589***	-0.0210***
	(0.00388)	(0.00388)	(0.00667)	(0.0131)	(0.00406)
Firm's characteristics:					
Lag log assets	-0.0107	-0.0105	-0.0285	-0.0181	-0.0104
	(0.0272)	(0.0261)	(0.0275)	(0.0273)	(0.0259)
Lag log ppe	0.0273	0.0245	0.0221	0.0254	0.0252
	(0.0279)	(0.0267)	(0.0270)	(0.0275)	(0.0265)
ROA	0.188	0.200	-0.0602	0.0148	0.181
	(0.340)	(0.342)	(0.344)	(0.342)	(0.339)
Market to Book asset	6.97e-09	1.68e-08	2.60e-08	6.61e-08	1.19e-08
	(1.73e-08)	(2.18e-08)	(5.64e-08)	(5.67e-08)	(2.10e-08)
Lagged returns	-0.0115*	-0.0122*	-0.0106*	-0.0122*	-0.0142**
	(0.00603)	(0.00620)	(0.00635)	(0.00630)	(0.00633)
Lag leverage	-0.0559	-0.0530	-0.0315	-0.0422	-0.0587
	(0.0599)	(0.0596)	(0.0627)	(0.0632)	(0.0588)
Dividend	-0.0503**	-0.0492**	-0.0476**	-0.0473**	-0.0536***
	(0.0201)	(0.0201)	(0.0214)	(0.0216)	(0.0190)
Constant	0.978***	0.954***	1.136***	1.472***	0.946***
	(0.0561)	(0.0550)	(0.0908)	(0.177)	(0.0569)
Firm FE	Y	Y	Y	Y	Y
Calendar FE	N	N	N	N	N
Observations	6,628	6,675	6,063	6,065	6,671
R-squared	0.575	0.575	0.573	0.571	0.577

Robust standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

B. *Relationship lender*

In Table III I report results from the main regression specification testing the relationship lending hypothesis. The sample is a panel of firm level data collected at quarterly frequencies. The dependent variable is LB_{it} and is part of the identification strategy in this chapter. All the coefficients in Table III are estimated using OLS with standard errors clustered at quarterly level. The regression equation also includes firms fixed effects to account for compositional effects. Finally the difference-in-differences approach net out all of the fixed differences between firms that are in the treatment group (those who have a close lending relationship with a bank) and firms in the control group. The key variable of interest in this chapter is the interaction between the lending variable and the relationship lending variable.

In column (1) the coefficient of the interaction variable is positive and significant at 5% level. According to the estimated coefficient, when credit standards tighten, firms with close bank relationship should be favoured in their loan application compared to other firms. This is evidence of a flight to quality for banks who experience a shock in loanable funds. Conversely, the coefficient for the lending variable is negative and is significant at 1% level, showing that while the lending standards are relevant in explaining why some firms choose to switch from bank loans to bonds, the presence of relationship lending can attenuate the shift from one form of financing to the other.

In column (2) the coefficient of the interaction variable has a negative sign and it is significant at 5% level. The lending growth variable also presents a positive coefficient. I interpret this result as an indication that in normal times, when lending growth is high, having a close relationship with a bank it is not enhancing the firm's probability to obtain credit, if something it might push away from bank loans and towards market finance some firms who have the possibility to switch to alternative forms of financing in order to avoid to pay the monopoly rent to the relationship bank. This hypothesis is also consistent with the academic literature on relationship lending (see Rajan (1992) and Bolton et al. (2016)).

In column (3) the variable of interest is formed by the interaction of the relationship lending variable and the non-performing loans variable. The point estimate for non performing loans is negative - as expected from theoretical literature and empirical evidences provided in the previous chapter. The coefficient of the interacted variable instead is positive and significant at 1% level. The coefficient estimated for the lending variable in column (3) is negative and significant at 1% level. The sign of the coefficient implies that firms tend to resort less to bank loans and more on bond financing when non performing loans in the banking industry increase. However, we are more interested in the interpretation of the coefficient of the interaction variable which is positive and strongly significant. The sign of the coefficient indicates that if a firm set up a close relationship with a bank, then the reduction in bank loan financing caused by the high level of non performing loans in the economy is less severe. Firms closely connected to a relationship bank still find relatively convenient to apply for loans relative to the costs of issuing bonds even in period of instability for the banking industry.

Overall the presence of relationship banking can improve the economic terms of the loan contract for the firms. The finding can be interesting also from a regulator point of view. The development of relationship banking links presents a trade-off for the firms. On the one hand it reduces competitiveness in the credit market allowing relationship banks to extract monopoly rents from the firm due to the informational advantage they acquired compared to other banks. On the other hand relationship lenders can mitigate the adverse effect of a negative economic shock by providing stable funding to profitable firms. The relationship lending practice can also reduce the problem of liquidity hold-ups that plagued the Eurozone financial system and that would threaten the functioning of the monetary policy lending channel. According to results in column (3), relationship banks tend to grant loans to already known firms with good investment projects as long as they have available funds, despite the high level of non-performing loans in the banking industry. Results in column (4) follow those in column (3). The loan allowances variable is very correlated to the amount of non-performing loans and therefore it is also correlated to the performance of the banking industry. For the same reason mentioned above, a firm that usually relies heavily on relationship funds will experience a lesser reduction of bank funds availability compared to firms without bank's ties.

Finally, in column (5) the coefficient for the monetary policy variable is positive and significant. I interpret the sign of the coefficient as a by-product of central bank interventions to keep yields low during crises, and the shortage of banks'loanable funds which lead to a consequential increase in the cost of bank's funds relative to the costs in the bond market. [21] However, as theory predicts, the increase in costs (and decline in loanable funds) should be experienced to a lesser extent from firms linked to banks through a significant lending relationship. The negative coefficient for the interaction variable in the last column is consistent with the above mentioned theoretical prediction. Indeed, the firms who usually obtain loans from a relationship banks, are less likely to switch to bonds even in period in which the liquidity injections of the central banks lower the yields of corporate bonds.

[21] LSAP implemented by the Fed, QE from BoE and QE from ECB

Table III. Relationship Lender

Table III reports the results of the main specification for the five lending variables considered: 1) Lending standards, 2) Lending growth, 3)Non-performing loans, 4) Loan allowances and 5) Monetary policy. The dependent variable is LB_{it} which is the ratio of the amount of loans raised by a firm in a given quarter divided by the total amount raised by the firm in that quarter. LB_{it} equals 0 if a firm issue loans only, equals 1 if the firm issues bonds and is a number between 0 and 1 if a firm issued both forms of finance in a given quarter. RL is the relationship lending variable. The interaction term is the product of the RL variable with the lending variable used in the specification. Each coefficient reported is the result of an OLS regression which includes firm-fixed effects and controls for firms' characteristics.The estimation period is 2002:Q1 - 2015:Q2, all errors are clustered quarterly.

	Dependent Variable: LB_{it}				
	(1)	(2)	(3)	(4)	(5)
Lending variables:					
(RL*Lending variable)	0.000805**	-0.00477**	0.0191***	0.0190**	-0.0240**
	(0.000315)	(0.00215)	(0.00665)	(0.00717)	(0.00903)
Lending standards	-0.000985***				
	(0.000340)				
Lending growth		0.00251*			
		(0.00146)			
NPL's			-0.0327***		
			(0.00627)		
Loan allowances				-0.0400***	
				(0.00816)	
Monetary policy					0.0142**
					(0.00617)
RL	0.908***	0.912***	0.932***	0.930***	0.905***
	(0.0116)	(0.0104)	(0.00954)	(0.00968)	(0.0113)
Firm's characteristics:					
Lag log assets	-0.0457***	-0.0375***	-0.0301**	-0.0323**	-0.0360**
	(0.0140)	(0.0138)	(0.0138)	(0.0139)	(0.0139)
Lag log ppe	-0.0109	-0.0141	-0.0154	-0.0145	-0.0144
	(0.0102)	(0.00975)	(0.0109)	(0.0109)	(0.0100)
ROA	-0.142	-0.102	-0.134	-0.129	-0.0962
	(0.130)	(0.138)	(0.137)	(0.137)	(0.138)
Market to book assets	6.08e-09*	4.21e-09	4.80e-09	4.81e-09	5.96e-09
	(3.43e-09)	(3.41e-09)	(3.61e-09)	(3.52e-09)	(4.00e-09)
Lagged return	0.00187	0.00937	0.00861	0.00897	0.00953
	(0.00527)	(0.00643)	(0.00653)	(0.00653)	(0.00668)
Lag leverage	0.0804**	0.0747**	0.0791**	0.0784**	0.0809**
	(0.0346)	(0.0366)	(0.0381)	(0.0381)	(0.0361)
Dividend	-0.0111	-0.00782	-0.00654	-0.00698	-0.00842
	(0.00940)	(0.00889)	(0.00896)	(0.00895)	(0.00902)
Time trend	-0.00923***	-0.00761***	-0.00591***	-0.00465**	-0.00752***
	(0.00197)	(0.00206)	(0.00206)	(0.00211)	(0.00201)
Constant	1.101***	1.051***	0.981***	0.990***	1.038***
	(0.0748)	(0.0781)	(0.0655)	(0.0663)	(0.0769)
Firm FE	Y	Y	Y	Y	Y
Calendar FE	N	N	N	N	N
Observations	16,784	16,909	16,150	16,150	16,585
R-squared	0.503	0.503	0.508	0.507	0.501

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5. Robustness

In this section I provide results for alternative specifications of the main empirical analysis. The objective of this section is to provide additional support to the evidences presented in section 4.

A. Alternative measure of main lender fundamentals

Another indicator of bank's "health" is the risk adjusted capital ratio. A safer bank should have a capital ratio higher than a riskier one. In Table IV I repeat the empirical exercise in the main lender section using two alternative ML variables. In Panel A I measure the status of the bank using the lagged value of the Tier1 capital ratio. All the elements constituting the Tier 2 capital are excluded from the numerator thus making the number smaller compared to the combined Tier 1-Tier 2 capital ratio. Tier 1 capital ratio is more restrictive than the combined capital ratio, thus providing a more conservative measure of bank's soundness.

In Panel B the main lender variable is the lagged value of the log loan allowances. Lag log loan allowances has to be interpreted in the opposite way compared to capital ratio. High value of the variable means that the bank is foreseeing many delinquent loans in the near future

The figures in Table IV point in the same direction of those in the main regressions in Table II. The coefficients of the interaction variable both in Panel A and in Panel B are strongly significant and positive. A higher capital ratio is a signal of a safer bank. The sign of the coefficients supports the hypotesis that main lender characteristics affect firm's funding decisions. In particular the sign of the coefficients for the interaction variables in Panel A and Panel B confirms that a firm interacting with safer banks -as measured by the capital ratio- tend to switch less from bank loans to bonds when the aggregate lending conditions deteriorates.

Table IV. Robustness 1/4

The table reports the results of the main lender analysis using alternative measures of main lender's health status interacted with the five lending variables considered: 1) Lending standards, 2) Lending growth, 3)Non-performing loans, 4) Loan allowances and 5) Monetary policy. The dependent variable is LB_{it} which is the ratio of the amount of loans raised by a firm in a given quarter divided by the total amount raised by the firm in that quarter. LB_{it} equals 0 if a firm issue loans only, equals 1 if the firm issues bonds and is a number between 0 and 1 if a firm issued both forms of finance in a given quarter. In Panel A the variable ML is the time series of the Tier 1 capital ratio for each main lender associated to a firm; whereas in Panel B ML is a time series of lag log loan allowances of each main lender. The interaction term is the product of the ML variable with the lending variable used in the specification. Each coefficient reported results from an OLS regression which includes firm-fixed effects and controls for firms' characteristics. The estimation period is 2002:Q1 - 2015:Q2, all errors are clustered quarterly.

Panel A: Tier 1 Capital Ratio

Dependent Variable: LB_{it}	(1)	(2)	(3)	(4)	(5)
Lending variables:					
(ML*Lending Variable)	-0.000242	-0.00107	0.907***	1.694***	-0.00145
	(0.000145)	(0.00123)	(0.233)	(0.502)	(0.00467)
Lending standards	0.00194				
	(0.00142)				
Lending growth		0.0132			
		(0.0111)			
NPL's			-11.78***		
			(2.553)		
Loan allowances				-19.40***	
				(5.361)	
Monetary policy					0.0445
					(0.0495)
ML	-0.0215***	-0.0196***	-0.0313***	-0.0542***	-0.0180***
	(0.00370)	(0.00372)	(0.00614)	(0.0114)	(0.00382)
Eurozone	0.215**	0.243***	0.355***	0.414***	0.234***
	(0.102)	(0.0852)	(0.0945)	(0.0868)	(0.0874)
Control Variables	Y	Y	Y	Y	Y
Observations	6,596	6,643	6,030	6,032	6,639
R-squared	0.576	0.577	0.575	0.574	0.578

Panel B: Loan allowances

Dependent Variable: LB_{it}	(1)	(2)	(3)	(4)	(5)
Lending variables:					
(ML*Lending variable)	0.000433	0.000292	-1.512***	-3.462***	0.00462
	(0.000363)	(0.00439)	(0.499)	(1.202)	(0.0157)
Lending standards	0.000655				
	0.000413				
Lending growth		0.00692**			
		(0.00264)			
NPL's			-2.293***		
			0.509		
Loan allowances				-4.825***	
				(1.212)	
Monetary policy					0.0460***
					0.00955
ML	0.0285**	0.0306***	0.0677***	0.109***	0.0310***
	(0.0112)	(0.0112)	(0.0139)	(0.0260)	(0.0110)
Eurozone	0.218**	0.258***	0.358***	0.413***	0.239***
	(0.106)	(0.0793)	(0.0924)	(0.0872)	(0.0861)
Control Variables	Y	Y	Y	Y	Y
Observations	6,914	6,961	6,348	6,349	6,955
R-squared	0.565	0.566	0.566	0.564	0.568

B. *Including time fixed effects*

In this section of the robustness checks I introduce quarterly calendar fixed effects. The introduction of a calendar dummy will absorb all the calendar related effects that are constant across firms and varies quarter by quarter. Calendar fixed effects net out effects related to the two crises included in the sample (the 2007-2009 financial crisis in U.S. and the 2009 sovereign debt crisis in Europe). The downside of including time fixed effects is that the effect of time-varying only variables will be absorbed. Including calendar fixed effects might absorb all the significance from the lending variables' coefficient.

In Table V the estimation of the main lender regression is repeated including calendar fixed effects. The coefficient of the interaction in column (4) (that uses the loan allowances as lending variable) loses some significance and it is now significant only at 5%. The rest of the coefficients are very close in magnitude to those obtained in Table II and they are still significant. Overall the effect documented in Table II seems robust to the introduction of quarterly calendar effects.

Table V. Robustness 2/4

Table V reports results of the main lender specification including calendar fixed effects for the five lending variables considered: 1) Lending standards, 2) Lending growth, 3)Non-performing loans, 4) Loan allowances and 5) Monetary policy. The dependent variable LB_{it} equals 0 if a firm issue loans only, equals 1 if the firm issues bonds and is a number between 0 and 1 if a firm issued both forms of finance in a given quarter. ML is the combined capital ratio. The interaction term is the product of the ML variable with the lending variable used in the specification. Each coefficient reported is the result of an OLS regression which includes both firm-fixed effects and calendar-quarter fixed effects. The specification also controls for firms' characteristics. The estimation period is 2002:Q1 - 2015:Q2, all errors are clustered quarterly.

	Dependent Variable: LB_{it}				
	(1)	(2)	(3)	(4)	(5)
Lending variables:					
(ML*Lending variable)	-0.000213	-0.000962	1.032***	1.880**	-0.000488
	(0.000180)	(0.00192)	(0.325)	(0.767)	(0.00596)
Lending standards	0.00161				
	(0.00244)				
Lending growth		0.0125			
		(0.0256)			
NPL's			-15.12***		
			(5.134)		
Loan allowances				-27.15**	
				(11.57)	
Monetary policy					0.0310
					(0.0857)
ML	-0.0141***	-0.0139***	-0.0331***	-0.0558***	-0.0148***
	(0.00444)	(0.00425)	(0.00660)	(0.0173)	(0.00424)
Eurozone	0.209**	0.224**	0.371***	0.414***	0.222**
	(0.0994)	(0.0886)	(0.0918)	(0.0935)	(0.0884)
Constant	0.696***	0.698***	1.043***	1.344***	0.712***
	(0.0835)	(0.0801)	(0.143)	(0.282)	(0.0798)
Controls	Y	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y	Y
Calendar FE	Y	Y	Y	Y	Y
Observations	6,628	6,675	6,063	6,065	6,671
R-squared	0.604	0.603	0.601	0.601	0.604

Robust standard errors in parentheses
*** p¡0.01, ** p¡0.05, * p¡0.1

In Table VI the only lending variables that remain significant -even after the introduction of time fixed effects- are the non-performing loans variable and the loan allowances variable in column (3) and column (4) respectively. The two lending variables maintain the negative sign despite with a lower magnitude. The evidences in this chapter suggest that these two variables are the most significant indicators of deteriorating lending conditions and are those

Table VI. Robustness 3/4

Table VI reports results of the specification including calendar fixed effects for the five lending variables considered: 1) Lending standards, 2) Lending growth, 3)Non-performing loans, 4) Loan allowances and 5) Monetary policy. The dependent variable LB_{it} equals 0 if a firm issue loans only, equals 1 if the firm issues bonds and is a number between 0 and 1 if a firm issued both forms of finance in a given quarter. RL is the relationship lending variable. The interaction term is the product of the RL variable with the lending variable used in the specification. Each coefficient reported is the result of an OLS regression which includes both firm-fixed effects and calendar-quarter fixed effects. The specification also controls for firms' characteristics. The estimation period is 2002:Q1 - 2015:Q2, all errors are clustered quarterly.

	Dependent Variable: LB_{it}				
	(1)	(2)	(3)	(4)	(5)
Lending variables:					
(RL*Lending variable)	0.000771**	-0.00351	0.0168**	0.0173**	-0.0157*
	(0.000317)	(0.00217)	(0.00664)	(0.00727)	(0.00864)
Lending standards	-0.000488				
	(0.000373)				
Lending growth		-0.00129			
		(0.00184)			
NPL's			-0.0239***		
			(0.00750)		
Loan allowances				-0.0344***	
				(0.00879)	
Monetary policy					0.00707
					(0.00637)
RL	0.883***	0.883***	0.909***	0.907***	0.879***
	(0.0153)	(0.0148)	(0.0114)	(0.0117)	(0.0150)
Constant	0.971***	0.945***	0.911***	0.906***	0.945***
	(0.0736)	(0.0698)	(0.0719)	(0.0718)	(0.0702)
Controls	Y	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y	Y
Calendar FE	Y	Y	Y	Y	Y
Observations	16,784	16,909	16,150	16,150	16,585
R-squared	0.520	0.521	0.521	0.521	0.518

Robust standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

whose changes are more likely to prompt firms to modify their debt structure. Nevertheless, we are interested only in the coefficients associated to the interaction between the lending variable and the lender's type. All of the coefficients of the key variable of interest from column (1) to column (5) maintain the same sign with respect to coefficients in the main specification and also the significance levels follow those already reported in Table III.

The coefficients in this robustness section confirm the main finding that the structure of the banking system is a main determinant of the firm choice of financing. The only exception in this table is given by the interaction between the relationship lending variable and the lending growth. In this case it appears that once controlled for the quarterly calendar effects, the aggregate lending growth does not interact with the relationship lending variable in a significant way. I interpret this result as if growth in lending does not affect differentially firms with bank relationship ties compared to other firms.

C. *Conditioning on past bond issuance and debt maturity*

In Table VII the main specification of Table III is run several times with different filters. Only coefficients for RL, the lending variable, and the interaction between the two variables are reported as long as their level of significance. All the regressions are estimated using OLS and include firm-level fixed effects. In the top row the columns refer to coefficients that are estimated as follows: i) without applying any bond filtering, ii) with a standard 5 year filter on past issuance, and iii) with a 2 years filter in columns (1), (2), and (3) respectively. Each of these three columns is further divided into "Long-term" which refers to coefficient obtained from a sample where shorter maturity debt obligations (with maturity<1 year) are filtered out and "Full" in which the sample is not filtered for the maturities. The column "No filter-Full" reports the benchmark results of the main regression specification.

The signs of the coefficients estimated in Table VII using different subsamples point in the same direction as those in the benchmark specification. Also their significance levels closely follow the benchmark. The magnitude of the coefficients slightly varies but is overall consistent with the evidences provided in this chapter. The robustness of the estimated coefficients to the applied filters significantly reduces the probability that the higher amount of bank credit obtained by firms in periods of monetary contraction is not due to the lack of accessibility to the bond market. Moreover, even when excluding shorter term loans, the coefficients do not change sensibly. I interpret this as evidence that the point estimates are capturing the effect of relationship lending. Informed lenders, using firm specific information collected over the years, do not necessarily lend funds for short terms as could be the case

Table VII. Robustness 4/4

Table VII reports the results of the main regression on different subsamples filtered according to past bond issuance and debt maturity. The dependent variable LB_{it} equals 0 if a firm issue loans only, equals 1 if the firm issues bonds and is a number between 0 and 1 if a firm issued both forms of finance in a given quarter. RL is the relationship lending variable. The interaction term is the product of the RL variable with the lending variable used in the specification. 5Y filter means that firm-quarters for which no bonds have been issued in the previous 5 years are dropped from the sample, 2Y filter means that firm-quarters for which no bonds have been issued in the previous 2 years are dropped from the sample and No filter does not filter for past bonds' issuance. Long term filter exclude all forms of debt with maturity lower than 12 months. Each coefficient reported is the result of an OLS regression which includes firm-fixed effects and controls for firms' characteristics. The estimation period is 2002:Q1 - 2015:Q2, all errors are clustered quarterly.

Bond filter:	No filter		5Y filter		2Y filter	
Maturity filter:	Long-Term	Full	Long-Term	Full	Long-Term	Full
RL	0.907***	0.908***	0.894***	0.895***	0.880***	0.882***
(RL*Lending standards)	0.000842***	0.000805**	0.00149***	0.00152***	0.00144***	0.00154***
Lending standards	-0.00108***	-0.000985***	-0.00208***	-0.00196***	-0.00243***	-0.00237***
RL	0.911***	0.912***	0.904***	0.904***	0.892***	0.894***
(RL*Lending growth)	-0.00485**	-0.00477**	-0.00739**	-0.00666*	-0.0110**	-0.00954*
Lending growth	0.00238*	0.00251*	0.00143	0.00159	0.00366*	0.00385*
RL	0.932***	0.932***	0.923***	0.922***	0.912***	0.912***
(RL*NPL's)	0.0201***	0.0191**	0.0199**	0.0183**	0.0215**	0.0199**
NPL's	-0.0348***	-0.0327***	-0.0428***	-0.0385***	-0.0527***	-0.0486***
RL	0.930***	0.930***	0.922***	0.921***	0.910***	0.910***
(RL*Loan allowances)	0.0201***	0.0190**	0.0205**	0.0189**	0.0218**	0.0202**
Loan allowances	-0.0433***	0.0400***	-0.0555***	-0.0493***	0.0642***	-0.0584***
RL	0.904***	0.905***	0.895***	0.896***	0.880***	0.882***
(RL*Monetary policy)	-0.0243***	-0.0240**	-0.0251	-0.0233	-0.0338*	-0.0313*
Monetary policy	0.0141**	0.0142**	0.0293	0.00356	0.0151	0.0139
Firm FE	Y	Y	Y	Y	Y	Y

*** p<0.01, ** p<0.05, * p<0.1

for transaction lenders. Indeed they can lend for longer term as they are better aware of the borrower's ability to repay the debt in the future.

6. Discussion

The role of information has always been crucial in the analysis of bank loan supply and of its link with the real economy. In this chapter, I investigate how informed lenders' characteristics affect the debt structure choice of firms. In particular, in section 4 I look at informed lender characteristics from two different perspectives.

In the first part of the empirical section I define the lead arranger as the informed lender following Sufi (2007). Since we are in a world in which borrowers and lenders repeatedly interact, I further define the lead arranger interacting the most with each borrower as his main lender. The main lender so defined should therefore be superiorly informed on firm's value and could continue lending (or stop lending) despite the credit cycle but only based on firms' fundamentals and bank own availability of funds.

The second part of the empirical section deals specifically with the effect of relationship lending on firms' debt structure. Relationship lending, in spite of the higher rates charged, could be beneficial to firms by rolling over debt when transaction banks pull out. Academic research has tried to shed light on the benefits and the costs that a firms face when choosing to release soft information to one or few banks over time. The most interesting development of the research in this field concerns the value of relationship lending in crisis period as compared to normal period. Previous literature addressed the issue from both a theoretical and an empirical point of view concluding that relationship lending is useful in periods of distress because superiorly informed banks will continue lending to profitable firms that otherwise would be credit rationed. On the other hand, in normal times there is no evidence of positive impacts of relationship lending on firms; if something the relationship bank will charge higher prices to exploit the monopoly rent acquired.

The challenge faced by the empirical literature lies in the absence of a proper measure of relationship lending and thus the need of choosing credible proxies for the latent variable. The problem of using proxies is that often they can capture a different effect with respect to the one at which the econometrician aims. Therefore, it is necessary a credible empirical strategy that addresses both the identification and the endogeneity problems arising in this field of empirical estimation. I use an empirical strategy that tackle the problems from three different angles so that I can reasonably assume to have captured the desired effect.

The first step is the definition of the relationship lending variable. Using a combination of two widely used measures of relationship lending adopted in the literature I am confident that the variable I construct is highly correlated with the existence of bank-firm long lasting connection. Unfortunately, this is not enough because I could be simply capturing the effect of a variable correlated to the relationship lending that it is not relationship lending, and it is correlated to other factors left in the error term. The main candidate confounding factor is the creditworthiness of the firm.

The second step is to define the dependent variable in a way that if the relationship lending variable were capturing the effect of a generalised lack of information or a low creditworthiness of the firm rather than proxying for relationship lending, then there should be no significant effect in the key coefficient of interest. In fact, in each firm-quarter there is at least a single debt contract written, thus a decrease in the dependent variable implies a switch to bond financing. If the effect captured was generalised and not related to relationship lending this should have affected any form of financing indifferently returning a null coefficient in statistical sense.

Finally, by using a diff-in-diff approach, all the effects that might have been captured by the explanatory variable and that were representing fixed differences between firms with relationship lender links and firms without it are netted out.

The results in section 4 give an interpretation to the apparently controversial figures in the previous chapter. Indeed, the inclusion in the analysis of factors related to the lender itself and not only to the borrower shed new light on the reasons why some firms raise additional funding from banks even when we expect to see a generalized decline in lending. The additional funding raised during a generalized reduction in loan supply will not be more costly for firms that are in some way linked to safe lender or alternatively for firms which entertain a long-lasting lending relationship with one or few specific banks.

The findings of this empirical analysis, and thus the contribution of this chapter to the literature on the relationship between bank characteristics and the credit cycle, confirm that informed lender characteristics are relevant in explaining the choice of the firm between bank debt and market debt. Lead arrangers that interact repeatedly with firms and thus are superiorly informed on firm's value, tend to lend more when their fundamentals are strong despite the credit cycle. Moreover, when the informed bank is a relationship lender (as defined in this chapter) the adverse effects of a monetary contraction are reduced.

IV. The Relative Pricing of Sovereign Credit Risk After the Eurozone Crisis

1. Introduction

Credit derivatives and debt securities are strictly related, since the pricing of both types of financial assets crucially depends on the risk of default of the reference entity. Credit Default Swaps (CDS) and bonds issued by the CDS reference entity produce similar exposure to the investor in terms of risk and return. The CDS provides protection to the acquirer in case of default of the reference entity, while the bond pays out yields to the bondholder as long as the reference entity is able to comply with its obligations.

In this paper, we study the relationship between sovereign CDS and sovereign bonds, in terms of risk and return, for the European countries, during and after the sovereign debt crisis, from 2010 to 2016. Our main finding is the following: after the launch of the Outright Monetary Transaction (OMT) Programme, by the European Central Bank, the relative mispricing of the sovereign credit risk has strongly reduced. We disentangle the effects of the ECB intervention on the sovereign credit risk market in different ways, and we provide evidence that the consistent relationship between risk and return for the Eurozone sovereign securities was restored after the ECB intervention.

Therefore, we contribute to three strands of academic research. We first offer empirical evidence on the theoretical relationship between CDS premium and bond yields across the European countries. Hull et al. (2004) point out that, under a large set of assumptions that ensure absence of frictions in the market, a portfolio including CDS and bond, issued by the reference entity, generates cash flows equal to a riskless bond in all states of the world. The difference between the two portfolios cash-flow is defined as basis, and it is usually adopted as observed measure of mispricing. Hence, the CDS premium should be equal to the excess risky yield over the risk-free rate (zero-basis condition).

Mispricing has been documented for both corporate (Longstaff et al. (2005), Blanco et al. (2005)), and sovereign securities (Palladini and Portes (2011), Arce et al. (2013), Fontana and Scheicher (2016)). These papers argue that CDS spreads are faster in price discovery, thus reacting quicker to changes in credit condition. As a consequence, the relationship CDS spread - bond spread does not hold in the short-term. However, they show that CDS spreads and bond yields exhibit strong co-movements in a long-term perspective. The widely used technique of detection of this relationship is the cointegration analysis.

While Palladini and Portes (2011), Arce et al. (2013), and Fontana and Scheicher (2016) provide evidence of the relative pricing of the sovereign credit risk before and during the sovereign crisis, we extend the analysis to the period following the ECB intervention, including also countries outside the Eurozone, with the aim of highlighting the differential effects of the unconventional monetary policy.

We show that the equilibrium condition was violated before the announcement of the OMT, and then restored afterwards, for the Eurozone countries, and in particular for the peripheral countries of the Eurozone. Instead, the deviation from the equilibrium condition is persistent and constant over the entire period for the European countries out of the Eurozone.

Moreover, deviations from the equilibrium condition may generate arbitrage opportunities, that should be unsystematic, and then quickly disappear. We document that these opportunities were large and persistent before the annnouncement of the OMT, and then almost disappear, for the Eurozone countries. Instead, we do not observe significant changes between before and after the annnouncement of the OMT for the countries outside the Eurozone. We detail the potential arbitrage strategies implementable by trading sovereign bond yields and CDS, and we show that in the Eurozone the strategies are largely profitable before the launch of the OMT, and then converge towards zero-profits afterwards.

As second contribution, we investigate the consistency of the relationship between risk and return for sovereign securities. The positive relationship between risk and expected return is one of the milestones in financial theory. Investors are willing to buy risky assets only if they are rewarded with a proper expected return. The higher is the risk associated to a given investment, the higher must be the expected return. It turns out that entities marked by higher risk of default should issue more rewarding securities, compared to safer issuers, in order to attract investors. The empirical contradiction of the positive relationship between risk and expected return is known in the financial literature as *distress puzzle*.

We document that a distress puzzle at the sovereign level emerges during the crisis period for the Eurozone countries, and then is ruled out after the launch of the OMT programme.

The distress puzzle has been widely investigated in the context of corporate securities, by studying the relationship between the firm's default risk and the expected return on firm's equity shares. The empirical evidence is far from being univocal (see, among others, Vassalou and Xing (2004), Campbell, Hilscher, and Szilagyi (2008), Friewald, Wagner, and Zechner (2014)). To the best of our knowledge, however, an analysis of the puzzle at the sovereign level is still missing. As countries do not issue equity, we focus on the debt-related securities.

The intuition is simple. If a country is more likely to default with respect to another country, then the riskier country must issue debt securities that generate higher expected return for the investor, with respect to the safer country. In practice, the riskier country must issue bonds that pay out higher yields. However, it may happen that the riskier country pays out an excess bond yield, with respect to the safer country, that is too low than it should be paid, or that the excess bond yield of the riskier country is too high. Therefore, the monotonic relationship between bond yields and CDS spreads across countries is a necessary but not sufficient condition to rule out the distress puzzle.

To determine the proper distance between bond yields of different countries, we adopt a simple credit risk structural model, in order to obtain a simultaneous relationship between CDS spreads and bond yields for a country. In a structural model, in fact, bond and CDS are implicitly related at each point in time, as both are derivative contracts of the same underlying quantity, that are the assets and the liabilities of the reference entity. In particular, we adopt a first-passage time model, where the issuer defaults as soon as the value of the assets crosses from above a default boundary, assumed to be deterministic and constant. This framework is an extension of the seminal model of Merton (1974), where the issuer may default only at the maturity of the liability. Gapen, Gray, Lim, and Xiao (2011) introduce contingent claims analysis to study sovereign credit risk, by using a Merton model.

Hence, the default risk of the country is priced in the CDS spread, where the default risk is due to the probability that the leverage of the country reaches a given threshold, to be estimated, that is unsustainable. There is, then, a one-to-one mapping between leverage and CDS spread, where the model provides the specific functional form of the mapping.

We estimate the model with a non-linear Kalman filter in conjunction with maximum likelihood, by using daily data on CDS spreads over three different time horizons, i.e. 1,5, and 10 years. We reconstruct the dynamics of the market value of the leverage of the country, defined as the ratio between debt and asset, and we estimate the value of the default boundary. Sovereign assets include current and future surpluses, international reserves, and residual items (see Gapen et al. (2011)). With the estimated parameters, we are then able to compute the bond yields implied by the model estimation using Monte Carlo (MC) simulation techniques. These are the yields implied by the CDS spreads, as we use the observed CDS spreads, and the relationship between default risk and leverage defined by the model, in order to estimate the model parameters and to reconstruct the dynamics of the country's leverage. Then, we use the relationship between bond yields and leverage defined by the model in order to compute the implied bond yields.

The implied bond yields are then subtracted from the observed bond yields, thus obtaining a net yield for each country, and each point in time. Then, we can evaluate the monotonicity between CDS spreads and bond yields across countries, for each point in time. If the excess bond yield of the riskier country, in fact, is too low than it should be, then the net yield of the safer country would be higher than the net yield of the riskier country. The result is a not monotonic relationship between CDS spreads and net yields.

To investigate the violation of the monotonicity condition over a cross-section of countries, we measure the Spearman's correlation between CDS spreads and net yields, for each point in time. The Spearman's correlation evaluates the presence of a monotonic relationship between two variables, regardless the relationship is linear or not. The closer is the correlation to 1, the closer is the distance in the bond yields, across countries, to the cross-sectional distance that is consistent with the differences across countries in terms of default risk priced in the CDS. In fact, if we compute the cross-sectional correlation between CDS spreads and risky bond yields by using the theoretical yield implied by the zero-basis condition, this correlation is always equal to 1, for each point in time.

We show that the correlation between CDS spreads and net yields randomly moves around zero for the Eurozone countries before the OMT announcement, then approaching 1 right after the OMT announcement, and remaining stable afterwards. Instead, the countries out of the Eurozone do not show significant change in the cross-sectional correlation between CDS spreads and net yields after the OMT announcement.

Note that if the observed distance between the bond yields of two countries is too high, then the monotonic relationship between CDS spreads and net yields still holds. Therefore, in principle, the correlation analysis is able to detect only if there is a sufficient distance between bond yields, across countries. However, it turns out that if the distance between the bond yields of two countries is too high, then it is likely that the distance between the yields of one of the two countries and a third country's bond yield is too low, thus returning at the end a lower value of the correlation coefficient.

Finally, we intervene in the discussion on the effects of the unconventional monetary policies implemented by central banks. Several papers have shown that the ECB intervention in 2012 has significantly lowered the credit spreads of sovereign bond securities, and has also drastically reduced the level of the premium paid on the CDS. Further to the simultaneous reduction of sovereign CDS spreads and bond yields, following the ECB intervention, we document a strong reduction of the distortion in the relative pricing of the sovereign credit risk, which restored the equilibrium conditions, and cleared the potential arbitrage opportunities.

Our paper is organized as follows. We first describe the data in the next section, then we provide empirical evidence on the relationship between CDS spreads and bond yields during and after the OMT announcement, in section 3. In section 4, we detail the underlying credit risk model, and our estimation methodology to compute the implied bond yields. In section 5, we present the empirical investigation. We start the analysis by comparing observed and implied yields, then we proceed with the correlation analysis, and finally we describe potential arbitrage strategies and riskless profits. Section 6 concludes the paper.

2. Data

Our main source of data is Thomson Reuter's DataStream. We download daily data for sovereign CDS spreads and sovereign government bond yields for several European countries, and a sample period going from the 4^{th} January 2010 to the 1^{st} February 2017. Hence, we collect a time series of 1850 daily observations for each country, for both CDS spreads and bond yields, and for three time horizons: 1,5, and 10 years maturity. Datastream provides reference par yields for sovereign bonds at different maturities. The par yield is the internal rate of return (yield to maturity) of a bond traded at par, and it is expressed as an annualized figure. Instead, the CDS spread is expressed in basis points, and represents the percentage of the CDS notional value that the protection buyer must pay, usually at quarterly frequencies, to the protection seller. CDS spreads are also expressed in annualized terms.

We use all the maturities of the CDS spreads to implement the estimation methodology, however we focus throughout the paper on the 5-years maturity in order to show the results of the empirical analysis. We also collect data on the Euribor to represent the European short term risk-free interest rate curve. At longer maturities we proxy the risk-free rate with the euro area yield curve computed exclusively on AAA-rated central government bonds, and we also use a Nelson-Siegel technique to bootstrap the maturities of the risk-free curve needed to obtain the present values of CDS that we use in the arbitrage strategies.

We apply a filter to the sample, excluding those countries which report an excessive number of missing data on bond yields or CDS spreads -more than 40% of the total observations for at least one maturity- thus dropping from the sample Cyprus, Luxembourg, and Malta. We also exclude Greece that deserves a specific analysis due to the dramatic turbulence experienced during the sample period. We drop from the sample Estonia, Latvia and Lithuania, as these countries change their status from Non-Eurozone to Eurozone over the sample period. We end up with a final sample of 22 countries. In particular, 12 countries belong to the Eurozone, and 10 are out of the Eurozone. Throughout the analysis, we also divide the sample of the Eurozone countries in two subgroups: core, and periphery. The list of countries is reported in table I

A. Descriptive Statistics

In table I we report data on CDS spreads and bond yields for each single country in the sample. Table I shows that both bond yields and CDS spreads are significantly lower after the announcement of the OMT Programme by ECB governor Mario Draghi on July 26^{th}, 2012. The differences are significant at 5% level (except for the CDS in Slovenia), when considering both mean and median.

In table II we report figures for the time series of mean and median across countries before and after July 2012. We also provide a breakdown of mean and median by different group of countries. Therefore, we observe that bond yields and CDS spreads are generally lower for the core countries with respect to both the peripheral and the No Eurozone countries, before and after the OMT announcement. Yet, the reduction in both spreads and yields is significant at 5% level even for the core countries. Finally, the distance that we report between mean and median of bond yields across countries after July 2012 is probably driven by the presence of some outlier country over a given interval of time.

3. The CDS - Bond basis

CDS spreads and yields on a risky bond issued by the reference entity of the CDS contract are strictly related. The CDS provides protection to the acquirer in case of default of the reference entity, while the bond pays out yields to the bondholder as long as the reference entity is able to comply with its obligations. In particular, Hull et al. (2004) have pointed

Table I. Descriptive Statistics by Country

Statistics:	Average			Median		
	Before OMT	After OMT	Difference	Before OMT	After OMT	Difference
Eurozone						
Core:						
Austria	78.19	20.22	-57.97*	3.14	1.21	-1.93*
Belgium	143.11	33.93	-109.19*	3.77	1.44	-2.33*
Finland	46.50	24.74	-21.76*	2.79	1.14	-1.65*
France	83.17	31.86	-51.31*	3.13	1.37	-1.76*
Germany	39.15	12.58	-26.57*	2.48	0.93	-1.55*
Netherlands	67.26	31.74	-35.53*	7.63	2.31	-5.31*
Peripheral:						
Ireland	485.07	80.00	-405.07*	4.94	2.81	-2.13*
Italy	229.15	138.40	-90.75*	2.80	1.15	-1.65*
Portugal	633.77	247.09	-386.67*	8.85	4.35	-4.49*
Slovakia	136.00	61.90	-74.10*	4.18	1.89	-2.29*
Slovenia	164.69	168.27	3.58	5.10	2.90	-2.20*
Spain	243.27	115.66	-127.62*	5.62	3.07	-2.55*
No-Eurozone						
Bulgaria	258.99	130.61	-128.39*	6.53	4.28	-2.25*
Croatia	316.38	274.95	-41.43*	3.72	1.30	-2.41*
Czech Republic	98.95	49.67	-49.28*	2.56	1.08	-1.48*
Denmark	60.44	17.83	-42.61*	7.86	4.66	-3.20*
Hungary	353.35	191.21	-162.14*	6.75	6.36	-0.39*
Norway	26.58	16.23	-10.35*	5.17	3.85	-1.32*
Poland	160.49	71.75	-88.74*	5.51	2.47	-3.04*
Romania	301.57	145.09	-156.47*	3.01	1.98	-1.02*
Sweden	36.48	12.96	-23.52*	5.79	3.45	-2.34*
UK	65.54	27.81	-37.73*	7.51	4.49	-3.02*

Legend: The table reports the figures for the descriptive statistics at country level. For each of the two statistics analysed the table reports the figure for the period before the OMT and for the period after the OMT the third column is the difference between the two subperiods: (After OMT - Before OMT). The average and the median statistic are computed as the average and the median of the whole subperiod time series for each country. The * indicates that the difference is significant at the 5% level.

□

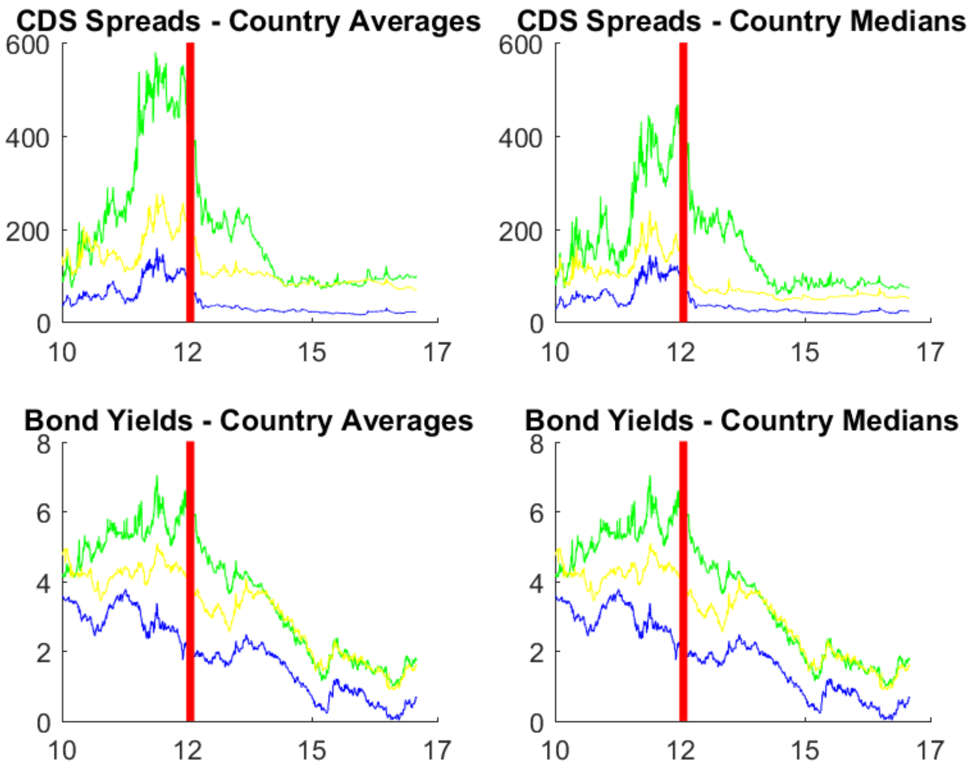
Table II. Descriptive statistics by asset

	Average of Mean			Average of Median		
	Before OMT	After OMT	Difference	Before OMT	After OMT	Difference
Overall:						
CDS	183.10	86.57	-96.53*	125.70	52.40	-73.30*
Yields	4.95	2.66	-2.29*	4.70	0.24	-4.45*
Breakdown by country group:						
<u>Core</u>						
CDS	73.23	25.84	-50.39*	70.57	26.24	-44.33*
Yields	3.82	1.40	-2.42*	3.13	0.13	-3.01*
<u>Periphery</u>						
CDS	315.33	135.22	-180.11*	239.24	125.14	-114.10
Yields	5.25	2.69	-2.55*	4.84	0.27	-4.58*
<u>Non-Eurozone</u>						
CDS	167.88	93.81	-74.07*	129.99	60.74	-69.24*
Yields	5.44	3.39	-2.05*	5.84	0.36	-5.48*

Legend: The table reports statistics for the for the time series of CDS spreads and bond yields before and after the OMT announcement date and their difference for the overall sample, and separately for the three different country groups that we identified as: "Core", "Periphery", and "No Eurozone". The "Average of Means" is computed as the average over the subperiod time series of the mean CDS spread and yield in the cross section of countries at each time t. The "Average of Median" is computed as the average over the subperiod time series of the median CDS spread and yield in the cross section of countries at each time t. The * indicates that the difference is significant at the 5% level

□

Figure 1. CDS spreads and Yields Dynamic



Legend: The figure reports the dynamics of average and medians of the cross section of countries for CDS spreads and bond yields over the sample time series, at the 5-years maturity, for the three different groups of countries. The blue line represents the dynamic for the core countries of the Eurozone, the green line is for the peripheral countries of the Eurozone, and the yellow line is the average of the cross section of No-Eurozone countries. The red line is the OMT announcement date.

□

out that, under a large set of assumptions, the T-years CDS spread should be equal to the T-years excess yield on a risky bond, issued by the reference entity, over the T-years riskless bond.

The reason is simple: if the assumptions listed by Hull et al. (2004) hold, a portfolio including a T-years CDS and a T-years par yield bond, issued by the reference entity, generates cash flows equal to a T-years par yield riskless bond in all states of the world, and so

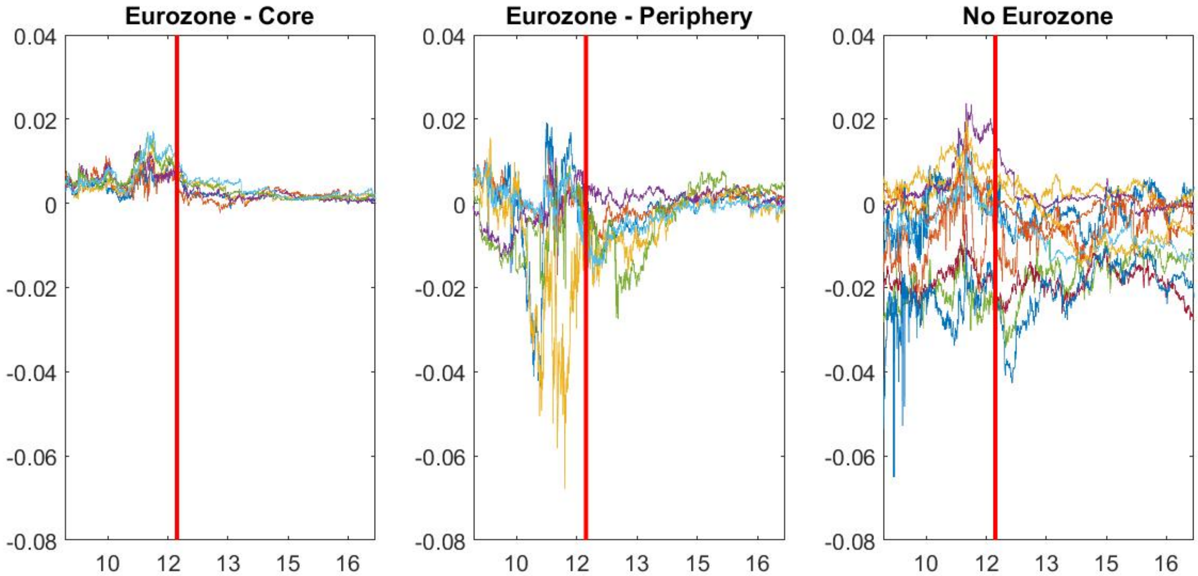
$$s = y - r, \tag{1}$$

where s is the T-years CDS spread, y is T-years yield on the risky bond, and r is the T-years yield on the riskless bond. If this relationship does not hold, then an arbitrage opportunity arises in the market by trading CDS, risky bond, and riskless asset. We will analyze later in the paper the riskless profits generated by the potential arbitrage strategies that exploit the violation of the equation (1).

We show now empirical evidence on the relationship between CDS spreads and risky bond yields for our sample countries, over the time interval covered by our dataset. We group the countries in the three sub-samples: Eurozone-Core (EC), Eurozone-Periphery (EP), and No-Eurozone (NZ). We define as *basis* the difference between the T-years CDS spread and the T-years excess yield on a risky bond, issued by the reference entity, over the T-years riskless bond.

Figure 2 shows the dynamics of the basis for each country. The EC countries have basis substantially lower than the EP countries and the NZ countries. More importantly, the basis of both the core and periphery countries of the Eurozone converge to zero right after the OMT announcement, and then remains around zero over the following years. The NZ countries, instead, do not show the same convergence in terms of basis, and appear to be spread around the zero in a similar way before and after the OMT announcement.

Figure 2. CDS spreads - Bond Yields basis



Legend: The figure reports the dynamics of the basis (CDS spread - Bond Yield) for each country over the sample time series, at the 5-years maturity, for the three different groups of countries. The basis is expressed in percentage terms, i.e. basis points divided by 10000. The red line is the OMT announcement date.

□

This result is also evident looking at the average of the absolute basis across groups of countries. Table III reports that the absolute basis has substantially reduced for the Eurozone countries in the second period of the time series(-65% for the EC, -55% for the PC, respectively), while the decrease is much lower for the NZ countries (-10%).

Table III. Average Absolute Basis (CDS spreads - Bond Yields)

	Euro - Core	Euro - Periphery	No Eurozone
Before OMT	0.0063	0.0078	0.105
After OMT	0.0022	0.0036	0.090

Legend: The basis is expressed in percentage terms, i.e. basis points divided by 10000. Both CDS spreads and Bond yields are at 5-years maturity

□

4. CDS-implied bond yields

In this section, we estimate a credit risk structural model in order to determine the risky bond yield of a country consistent with the country's default risk priced in the CDS spreads of the country. The procedure that we adopt is the following: first, we reconstruct the unobservable dynamics of the leverage, defined as debt/asset ratio, of each country, by performing a non-linear Kalman filter, and using the CDS spreads as observable variables. The Kalman filter enables to retrieve the dynamics of a latent variable, by using an observable variable and the ex-ante known relationship between the two variables. The relationship between the observed and the unobserved variables forms the *measurement equation*, while the evolution over time of the latent variable is called *transition equation*. We estimate the model parameters by adopting a quasi-maximum likelihood algorithm, in conjunction with the Kalman filter. Details of the estimation methodology are provided in Appendix A.

Then, we perform Monte Carlo (MC) simulations to compute the implied yields on a risky zero-coupon bond, for each country, over the sample time series. In the MC simulations, for each country, we use the dynamics of the leverage, and the estimates of the model parameters, of the first step. In the next subsection, we describe the underlying model, then we briefly introduce the Kalman filter applied to our estimation problem. In the last subsection, we detail the MC simulations, and we describe the implied yields obtained from the simulations.

A. Underlying Model

The asset value of the i-th country is described by a geometric Brownian motion on the filtered probability space $(\Omega, \mathcal{F}, \{\mathcal{F}_t : t \geq 0\}, \mathcal{P})$:

$$dV_{i,t} = \mu_{V_i} V_i dt + \sigma_{V_i} V_i dW_{i,t},$$

where μ_{V_i} and σ_{V_i} are the $\mathcal{P}$-drift and diffusion constant coefficients, $W_{i,t}$ is a standard Brownian motion under the physical probability measure $\mathcal{P}$.

We define the i-th market value of leverage as $L_{i,t} = \ln\left(\frac{F_i}{V_{i,t}}\right)$, following an arithmetic Brownian motion,

$$dL_{i,t} = \mu_{L_i} dt - \sigma_{L_i} dW_{i,t}, \tag{2}$$

where $\mu_{L_i} = -\left(\mu_{V_i} - \frac{1}{2}\sigma_{V_i}^2\right)$ is the $\mathcal{P}$-leverage drift coefficient, and $\sigma_{L_i} = \sigma_{V_i}$ is the leverage diffusion component. As result of the inverse relationship between the asset and the leverage values, the minus before the diffusion component stands for the perfect and negative correlation between the Brownian motions of the asset value and the leverage dynamics.

In the first-passage time framework, default occurs as soon as the asset value crosses from above a constant and deterministic barrier C_i, that we assume to be below the face value of the debt, at any time s, with $t \leq s \leq T$, where T is the outstanding debt maturity. The country's default risk is priced in the credit default swaps (CDS) issued with different maturity τ_j, with j going from 1 to J, where the longest maturity τ_J matches the debt maturity T. In a CDS contract, the protection buyer pays a fixed premium each period until either the default event or the contract expiration, and the protection seller is committed to buy back from the buyer the defaulted bond at its par value.

Therefore, the price of the CDS, i.e. the premium (the spread) paid by the insurance buyer, is defined at the inception date of the contract in order to equate the expected value of the two contractual legs. Then, by assuming the existence of a default-free money market account appreciating at a constant continuous interest rate r, and M periodical payments occurring during one year, the CDS spread γ with time-to-maturity τ_j, priced at $t = 0$, solves the following equation:

$$\sum_{m=1}^{M} T \frac{\gamma}{M} \exp\left(-r\frac{m}{M}\right) \mathcal{E}_0^{\mathcal{Q}}[1_{t^* > \frac{m}{M}}] = \mathcal{E}_0^{\mathcal{Q}}[\exp(-rt^*)\alpha 1_{t^* < \tau_j}],$$

where t^* stands for the time of default, α is the amount paid by the protection seller to the protection buyer in case of default, and $\mathcal{E}_0^{\mathcal{Q}}$ indicates that the expectation is taken under the risk-neutral measure $\mathcal{Q}$. Therefore, $\mathcal{E}_0^{\mathcal{Q}}[1_{t^*<\tau_j}]$ is the probability that the country defaults at any time before τ_j, that is the probability that the asset value crosses from above the barrier C_i. At t, this probability is equal to:

$$PD_{i,t}^{\mathcal{Q}}(\tau_j) = \Phi\left(\frac{K_i + L_{i,t} - \left(r - \frac{1}{2}\sigma_{L_i}^2\right)(\tau_j - t)}{\sigma_{L_i}\sqrt{(\tau_j - t)}}\right) + \exp\left((K_i + L_{i,t})\left(\frac{2r}{\sigma_{L_i}^2} - 1\right)\right)\Phi\left(\frac{(K_i + L_{i,t}) + \left(r - \frac{1}{2}\sigma_{L_i}^2\right)(\tau_j - t)}{\sigma_{L_i}\sqrt{(\tau_j - t)}}\right), \quad (3)$$

if $\tau_j < T$, otherwise

$$PD_{i,t}^{\mathcal{Q}}(\tau_J) = 1 - \Phi\left(\frac{-L_{i,t} + \left(r - \frac{1}{2}\sigma_{L_i}^2\right)(\tau_J - t)}{\sigma_{L_i}\sqrt{(\tau_J - t)}}\right) + \exp\left((K_i + L_{i,t})\left(\frac{2r}{\sigma_{L_i}^2} - 1\right)\right)\Phi\left(\frac{(2K_i + L_{i,t}) + \left(r - \frac{1}{2}\sigma_{L_i}^2\right)(\tau_J - t)}{\sigma_{L_i}\sqrt{(\tau_J - t)}}\right), \quad (4)$$

as $\tau_J = T$, and we have to consider not only the early bankruptcy risk as in the equation (2), but also the probability of the country not being able to pay back the outstanding debt F_i at time T, even though the asset value never crossed the default boundary.

Φ stands for the cumulative distribution function of a standard normal variable, and $K_i = \ln\left(\frac{C_i}{F_i}\right)$. As the default barrier is below the face value of the debt, K_i assumes only negative values. The larger is the magnitude of the absolute value of K_i, the larger is the distance between the face value of the debt F_i and the default barrier C_i.

B. *Model Estimation*

We formulate our problem in a state-space model, where the measurement equations come from (2)-(3). The noise terms associated with the CDS implied-default probability for different time to maturities τ_j are assumed to be uncorrelated, and with equal variance.

$$PD^{Q}_{i,t}(\tau_j) = g\left(L_{i,t}; K_i, \sigma_{L_i}\right) + \epsilon_{i,t}(\tau_j), [j = 1, 5, 10]$$

where the time to maturity is expressed in years, and $j = 10$ stands for the maturity T of the outstanding debt F_i (i.e., 10 years). The function g defines the non-linear relationships between the observable and the latent variable, and $\epsilon_{i,t}(\tau_a)$ is the measurement noise associated with the CDS implied-default probability equation and the time horizon j. These four measurement noises, for each country i, are assumed to follow a multivariate normal distribution, with zero mean, and diagonal covariance matrix R_i. We assume a homoscedastic covariance matrix, which is country-varying.

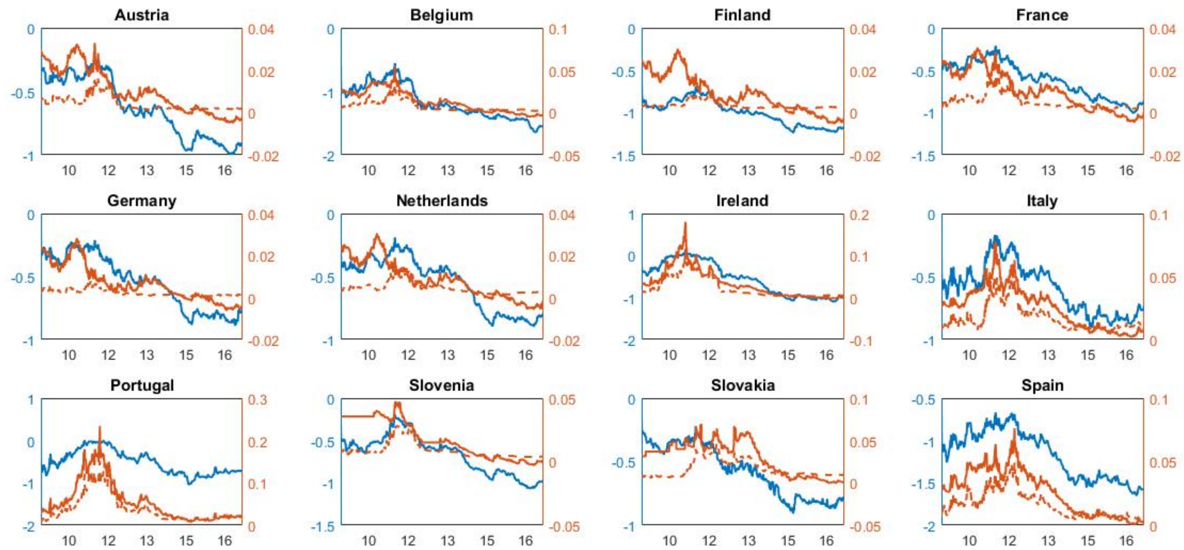
On the other side, the transition equation describes the evolution of the country's leverage. It follows from the discretization of the stochastic process defined in (1):

$$L_{i,t+\delta t} = L_{i,t} + \mu_{L_i}\delta t + \eta_{i,t+\delta t},$$

where $\eta_{i,t+\delta t} = \sigma_{L_i}(W_{i,t} - W_{i,t+\delta t}) \backsim \mathcal{N}(0, Q_i)$ is the transition error, and $Q_i = \sigma^2_{L_i}\delta t$.

The dynamics of $L_{i,t}$, and the parameters of the model, such as the parameters of the leverage dynamics (μ_{L_i}, σ_{L_i}) and K_i, are then estimated by performing a non-linear Kalman filter in conjunction with quasi-maximum likelihood estimation. For parsimony, the steps to implement the non-linear Kalman filter, and the construction of the likelihood function, are described in details in the Appendix A.

Figure 3. Leverage, CDS spreads and Bond Yields. Eurozone Countries



Legend: The figure shows the dynamics of the leverage of the country (blue line), as defined in the equation (1), reconstructed for each country by using the Kalman filter, the 5-years CDS spreads (dashed line) and the 5-years bond yields (red line), both expressed in percentage terms, i.e. basis points divided by 10000

□

Figure 3 provides an idea of the estimation results, thus comparing the reconstructed dynamics of the leverage, for the European countries, over the sample time series, against the observed dynamics of the 5-years CDS spreads and the 5-years observed bond yields. The dynamics of both CDS spreads and bond yields is in line with the dynamics of the country's leverage. When the CDS spreads and the bond yields reach very low values, in particular in the last part of the time series, then we estimate a leverage that moves far away from zero, towards negative values.

C. Monte Carlo simulations

The implied risky yields, for each point in time t, and each country, are obtained as average over the results of 10000 simulations. In particular, for each point in time t, and each country, we simulate the dynamics of the leverage for a time interval going from t to

$t + K * 360$, where K is the maturity of the bond expressed in years.

The leverage of a country is simulated by using the equation (2), where dt is one day step, the parameters of the stochastic process are the estimates obtained in the previous step, and we use the estimated leverage for the time t as starting point of the simulated dynamics. We generate $K * 360$ normally distributed random numbers for each country to simulate the daily increment of the Brownian motion, thus finally obtaining a simulated dynamics of the country's leverage of length $K * 360$.

Then, we use the condition of default implied by the model. The country defaults if $V_{i,t} < C$, that corresponds to $L_{i,t} > (-K_i)$. Therefore, if the simulated leverage of the country, at least for one point in time over the simulation time horizon, is above $-K_i$, we impose that the bond defaults and the t-value of the bond is zero. Otherwise, the t-value of the bond is equal to the risk-free discount factor, by using the risk-free rate at time t.

We then compute the bond price for each time t averaging across the 10000 simulations, and the corresponding yield by simple inversion. Let define B the price of the bond obtained with MC simulations, then the implied yield Y is equal to

$$Y = \log\left(\frac{1/B}{K * 360}\right)$$

5. Empirical Analysis

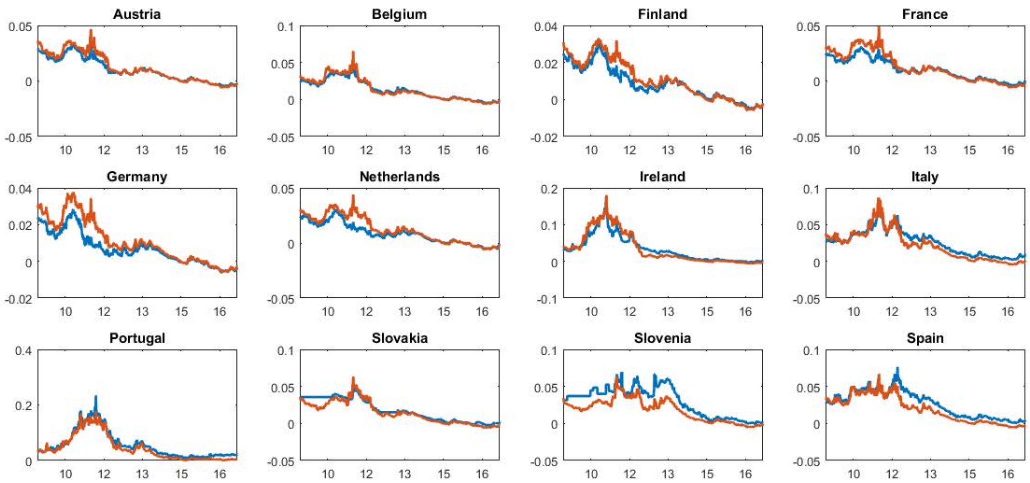
We now carry on our empirical analysis by combining the information on the CDS spreads and the observed bond yields with the estimation of the model-implied bond yields. We disentangle the main question of the paper from three different points of view. First, we study the distance between observed and implied risky yields for each country. Then, we study the correlation between CDS spreads and bond yields, by using both observed and implied yields. The correlation is examined across countries for each point in time (cross-sectional correlation), and for each country over time (time-series correlation). Finally, we test the consistency of the risky bond yields in terms of default risk priced in the CDS spreads, by constructing riskless arbitrage strategies, and we verify whether the strategies are profitable.

A. Implied and Observed Bond Yields

The difference between observed and implied risky yields should be zero for each country, and each point in time, if the observed risky yields of a country are consistent with the default risk priced in the CDS spreads of the country. Indeed, the maintained assumption behind this statement is that the model-implied yields are well estimated, and the model is able to fully capture whatever drives the relationship between default risk and bond prices. With these caveats in mind, we compare observed and implied yields for each country, over the sample time-series.

Figure 4-6 show that the estimated yields are generally closer to the observed yields for the Eurozone countries with respect to the No Eurozone countries. Within the Eurozone group (Figure 4), we obtain implied yields that are very close to the observed yields for the core countries in the second part of the time series. At the opposite, the NZ countries show a persistent deviation of the estimated yields from the observed yields over the entire time series.

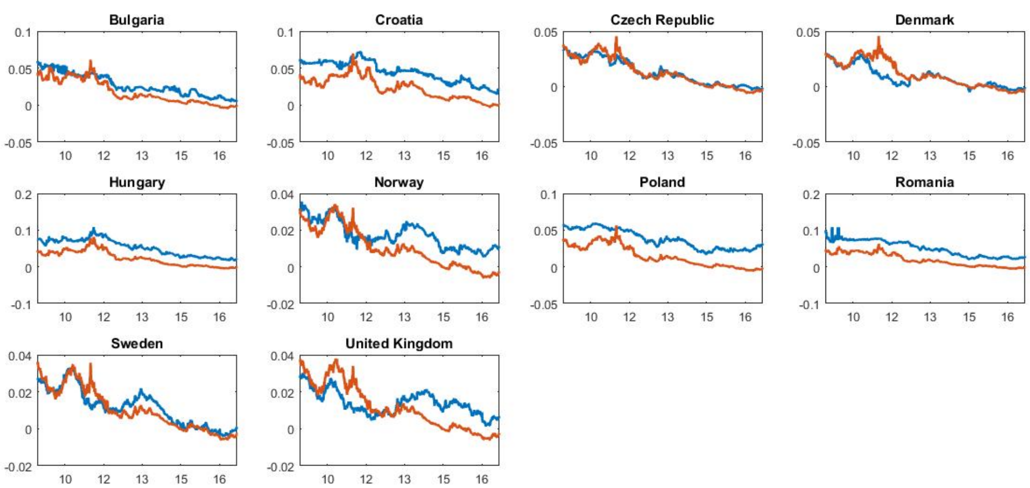
Figure 4. Implied versus Observed Yields. Eurozone



Legend: The figure shows the observed (blue line) and the implied (red line) yields, at 5-years maturity, for each country in the Eurozone group, over the sample time series. The implied yields are obtained by implementing the steps of the estimation methodology described in section 4

□

Figure 5. Implied versus Observed Yields. No Eurozone



Legend: The figure shows the observed (blue line) and the implied (red line) yields, at 5-years maturity, for each country in the No Eurozone group, over the sample time series. The implied yields are obtained by implementing the steps of the estimation methodology described in section 4

□

The additional straightforward consequence of a perfect equality between observed and implied risky yields would be that the differences in the observed risky yields across countries are perfectly consistent with the differences in the default risk priced in the CDS spreads, under the assumption that the differences across countries in terms of default risk are well reflected by the model on the differences across bond yields.

Indeed, this assumption is very strong and not strictly necessary for the purpose of our analysis. What we actually aim to investigate is whether the differences in the observed yields across countries are in line with the differences in the yields derived by the model estimates, thus implied by the CDS spreads.

Therefore, we define the observed risky bond yield as the sum of the unobservable true yield and the mispricing currently arising in the market. We define true yield as the yield that should be paid by the risky bond in absence of any market distortion and friction, thus being perfectly consistent with the default risk of the country.

$$\widehat{Y}_{i,t} = Y_{i,t} + \varepsilon_{i,t},$$

where $\widehat{Y}_{i,t}$ is the observed yield, $Y_{i,t}$ is the true yield, and $\varepsilon_{i,t}$ is the market mispricing, for each country i, and each point in time t. The true yield is indeed unobservable, therefore we assume that the true yield is the sum of an observable proxy and an error:

$$Y_{i,t} = \widetilde{Y}_{i,t} + \eta_{i,t},$$

where the error term $\eta_{i,t}$ is proportional to the current level of the true yield proxy, for a given constant k to be estimated. Thus, we have:

$$\widehat{Y}_{i,t} = (1+k)\widetilde{Y}_{i,t} + \varepsilon_{i,t} = \beta\widetilde{Y}_{i,t} + \varepsilon_{i,t}, \tag{5}$$

where k is assumed to be constant across countries and time. Therefore, we can estimate the equation (5) with a panel regression, where i goes from 1 to 22, and t goes from 1 to T,

Table IV. Panel Regression - Observed and True Yield

	Obs Yield	Obs Yield
Model Yield	0.882***	
	(0.0014)	
Basis Yield		1.052***
		(0.0016)
N	40656	40656
R^2	0.73	0.85

Legend: The table reports the results of the panel data regression of the observed risky bond yields against the proxy of the unobservable risky bond true yields. The Model Yield is the result of the MC simulations using the model estimates, and the Basis Yield is the theoretical true yield given by the zero-basis condition. The stars over the coefficient stand for a 1% significance level, and we report in brackets the standard errors.

□

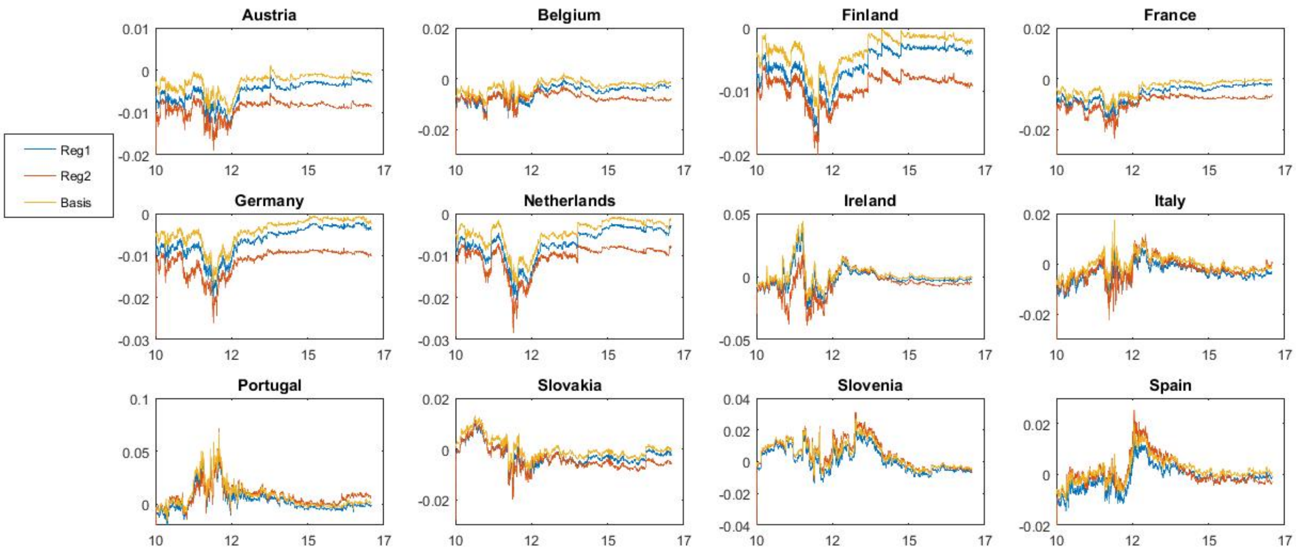
where T is the length of the sample time series (i.e., 1850 daily observations).

We adopt two specifications for the true yield proxy. First, we use the theoretical true yield given by the zero-basis condition described in equation (1). The second proxy is instead the yield implied by the model estimation and generated by MC simulations. The corresponding error terms are then easy to interpret. As for the first proxy, the error is given by the strong set of assumption at the base of the zero-basis condition, while the error in the second proxy is the result of the model assumptions and the estimation error.

Two additional consequences of (5) are straightforward. First, the closer is the regression β to 1, the closer the error term of the proxy is to zero. Moreover, the bond yield market mispricing is simply measured by the regression residuals.

Table IV reports a value of the coefficient close to 1 for both the true yield proxies. Then, we generate the regression residuals for both the equations estimates, and we compare them in the next plot.

Figure 6. Regression Residuals and Basis. Eurozone



Legend: The figure shows the residuals of the panel regression (5) by using the two different true yield proxies, and the CDS spread/Bond Yield basis, for the Eurozone countries, over the sample time series

□

Figure 6 shows that both the regression residuals and the CDS spread/Bond Yield basis are very close to each other for all the countries, and over the entire time series, supporting the interpretation of the regression coefficients close to 1. Moreover, measuring the market mispricing by using either the observed basis or the regression residuals does not lead to great differences. We report here only the results for the Eurozone, but equivalent results hold for the No-Eurozone countries.

B. Correlations Analysis

If the distance in terms of default risk across countries is consistently reflected on the distance in terms of risky yields across countries, then the cross-sectional correlation between CDS spreads and risky bond yields should be close to 1. When the CDS spread of the country A is higher than the CDS spread of the country B, then the yield on a bond issued by A

must be higher than the yield on a bond issued by B. Such a relationship should hold across the whole set of countries, therefore the cross-sectional correlation between CDS spreads and risky bond yields should be close to 1, for each point in time.

In fact, if we compute the cross-sectional correlation between CDS spreads and risky bond yields by using the theoretical yield implied by the zero-basis condition, this correlation is always equal to 1, for each point in time.

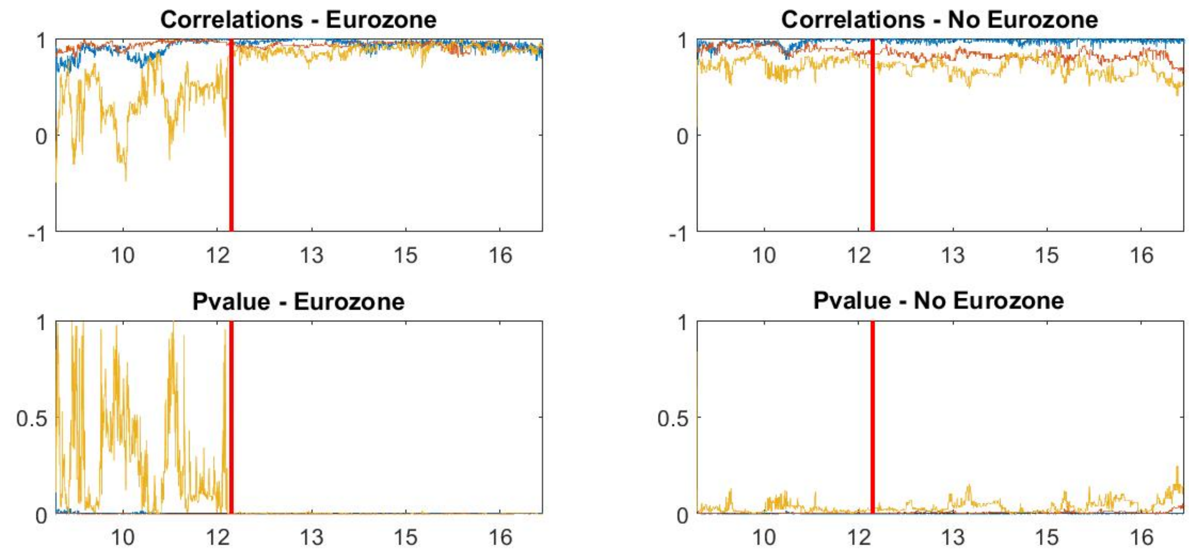
However, computing only the correlation between CDS spreads and observed bond yields is not enough to rule out the distress puzzle. In particular, the monotonicity of bond yields is a necessary but not sufficient condition to rule out the distress puzzle. We require, in fact, that the relationship between CDS spreads and observed bond yields across countries is not only monotonic, but also that the size of the differences in terms of default risk across countries is reflected in the size of the differences in the risky yields. The rationale behind this condition is that a country might be paying a disproportionately high or low yield compared to what the default risk priced in the CDS would imply, without violating the monotonicity condition.

Therefore, we proceed as follows. First, we deduct the estimated implied yields from the actual yields for each country, thus obtaining a *net yield*. Once the observed yields have been adjusted by deducting the corresponding implied yields, we can evaluate whether the monotonicity condition still holds, by computing the Spearman's correlation between CDS spreads and the net yields across countries, for each point in time. As result, we generate a series of cross-sectional correlations over time, between CDS spreads and net yields. The closer is the correlation to one, then the closer is the market to ruling out the distress puzzle. We adopt the Spearman's index of correlation as it fits much better the goal of our analysis, by evaluating the monotonic relationships between two variables, regardless whether the relationship is linear or not.

The intuition for this approach is simple. If the excess bond yield of the riskier country, in fact, is too low than it should be, then the net yield of the safer country would be higher than the net yield of the riskier country. The result is a not monotonic relationship between CDS spreads and net yields. However, if the observed distance between the bond yields of two countries is too high, then the monotonic relationship between CDS spreads and net yields still holds. Hence, we say that the correlation analysis is able to detect only if there is a sufficient distance between bond yields, across countries. However, as a consequence, if the distance between the bond yields of two countries is too high, then it is likely that the distance between the yields of one of the two countries and a third country's bond yield is too low, thus returning at the end a lower value of the correlation coefficient.

The next figure represents graphically the main result of the paper. Figure 7 shows the dynamics of the cross-sectional correlations between the 5-years CDS spreads and the estimated bond yields (blue line), the observed bond yields (red line), and the net yields (red line), for the Eurozone and the No-Eurozone countries, respectively. Moreover, the bottom plots report the corresponding p-values associated to the test on the statistical significance of the correlation.

Figure 7. CDS spreads - Bond Yields. Cross-sectional correlations



Legend: The top plots show the correlation between CDS spreads and implied (blue line), estimated (red line), and net (yellow line) yields (yellow)at 5-years maturity, for each point in time, across Eurozone (top left) and No Eurozone countries (top right). The bottom plots show the corresponding p-value, and the red line is the OMT announcement date

□

The top plots show that the correlation of the CDS spreads with both observed and implied yields is close to 1, over all the time series, and for both groups of countries. This result is natural for the implied yields, that are estimated by using the CDS spreads. Though, the correlation is not perfectly equal to 1, as the model is subject to an error, and because the yields are then generated by MC simulations still subject to an error. On the other hand, this result documents that also the relationship between CDS spreads and actual yields is monotonically positive, as it should be. This means that riskier countries issue bonds with higher yields.

However, this result does not imply that the distress puzzle is ruled out. What really matter is the dynamics of the red line, where we analyse the presence of a monotonic relationship between CDS spreads and bond yields, only after adjusting the observed yields by using the implied yields.

Indeed, the key result arises when we focus on the correlation between CDS spreads and net yields. This correlation, in fact, randomly moves around zero for the Eurozone countries before the OMT announcement, and approaches 1 right after the OMT announcement, thus remaining stable afterwards. It turns out that the sovereign bond yields were not consistent with the size of the distance in terms of default risk across countries before the OMT announcement, and that right after the announcement the consistency in terms of differences in the bond yields across countries is restored.

This result is even more interesting and stronger if we compare Eurozone and No Eurozone countries. In fact, the NZ countries do not show any change in the cross-sectional correlation between CDS spreads and net yields over the entire period. The correlation is quite stable over the entire time series, however never approaching 1. Moreover, the jump in the cross-sectional correlation across the Eurozone countries is also highlighted by the jump towards zero of the corresponding p-value. Therefore, after the OMT announcement, the correlation between CDS spreads and net yields is always significantly different from zero, whereas before the OMT we observe large and very volatile p-values.

Table V. Correlation CDS spreads - Bond Yields

	Eurozone			No Eurozone		
	Obs Yields	Imp Yields	Net Yields	Obs Yields	Imp Yields	Net Yields
Before OMT	0.883	0.938	0.367	0.956	0.895	0.737
	(0.0027)	(0.0001)	(0.2755)	(0.0004)	(0.0017)	(0.0258)
After OMT	0.951	0.927	0.885	0.978	0.818	0.683
	0.0000	0.0001	0.0008	0.0000	0.0082	0.0439

Legend: The table reports the average cross-sectional correlation of the CDS spreads and Observed Yields, Implied Yields, and Net Yields (Observed Yields - Implied Yields) for the 5-years time horizon, across Eurozone and No-Eurozone countries, and within the pre and the post OMT announcement. We first compute the series of the cross-sectional correlations over the sample period for each group of countries, and then we compute the average within each of the two time intervals (before/after OMT announcement. The same method is applied to compute the p-values, that we report in parentheses

□

Table V reports the average correlation, for the different measures of bond yields, across countries in each group, and within each time interval (before/after the OMT announcement). The average correlation between CDS spreads and both actual and implied yields is very close to 1 for both groups, and in each period. Instead, the average correlation across Eurozone countries between CDS spreads and net yields is more than double in the second period with respect to the first period, thus approaching 1. On the other side, this correlation is very similar across the two periods for the NZ countries, and is even lower after the OMT announcement. Moreover, the corresponding average p-value is large for the Eurozone countries before the OMT announcement, and approaches zero after the OMT announcement.

C. Arbitrage Strategies

In this section, we examine two potential arbitrage strategies that exploit riskless profit opportunities. We show that the intervention of the ECB drastically reduced these opportunities for the Eurozone countries. We compare the arbitrage profits across Eurozone and No Eurozone countries, and we show that for the second set of countries, instead, the OMT announcement does not generate any difference in the potential arbitrage profits over the sample time series.

Before looking at the strategies, we recall the definition of the no-arbitrage condition, obtained from the definition of the basis that we used in the previous section of the paper.

$$s = y - r, \tag{6}$$

where s is the T-years CDS spread, y is T-years yield on the risky bond, and r is the T-years yield on the riskless bond. If this relationship does not hold, then an arbitrage opportunity arises in the market by trading CDS, risky bond, and riskless asset, under a set of assumptions exhaustively explained in Hull et al. (2004). Here we report only the most relevant assumptions that support the flow of our argument.

1. Market participants can short sovereign bonds
2. Market participants can short the risk-free bond (they can borrow money at the risk-free rate)
3. The "cheapest-to-deliver bond" option is ruled out, so that the profit is not affected by the ability of the protection seller to find a cheaper bond to deliver in case of default
4. The recovery rate of the bond in case of default is equal to zero

In order to compute the profits, we express all the variables in monetary terms, thus computing the present value of the CDS, the risk-free bond and the risky bond by using continuous compounding, such that the no-arbitrage condition can be rewritten as follows

$$P_{CDS} = P_{BY} - P_{RF},$$

where P_{CDS}, P_{BY}, P_{RF} denote the present value of the CDS, the risky bond, and the riskless bond, respectively, and we omit the subscripts i and t to save in notation.

Strategy 1: The first arbitrage strategy is based on the CDS spread-bond yield basis. Suppose that for the i-th country, at time t,

$$P_{CDS} > P_{BY} - P_{RF}$$

,

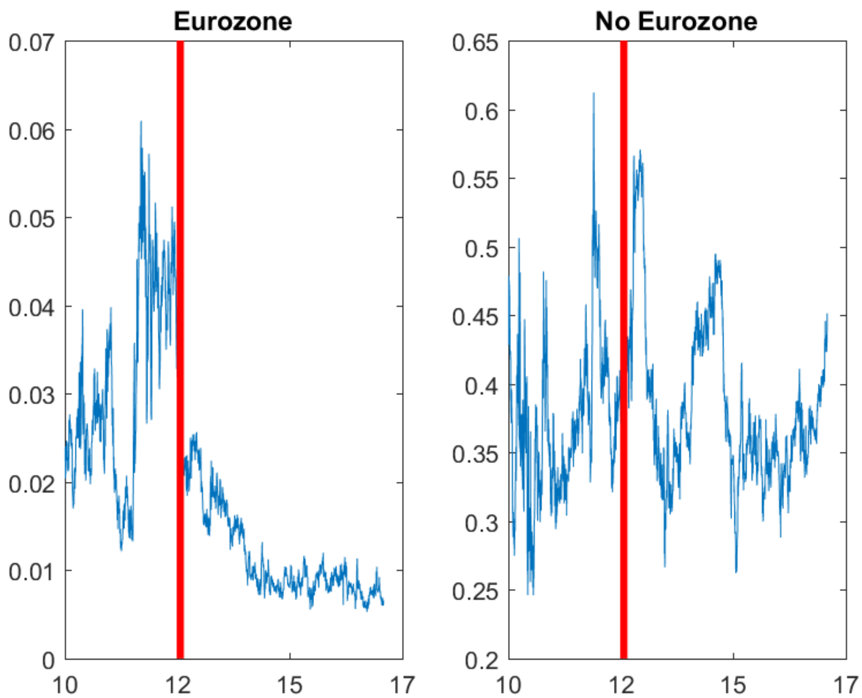
then the arbitrageur can sell the risk-free asset, and purchase the CDS and the risky bond issued by the CDS reference entity. The mispricing of the bond generates a positive difference, that is exactly the risk-free arbitrage profit. Conversely, if

$$P_{CDS} < P_{BY} - P_{RF}$$

the arbitrageur obtains the same arbitrage profit by reversing the strategy. In practice, the arbitrageur purchases the risk free asset, and sells the mispriced risky bond and the CDS to obtain the risk-free profit.

Figure 8 shows the arbitrage profits potentially obtained on a portfolio where each i-th country has equal weight in the portfolio. The panel on the left shows the profits that an arbitrageur could obtain by trading on Eurozone sovereign bonds, and the panel on the right shows potential profits by trading No Eurozone sovereign bonds. The profits are large and volatile before the OMT Programme announcement in both the Eurozone and No Eurozone areas. After the announcement, however, the profits drop immediately and start to converge towards zero for the Eurozone countries, whereas they remain positive and volatile for the countries out of the Eurozone.

Figure 8. Arbitrage Profits - Strategy 1



Legend: The figure shows the arbitrage profits that could be made on an equally weighted portfolio of sovereign CDS and bonds using strategy 1 described in the paper, over the sample time series. The profits are expressed in monetary terms assuming nominal value of 1 for the bonds, and where the CDS price is computed as present value of the CDS spreads expressed in percentage terms.

□

Strategy 2: The second strategy exploits the deviation of the observed yields from the yields implied by the model estimates, that are consequently consistent with the default risk priced in the CDS spreads which are used to estimate the model. We compute the difference between observed and estimated risky bond yields, at each time t for each country i, and we calculate the unconditional mean of those differences for each country, which we consider the benchmark to which the difference should tend to.

Then, at time t, for the country i, if the difference between observed and estimated yield is above the i-th country's unconditional mean, we say that the i-th bond is *undervalued* at t, whereas if the difference between observed and estimated yield is below the i-th country's unconditional mean, we say that the i-th bond is *overvalued* at t.

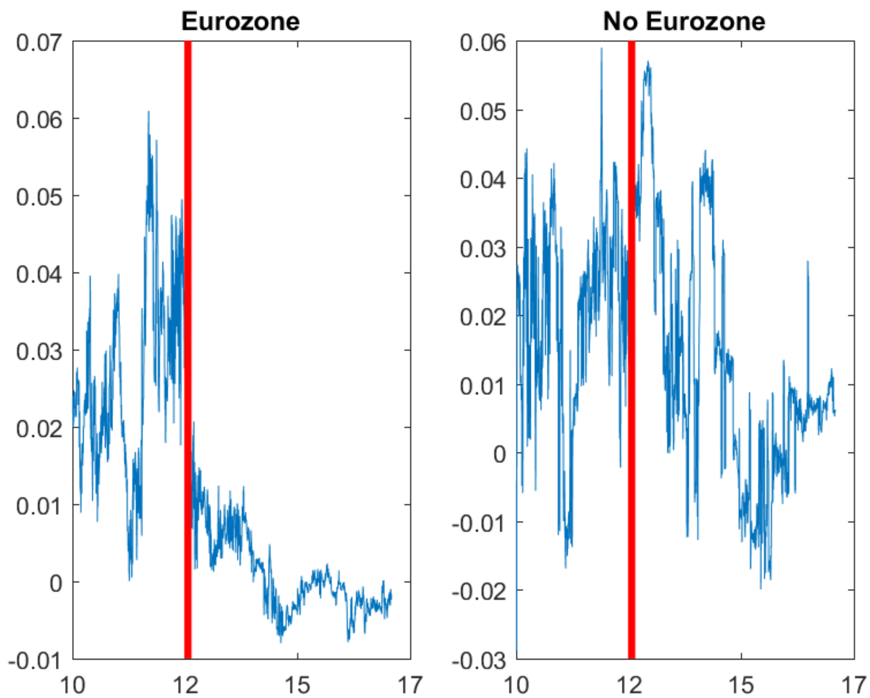
If the i-th country is undervalued, the arbitrageur can sell the risk-free asset, and purchase the CDS and the risky bond issued by the CDS reference entity. Otherwise, if the i-th country is overvalued, the arbitrageur purchases the risk free asset, and sells the mispriced risky bond and the CDS to obtain the risk-free profit.

The implementation of the strategy 2, then, works exactly as for the strategy 1, in terms of long-short portfolio. The difference between the two strategies is the signal of the opening of a riskless profit opportunity. While in the strategy 1 the signal is the non-zero basis at a given point in time, for a given country, the strategy 2 has the distance between observed and estimated yield as key driver.

In figure 9, we compare the potential profits obtained with the strategy 2 by trading on Eurozone and No Eurozone countries, respectively, with an equally weighted portfolio of countries-bonds. The profits plotted in figure 9 are very similar with those presented in figure 8, for both sets of countries. Therefore, the second arbitrage strategy supports our interpretation of the outcome generated by the OMT programme in terms of sovereign bonds market mispricing for the Eurozone countries.

Finally, table VI and table VII report the mean and the standard deviation of the potential profits obtained with the two arbitrage strategies, before and after the OMT announcement, and for the Eurozone and the No Eurozone countries, respectively. Table VI reports the results for the Eurozone countries, and shows a pronounced difference in the average profits between the two subperiods. Further, the standard deviation drops sensibly after the announcement. Such numbers indicate that after the OMT announcement the arbitrage opportunities were approximately absent, or immediately cleared. Instead, for the No Eurozone area, table VII reports similar figures for mean and standard deviation, across the periods before and after the OMT announcement. All the differences reported are not statistically different from zero.

Figure 9. Arbitrage Profits - Strategy 2



Legend: The figure shows the arbitrage profits that could be made on an equally weighted portfolio of sovereign CDS and bonds using strategy 2 described in the paper, over the sample time series. The profits are expressed in monetary terms assuming nominal value of 1 for the bonds, and where the CDS price is computed as present value of the CDS spreads expressed in percentage terms.

□

Table VI. Arbitrage Profits. Eurozone

Statistic:	Before OMT	After OMT	Difference
Strategy 1			
Mean	0.034	0.014	-0.020*
Std. Dev.	0.012	0.005	
Strategy 2			
Mean	0.029	0.003	-0.027*
Std. Dev.	0.012	0.005	

Legend: The table reports the mean and the standard deviation of the profits due to the arbitrage strategy applied to the Eurozone countries before and after the OMT announcement date. In the last column the difference between the two subsamples statistic is reported (After OMT-Before OMT). The * indicates that the difference is significant at 5% level

□

Table VII. Arbitrage Profits. No Eurozone

Statistic:	Before OMT	After OMT	Difference
Strategy 1			
Mean	0.036	0.036	-0.000
Std. Dev.	0.006	0.006	
Strategy 2			
Mean	0.020	0.012	-0.008
Std. Dev.	0.013	0.017	

Legend: The table reports the mean and the standard deviation of the profits due to the arbitrage strategy applied to the No Eurozone countries before and after the OMT announcement date. In the last column the difference between the two subsamples statistic is reported (After OMT-Before OMT). The * indicates that the difference is significant at 5% level

□

6. Conclusion

In the paper, we conduct an empirical investigation of the relationship between sovereign CDS spreads and sovereign bond yields. In a nutshell, we document that, after the launch of the OMT programme by the ECB, the consistent relationship between CDS spreads and bond yields across Eurozone countries was restored, differently from the No-Eurozone countries, which instead show a persistent deviation from the theoretical equilibrium relationship over the entire sample period.

We shed light on the effects of the unconventional monetary policy of the ECB on the CDS-bond relationship, and more in general on the consistent risk-return relationship in the sovereign context, with different approaches, that produce a unified and homogenous evidence on the behaviour of the sovereign credit risk market prior and following the launch of the programme, and across groups of countries.

Further investigation should focus on the big challenge of isolating the long term effects of the OMT programme on the relative pricing of the sovereign credit securities, in order to prove and identify a robust causal relationship. The main issue in a sovereign analysis is created by the unavoidable interaction between external and internal factors simultaneously at work. With this paper, we want to highlight a crucial evidence for the analysis of the risk-return relationship, linking this cornerstone of the financial theory with macro-economic and monetary events, then awaiting for further and deeper research.

A. Kalman filter and Quasi-Maximum Likelihood Estimation

In a general formulation, with a non-linear relationship between the measurement and the state variables, the state-space model is defined by two sets of equations, the transition and the measurement equation, respectively:

$$X_{i,t+\delta t} = X_{i,t} + c_i + \epsilon_{i,t+\delta t},$$

$$Y_{i,t+\delta t} = \psi(X_{i,t+\delta t}) + u_{i,t+\delta t},$$

where $X_{i,t+\delta t}$ is the i-th observation of the state variable at time $t+\delta t$, c_i is the time-invariant component driving the evolution of the state variable, $\epsilon_{i,t+\delta t}$ is the transition error on the i-th observation of the state variable at time $t+\delta t$. On the other hand, $Y_{i,t+\delta t}$ is the i-th observation of the measurement variable at time $t+\delta t$, ψ is the measurement function which links the observable and the latent variable, and $u_{i,t+\delta t}$ is the measurement error.

For a Gaussian state-space model, under standard assumptions, the discrete Kalman filter is proved to be the minimum mean squared error estimator. However, in the case of non-linear relation between the measurement and the state variable, the classic linear Kalman filter is not longer optimal. One possible solution is to linearize the estimation around the current estimate by using the partial derivatives of the process and measurement functions. To linearize the measurement process, we need to compute the derivatives of ψ with respect to

(a) the state variable: $H_{i,j} = \frac{\partial \psi_i}{\partial X_j}(\tilde{X}_t, 0)$,

where H is the Jacobian matrix of partial derivatives of the generic measurement function $\psi(\cdot)$ with respect to the state variable X, and $\tilde{X}_t$ is the current estimate of the state.

(b) the measurement noise: $\breve{H}_{i,j} = \frac{\partial \psi_i}{\partial \nu_j}(\tilde{X}_t, 0)$,

where $\tilde{H}$ is the Jacobian matrix of partial derivatives of $\psi(\cdot)$ with respect to the noise term ν.

Once the linearization has been completed, we can implement the discrete Kalman filter in the usual steps. First, we need to set the *initial conditions*:

$$\lambda_{i,0} \quad P_{i,0},$$

where $P_{i,t} := var[X_{i,t} - \lambda_{i,t}]$ is the variance of the estimation error, and $\lambda_{i,t}$ is the estimate of the state at time t based on the information available up to time t. Then, the filter implementation is based upon two sets of equations, the *predicting* equations, and the *updating* equations, that must be repeated for each time step in the data sample.

- *State Prediction*

$$\lambda_{i,t+\delta t/t} = \lambda_{i,t} + c_i,$$

and

$$P_{i,t+\delta t/t} = P_{i,t} + Q_i,$$

where $\lambda_{i,t+\delta t/t}$ is the estimate of the state at time $t + \delta t$ based on the information available up to time t, and Q_i is the covariance of the transition noise.

- *Measurement Update*

$$\lambda_{i,t+\delta t} = \lambda_{i,t+\delta t/t} + P_{i,t+\delta t/t} H'_{i,t+\delta t} Z^{-1}_{i,t+\delta t} \left(Y_{i,t+\delta t} - \psi(\lambda_{i,t+\delta t/t}) \right)$$

$$P_{i,t+\delta t} = P_{i,t+\delta t/t} - P_{i,t+\delta t/t} H'_{i,t+\delta t} Z^{-1}_{i,t+\delta t} H_{i,t+\delta t} P_{i,t+\delta t/t}$$

$$Z_{i,t+\delta t} = H_{i,t+\delta t} P_{i,t+\delta t/t} H'_{i,t+\delta t} + R_i,$$

where H stands for the Jacobian matrix of partial derivatives of the generic measurement function ψ with respect to the state variable X, $Z_{i,t+\delta t}$ is the covariance matrix of the prediction errors at time $t + \delta t$. The prediction errors are defined as $v_{i,t+\delta t} = Y_{i,t+\delta t} - \psi(\lambda_{i,t+\delta t/t})$, where $Y_{i,t+\delta t}$ is the observation of the measurement variable at time $t + \delta t$.

The parameters that describe the dynamics of the transition and the measurement equations (i.e., *hyperparameters*) are unknown, and need to be estimated.

Let rewrite the state-space model as follows:

$$(y_{t+\delta t}, x_{t+\delta t}) = (x_t, \{\theta\}), \quad \{\theta\} = \{\theta^{(f)}; \theta^{(g)}\}$$

, where $y_{t+\delta t}$ is the observable variable at time $t + \delta t$, $x_{t+\delta t}$ is the state variable at time $t + \delta t$, $\{\theta^{(f)}\}$ is the set of unknown parameters in the transition equation, and $\{\theta^{(g)}\}$ is the set of unknown parameters in the measurement equation. The measurement and transition equations of the system are:

$$g(y_{t+\delta t}, \alpha) = \varphi(x_{t+\delta t}, \beta) + \epsilon_{t+\delta t}, \quad \epsilon_t \backsim \mathcal{N}(0, \sigma^2_\epsilon)$$

$$x_{t+\delta t} = f(x_t, \gamma) + \eta_{t+\delta t}, \quad \eta_t \backsim \mathcal{N}(0, \sigma^2_\eta)$$

Then,

$$\{\theta^{(f)}\} = \{\gamma, \sigma^2_\eta\}$$

$$\{\theta^{(g)}\} = \{\alpha, \beta, \sigma^2_\epsilon\}$$

We assume that the nonlinear regression disturbance, ϵ_t, is normally distributed:

$$f(\epsilon_t) = \frac{1}{\sqrt{2\pi\sigma_\epsilon^2}} \exp\left[-\frac{\epsilon_t^2}{2\sigma_\epsilon^2}\right]$$

By transformation of variable, the density of y_t is given by

$$f(y_t) = f(\epsilon_t)\left|\frac{\partial\epsilon_t}{\partial y_t}\right|, \quad \frac{\partial\epsilon_t}{\partial y_t} = \frac{\partial g(y_t,\alpha)}{\partial y_t}$$

Then, the density of y_t is

$$f(y_t) = \frac{1}{\sqrt{2\pi\sigma_\epsilon^2}} \exp\left[-\frac{\left(g(y_t,\alpha)-\varphi(x_t,\beta)\right)^2}{2\sigma_\epsilon^2}\right]\left|\frac{\partial g(y_t,\alpha)}{\partial y_t}\right|$$

The log-likelihood function for observation t is

$$\ln\Omega_t\left(y_t;\{\theta\}\right) = -\frac{1}{2}\ln(2\pi) - \frac{1}{2}\ln(\sigma_\epsilon^2) - \frac{\left(g(y_t,\alpha)-\varphi(x_t,\beta)\right)^2}{2\sigma_\epsilon^2} + \ln\left|\frac{\partial g(y_t,\alpha)}{\partial y_t}\right|,$$

and the log-likelihood function for $t = 1, 2, ..., T$ observations (i.e., $\delta t = 1$) is

$$\ln\Omega = \sum_{t=1}^{T}\ln\Omega_t\left(y_t;\{\theta\}\right) = -\frac{T}{2}\ln(2\pi) - \frac{T}{2}\ln(\sigma_\epsilon^2) - \frac{1}{2\sigma_\epsilon^2}\sum_{t=1}^{T}\left(g(y_t,\alpha)-\varphi(x_t,\beta)\right)^2$$

$$+\sum_{t=1}^{T}\ln\left|\frac{\partial g(y_t,\alpha)}{\partial y_t}\right|$$

As long as $g(y_t,\alpha) = y_t$, then

$$f(y_t) = f(\epsilon_t) \Rightarrow \ln\Omega_t\left(y_t;\{\theta\}\right) = \ln\Omega_t\left(\epsilon_t;\{\theta\}\right)$$

The last term in the log-likelihood function is equal to zero, and the space of the hyper-parameters to be estimated is reduced to:

$$\{\theta^{(f)}\} = \{\gamma, \sigma_\eta^2\}$$

$$\{\theta^{(g)}\} = \{\beta, \sigma_\epsilon^2\}$$

In practice, the iteration of the filter generates a measurement-system prediction error, and a prediction error variance at each step. Under the assumption that measurement-system prediction errors are Gaussian, we can construct the log-likelihood function as follows:

$$\ln \Omega(y_t; \{\theta\}) = \ln \prod_{t=0}^{T-\delta t} p\left(y_{t+\delta t/t}\right) = \sum_{t=0}^{T-\delta t} \ln p\left(y_{t+\delta t/t}\right) =$$

$$= -\frac{N}{2}\ln(2\pi) - \frac{1}{2}\sum_{t=0}^{T-\delta t} \ln|Z_{t+\delta t}| - \frac{1}{2}\sum_{t=0}^{T-\delta t} v_{t+\delta t}{}' Z_{t+\delta t}^{-1} v_{t+\delta t},$$

where N is the number of time steps in the data sample. Finally, this function is maximized with respect to the unknown parameters vector $\{\theta\}$. This is known as the *Quasi-Maximum Likelihood* estimation, in conjunction with the non-linear Kalman filter.

B. List of Tables

C. List of Figures

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