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The Feedback Loop Between the Sovereign and Banking Sector Credit Risk in Europe

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ACADEMIC YEAR 2016/2017

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Introduction

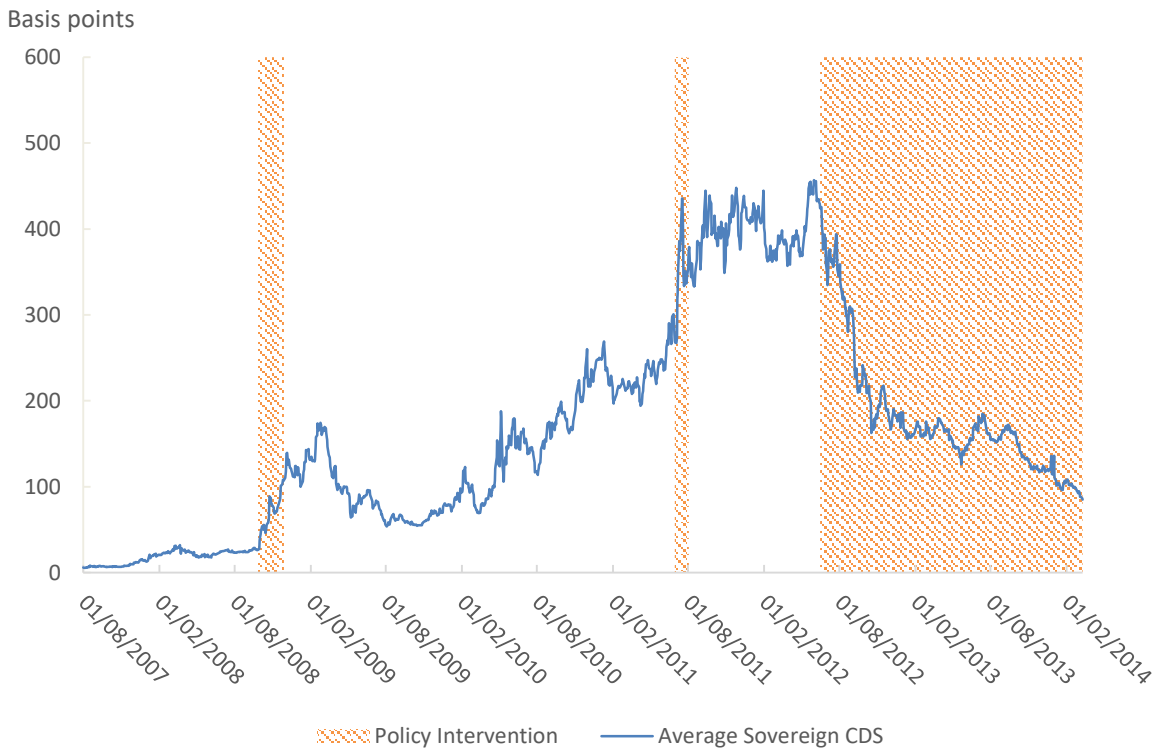
All over the last decade, developed economies have experienced periods of financial turmoil. The subprime crisis has first threatened the soundness of the financial sector, making its collapse a realistic outcome as never before, and then has raised some concerns on the strength of the public sector. However, the magnitude and the extent of the financial distress has led governments and investors to deal with a significant decrease in the public sector's creditworthiness. Since the collapse of Lehman Brothers in 2008, governments, in advanced economies, have stepped in to provide support to banks and financial institutions. Significant public intervention seemed to be necessary in order to avoid chain effects across intermediaries and across countries. The surge of the sovereign credit risk, therefore, finds its roots in the bailout measures (capital injections, explicit guarantees to the financial sector and purchases of deteriorated assets) employed by the public sector. Indeed, there is evidence that the financial sector bailouts were a crucial factor in triggering the rise of the sovereign credit risk. Government support measures have had the effect of increasing the explicit and implicit guarantees and holdings of sovereign bonds and strengthening the linkage between the banking and the sovereign sector. As the December 2008 quarterly report of the Bank for International Settlements (BIS) stated:

> "The scope and magnitude of the bank rescue packages also meant that significant risks had been transferred onto government balance sheets. This was particularly apparent in the market for CDS referencing sovereigns involved either in large individual bank rescues or in broad-based support packages for the financial sector".

Before to look at the risk transfer mechanism, triggered by the financial support measures, between public sector and financial sector, it may be useful and interesting to comprehend that the surge of sovereign credit risk is on it-self a rare phenomenon. Prior to 2007, there was no sign of sovereign credit risk in developed countries and the prevailing view was that such risk was unlikely in the near future. Among different methodologies, government bonds have, typically, been used by operators in the market to get a measure of the risk-free rate, since governments have been entities considered

to bear very low credit risk. Here below, Figure 1 plots the simple average Sovereign CDS spread of 13 European countries[1].

Figure 1: Sovereign Credit Risk in the Euro Area



Source: Bloomberg, December 2016

As it can be seen, before the failure of Lehman Brothers and the consequent intensifying financial crisis, there is no significant presence of sovereign credit risk in Europe. Starting from the second half of 2008 participants in the financial market keep hedging their positions against a hypothetic default of governments in Europe. As a reminder of the importance of policy action, the shadowed areas in Figure 1 represents three periods of marked policy activism. The first depicts the two months of 2008 in which most countries in the sample enacted programs of support for their financial systems. The second shadowed area detect a second major European rescue package, aimed at providing funds to Greece as well as calming down fears over peripheral countries. The third shadowed period in Figure 1 corresponds to that following the ECB announcement of the Outright Monetary Transactions (OMT) instrument (August 2012). According to

[1] In particular, the Figure considers sovereign CDS for Eurozone countries plus Denmark, Norway, Sweden and the United Kingdom for the period 01/08/2007 to 11/03/2014.

Acharya et al. (2013), as governments stepped in providing financial support, investors' concerns, in financial markets, focused on the credit risk premium associated with these movements. The demand for financial instruments able to adjust investment positions, according to the new risk involved, sharply increased. Therefore, one of the factor able to explain the increase in the sovereign credit risk as never before is the strong interconnectedness between the financial sector and the public sector. In recent years, mainly due to the spreading of the crisis from the former sector to the latter, this linkage has attracted increasing attention. Indeed, on one hand the materialization of contingent claims brought deep distress onto the sovereign's balance sheet of several European countries: in Iceland, for example, bank failures directly increased net public debt by 13% of GDP. On the other hand, pro-cyclical fiscal policy and a lack of competitiveness led to a sovereign debt crisis in peripheral European countries. World-wide (but mainly in Europe), as foreign investors withdrew, banks became major holders of public debt (Broner et al., 2014). This, in turn, has additionally weakened the financial sector by eroding the value of its government guarantees and bond holdings. This phenomenon has been named ***Sovereign-Bank Feedback Loop (SBF Loop)***: an increase in the cost of sovereign debt leads to a devaluation of the government debt that impairs the balance sheets of banks that hold these assets. Acharya et al. (2011) have used the term "two-way feedback" to stress that this phenomenon can be, theoretically, sparked by both the financial sector and the public sector when there are several channels linking the one to the other. Recently the SBF Loop has raised a lot of concerns as it shows that public measures in support of financial institutions are not only questionable from an economic point of view and from a moral hazard point of view. Commonly, the main problems concerning the bailout system have been two:

- on one hand it represents an unfair cost for taxpayers, mostly in countries where the financial sector participates in an important part of the national GDP.
- on the other hand, if the government resources are used in rescuing troubled financial institutions, in future the incentives for the whole sector might be weak.

Now the SBF loop effect may reveal that bailout costs are not just in the future. Rather, they are tangible at the time of a bailout and are priced into the sovereign's credit risk and cost of borrowing, weakening further the financial sector.

1. Related Literature

Considering that the SBF Loop has been attracting interest just after the financial crisis, the literature concerning this phenomenon is quite small. Keeping the entire literature on the effects of the 2008 financial crises as main reference, it is possible to identify two branches of work. A first body of literature in banking has mainly focused on the assessment of the impact on the government's fiscal position of the assistance measures undertaken to support the financial sector. This branch typically analyzes the bailout instrument by posing one important question: What is the magnitude of the financial resources needed by governments to provide financial support? Maurer and Patrick Grussenmeyer (2015) found the financial needs for government bailouts in the euro area to be estimated at 5.1% of GDP for the whole period 2008-2013 and that these financial needs are met through the issuance of new debt and in some cases (such as that of Ireland) through the sale of financial assets. They in particular conduct further analysis on the current gain or loss to governments and how the guarantees provided by the public sector have changed over the period 2008-2013. The Bank for International Settlement's Paper number 48 stresses on the great heterogeneity of size of the government measures undertaken in supporting the banking sector among different countries: the size of interventions is higher in countries such as the United Kingdom and the Netherlands (here outlays have reached 44.1% and 16.6% of GDP, respectively) where the banking system is large relative to the real economy and is dominated by large institutions that have been severely hit by the crisis. It is lower in countries such as Japan (0.1% of GDP) and Italy (0.6%) where banks are more focused on traditional credit activities.

A large body, instead, even though considering the ex-ante costs, analyses the moral hazard cost of bank bailouts. Concerning this aspect, the related literature has mainly treated the moral hazard both from the point of view of the regulator and from the one of the banking sector. In particular, Acharya and Yorulmezer (2007) have considered the moral hazard costs of a support program to the financial system at the aggregate level, stating that in a systemic crisis, modelled as a situation in which many banks fail, the regulator has no ex-post choice but to bail out some or all these banks. However,

this is inefficient ex-ante since it gives incentive to herd (basically to invest in common markets or behave in the same way) increasing the likelihood of a systemic crises.

While there is a broad literature relating the ex-ante costs of a banking sector bailout, only a small part considers the ex-post costs. Gennaioli, Martin and Rossi (2010) have considered the damage of a sovereign default to the banking sector relatively to the impact on bonds' holdings. They have concluded that the banks' holdings of public bond are positively related to the default rate. Furthermore, they observed that during periods of financial crisis there is a large, negative and statistically significant correlation between banks' bondholdings and subsequent lending activity. King (2009)[2] has argued that government interventions benefited creditors at the expense of shareholders, showing that bailout's costs are borne not only by taxpayers. Different event studies have shown evidence that after an announcement of rescue package banks' CDS have narrowed while stock prices have underperformed.

Since the credit risk transmission loop has raised concerns after the financial crisis, there are very few studies on this specific subject. An important contribution to such phenomenon has been provided by Paolo Angelini, Giuseppe Grande and Fabio Panetta (2014). They have mainly focused on the channels linking the credit risk of the sovereign sector to the credit risk of the banking sector. In such sense, the authors state that regulation plays a role: since capital charges for government securities are typically low, banks tend to boost their exposures on government debt. However, the main contribution to the study of the effects of the sovereign-bank feedback loop has been provided by Acharya, Drechsler and Schnabl (2014). The authors have developed a model in which, in the short run, bailouts are funded through the issue of new debt, but, on the other hand a higher level of debt raises the sovereign credit risk, triggering a feedback loop between sovereign and financial sector. Furthermore, the model is later confirmed using data on bank and sovereign CDS spreads.[3]

Another import study, worth mentioning, is the one by Alter and Schuler (2010, 2012). In their work they show that the link between sovereign and banking sector changes over

[2] In particular, the author has used a broad panel data on banks' CDS spread going from October 2008 to January 2009.

[3] The authors have shown that changes in sovereign CDS explain changes in bank CDS after the bank bailouts even controlling for aggregate and bank-level CDS spread determinants.

time and it is mainly function of announced rescue programs: before government interventions, changes in the sovereign CDS spreads have a weak impact on both bank and sovereign CDS markets, while during and after government interventions, changes in sovereign CDS spreads contribute permanently to the financial sector CDS spreads.[4] Finally, my study is also related to the body of literature on the determinants of credit spread. In such sense, Attinasi, Checherita and Nickel (2009) have studied widening sovereign bond yield spreads vis-à-vis Germany in selected euro area countries during the period end-July 2007 to end-March 2009 finding that government announcements of substantial bank rescue packages explain a significant part. Gerlach et al. (2010) analyse the determinants of Eurozone sovereign bond spreads. They show that the size of the banking sector has an important explanatory value for changes in bond spreads, suggesting that markets perceive countries whose financial sectors represent a big portion of the national GDP as more likely to employ rescue programs.

[4] An important result of Alter and Schuler is that the linkage between sovereign-bank CDS spread shows country specific bailout characteristics.

2. Risk Measurement and Data

Before we look at the empirical evidence, we should first have a glance to the data that has been used and analysed in this work. It could be, furthermore, useful and interesting to consider the reasons of the choice of such data set.

2.1. Risk measurement alternatives: strength and weaknesses

By definition the SBF Loop, is a channel or a set of channels through which the government sector and the banking sector are interconnected the one with the other. All the ways these two areas are tied, we are mainly interested in the effect the sovereign risk has on the banking risk (and vice versa). Therefore, we face some preliminary issues: which are the possible ways through which measure the risk? And, among these methods, which one best fits our purpose of identifying a sovereign-bank loop?

First of all, it is needed to specify which kind of risk we want to observe. The SBF Loop has been mainly referred to as an interconnection that makes credit risk spreading from the public sector to the financial or the other way back. According with the literature, there is evidence that bailout measures have first triggered the risk transmission loop. Thus, we should look at some credit risk measurement methods. There are different ways to measure credit risk, but only few of these are frequently available or observable. In particular, there are three main ways to estimate the credit risk associated at a specific individual:

1. credit ratings
2. bond yield spread
3. credit default swap spread

As we know, rating agencies employ different statistical methods in order to assess the creditworthiness of a particular corporate bond. In theory, a credit rating is an attribute of a bond issue, not a company. However, in many cases all bond issued by a company have the same rating. A rating is therefore often referred to as an attribute of a company. Acharya et al (2013) have used Moody's credit rating in order to construct a measure of government

support[5]. In particular, they have considered the Long-term issuer rating, a measure that incorporates government support, and Bank financial strength rating, which does not. The difference between the two ratings ("rating uplift") is an estimate of the value of government support to banks[6]. The main problem in dealing with credit rating observations is that they tend to be smoothed. Indeed, one of the objectives of rating agencies when they assign ratings is ratings stability. For example, they want to avoid rating reversals, where a company's bonds are downgraded and then upgraded a few weeks later. Ratings therefore changes only when there is a reason to believe that the company' s creditworthiness has modified in the long-term perspective. Often, in order to overcome these problems studies on the credit risk consider the other two proxies. Bond yields and CDS spread can be considered as market based measures of credit risk since, unlike the credit ratings, are determined by market operators in aggregate. They are therefore able to immediately catch any important change in the market as investors move to adjust their positions. Nevertheless, bond yield spreads, defined as the bond yield over the maturity-matched risk-free rate, suffer of several frictions. First of all, there is the need of identify an appropriate risk-free rate: different choices lead to different measures of credit components. Second, for a same credit entity and even for a same category of bonds there are several maturities. This implies that, for the purposes of establishing the existence of a sovereign-bank feedback, we should choose a roll-over date. It is important to consider that empirics shows that the off-the-run bonds have usually an higher return compared with the on-the-run bonds. The reason behind this on-the-run versus off-the-run spread has been attributed to the difference in liquidity: investors perceive the less recent bonds as less liquid and therefore they are willing to hold them only in exchange for an higher return. Thus, liquidity is dispersed among individual bonds rather than being concentrated in a single contract. These are the principal reasons to the fact that a big portion of the empirical studies uses CDS as a measure of the credit risk. Indeed, their standardization, availability and liquidity put them in evident advantage with respect to the other ways to measure credit risk movement. Furthermore, selling CDS is easier than shorting bonds, since it doesn't

[5] They have assigned numerical values to each ratings (such that AAA=1, AA+=2, etc.).
[6] The authors have shown evidence that in the post bailout period a one-notch decrease in the country' s credit rating reduces the rating uplift by almost 0.32 notches.

require borrowing a security and therefore making their quotations more reliable. Let' s have an overview on how these instruments work and why they are a good indicator in capturing the private-to-public risk transfers. The simplest type of CDS is an instrument that provides insurance against the risk of a default by a particular company. The company is known as reference entity and a default by the company is known as a credit event. The buyer of the insurance obtains the right to sell bonds issued by the company for their face value when a credit event occurs. This kind of contract has two types of settlement: physical settlement and, more commonly, cash settlement. In the first case the buyer of protection has the right to sell to the seller bonds issued by the reference entity at their face value; in the second case, a two-stage auction process is used: first is determined the mid-market value of the cheapest deliverable bond then the seller counterparty pays the difference between the face value of the bond and the cheapest-to-deliver bond' s price. Furthermore, the buyer of a CDS makes periodic payments to the seller until the end of the life of the CDS or until a credit event occurs. The total amount paid per year, as a percentage of the notional principal, to buy protection is known as *CDS Spread*, which is typically expressed in basis points. With respect to our study, the reference entities are banks and governments. The credit default swap spread depends on the probability that these banks and governments will default during a particular period of time[7]. By monitoring a CDS' s trend it is possible to assess the perceived creditworthiness of banks and the countries. So following the most recent and specific strand of literature on the SBF loop, I opted for using CDS which, in sum, are the instruments most related with the credit risk. Now let' s see in depth the composition of our data set.

2.2. Data

Once identified the proper instrument able to express credit risk, it is needed to identify the reference entities and a relative time frame. In every empirical analysis it is crucial to choose the proper dataset. In this case I use a panel data, that is, observations collected over countries and banks as well as over time. From the country perspective, I build a dataset collecting CDS for all countries in the Eurozone plus Denmark, Norway, Sweden and the

[7] A key aspect of a CDS contract is the definition of a credit event (default). Usually a credit event is defined as a failure to make a payment as it becomes due, a restructuring of debt, or a bankruptcy.

United Kingdom, for a total of 13 European countries. In order to identify the banking sector sample, I have looked at the European Banking Authority (EBA) website where all the systemically important banks are sorted by country. My choice of looking at the data only for big banks has been led by two motivations, one more theory-based and the other more practical-based. First of all, governments are no interested in rescuing small or medium banks while they are very concerned in supporting very big ones. This is mainly due to the common reluctance of the governments to leave the so-called G-SIBs fail, given the systemic effect that a default of one of these entities would have on the economy. Second, from a practical point of view, only very big banks have publicly traded CDSs. Furthermore, among the entities found on the EBA' s website, I chose only those that were active even before the crisis and, in any case those whose CDS are heavily traded. To avoid a country specific bias I have collected data for not more than three banks for each country[8]. In doing so, my dataset contains 23 banks. Daily 5-year CDS contracts, denominated in euro, for both individual banks and sovereigns come from Bloomberg. From the time perspective, this analysis focuses on the period going from February 2007 to December 2016. I dropped observations with two consecutive zero changes in bank CDS and sovereign CDS to avoid stale data.

Let's take in consideration the period going from 1/02/2007 to 30/04/2011. It is possible to divide this period into three sub-periods: a pre-bailout period going from February 1,2007, to September 25, 2008, a one-month bail-out period going from September 26, 2008, to October 21,2008, and a post-bailout period going from October 22, 2008, to April 30, 2011. Table 1, 2 and 3 present some summary statistics on credit risk of sovereign and banks. Notice that the first period doesn't' correspond exactly to the ante-crisis period: the Lehman Brothers failure on September 15, 2008 is, indeed, in the pre-bailout period. Therefore, ex-ante, we expect the first period to have a low level of both sovereign and bank credit risk since the financial crisis has not yet intensified. Nonetheless, we should expect also a positive log change since in the first period investors should have increased their weights of credit default protection as the crisis got worsening.

[8] For some country, such as Greece and Norway, there is just one bank whose CDS data are available.

Table 1
Pre-bailout period (1/02/2007 to 25/09/2008)

Table 1, 2 and 3 provide summary statistics on bank characteristics and bank credit risk. The sample covers all banks with publicly traded credit default swaps (CDS) in Eurozone countries and Denmark, Norway, Sweden and United Kingdom. Table 1 shows summary statistics for the period before bank bailouts, Table 2 shows summary statistics for the period during bank bailouts and Table 3 shows summary statistics for the period after bank bailouts. Sovereign CDS is the average sovereign CDS in basis points (bp), Bank CDS is the average bank CDS (bp), ΔLog(Sovereign CDS) is the daily log change in sovereign CDS and ΔLog(Banks CDS) is the daily average change in bank CDS.

	Observations	Mean	Standard deviation	50^{th} percentile	5^{th} percentile	95^{th} percentile
Sovereign CDS (bp)	5590	14.62	9.43	10.20	4.48	29.59
Bank CDS (bp)	9890	53.57	38.71	49.40	8.48	118.30
$\Delta Log(Sovereign\ CDS)$	5589	0.4%	5.8%	0.2%	-7.8%	9.3%
$\Delta Log(Bank\ CDS)$	9889	0.6%	5.1%	0.6%	-8.4%	8.3%

As we can see from the above Table 1, data confirms what we expected a priori: no sign of significant credit risk level for the sovereign sector as well as for the financial one. The average percentage changes are positive, suggesting that investors are, on aggregate, slightly increasing their protections over adverse scenarios, once the crisis has become evident.

Table 2
Bailout period (26/09/2008 to 21/10/2008)

	Observations	Mean	Standard deviation	50^{th} percentile	5^{th} percentile	95^{th} percentile
Sovereign CDS (bp)	234	47.04	9.47	49.11	27.77	58.17
Bank CDS (bp)	414	120.22	24.11	121.26	90.64	149.06

$\Delta Log(Sovereign\ CDS)$	234	5.4%	8.0%	4.7%	-4.5%	16.5%
$\Delta Log(Bank\ CDS)$	414	-2.0%	9.2%	-2.5%	-15.0%	10.9%

The bailout period, defined as the period covering bank bailout announcement in Europe, accounts for 18 days. Comparing Table 2 with Table 1 is evident that the credit risk levels incredibly soared: in this period the average sovereign CDS is more than three times the value it had in the previous period, while average bank CDS has more than doubled. What is extremely important in the statistics concerning the during-bailout sample is the log change. First of all, in absolute values they are much greater than the relative data in the first period. Second, while both sovereign and bank credit risk has hugely increased in the period, the average percentage change in the financial sector is deeply negative (-2.0%), sign that there have been several massive daily decrements. The high volatility (9.2%) confirms such interpretation. This is further proving of a risk transfer mechanism that the bailouts have triggered.

Table 3
Post-bailout period (27/10/2008 to 29/06/2012)

	Observations	Mean	Standard deviation	50^{th} percentile	5^{th} percentile	95^{th} percentile
Sovereign CDS (bp)	8593	138.25	61.00	128.15	58.36	242.14
Bank CDS (bp)	15203	167.75	59.97	153.84	93.92	282.16
$\Delta Log(Sovereign\ CDS)$	8593	0.1%	4.0%	0.0%	-5.8%	6.7%
$\Delta Log(Bank\ CDS)$	15203	0.1%	3.1%	0.0%	-4.4%	4.9%

In Table 3, we can notice that the sovereign and the bank credit risk levels have still increased even if not at the pace of the previous period. The low average daily changes

suggest that some concern on the creditworthiness on the public and private sector still remains.

3. Preliminary Evidence

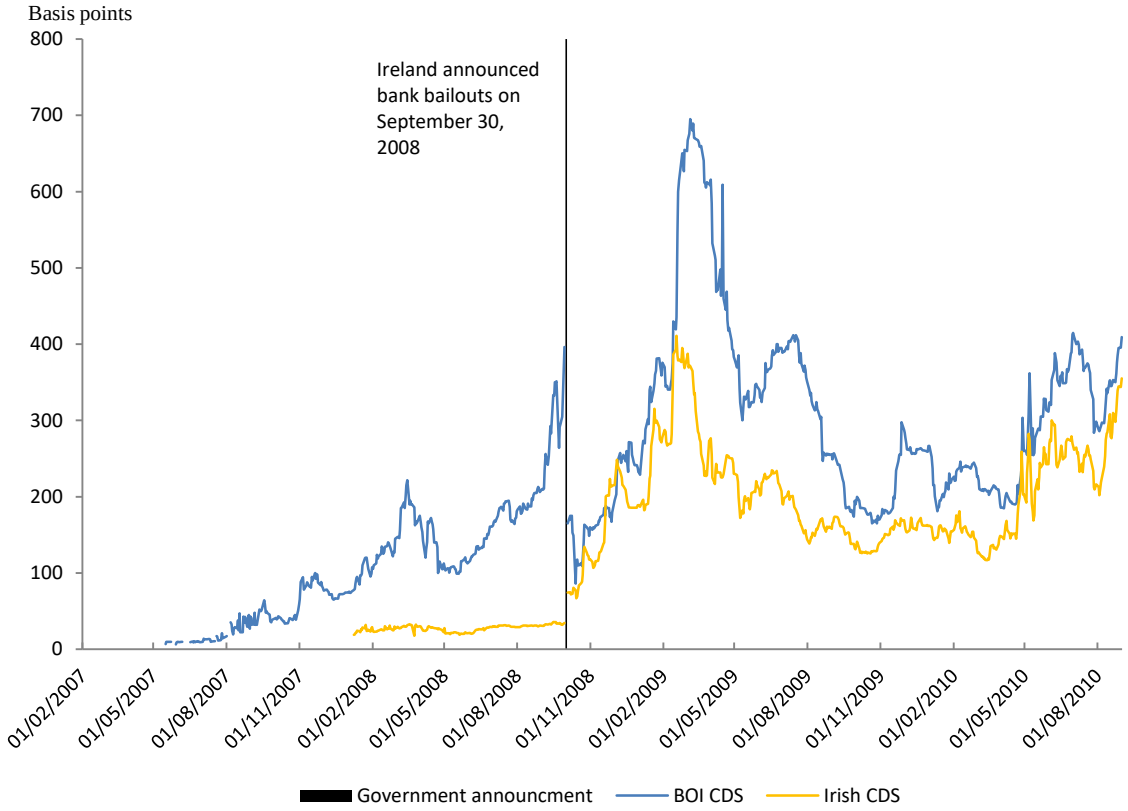
This section sheds light on the intertwined relationship between the sovereign sector and the banking sector. Before we look at the data, it can be useful to make some remarks. First of all, the extent of the link between the two sectors has not to be necessary constant over time. Thus, the analysis will be conducted considering different periods of time. Second, the bailout measures have had the effect of transferring the credit risk from the banking sector to the sovereign sector. Furthermore, as consequence of the governments' financial support measures, such interconnectedness has deepened.

Then, I present some preliminary evidence on the risk transfer mechanism and then some more specific analysis on the sovereign-bank loop. The first part focuses on the emergence of sovereign risk during the European financial crises of 2007 to 2011. It shows evidence that bank bailout transferred risk from bank balance sheets to sovereigns, triggering the rise in sovereign risk. Furthermore, we provide evidence that the country's pre-bailout level of financial distress predicts a post-bailout increase in sovereign credit risk.

3.1. Risk Transfer

As the BIS has highlighted, the risk transfer can be easily detected through the derivative markets, in particular in the CDS market. While such CDS were thinly traded prior to the announced rescue packages, spreads widened suddenly on increased demand for credit protection, while corresponding financial sector spreads tightened. A priori, we expect that in common periods the banks' CDS and the sovereigns' CDS are poorly correlated since investors do not see imminent connections between the credit risk of a bank and the credit risk of its national government. While in periods of financial distress this correlation should increase due to the possibility of a public intervention. As an illustrative example, in Figure 2 the CDS of Bank of Ireland (in blue) and that of the Irish government (in orange) are plotted. On September 30, 2008 the government of Ireland announced that it had guaranteed all deposits of six of its biggest banks.

Figure 2- Risk transfer: Ireland case



Source: Bloomberg, December 2016

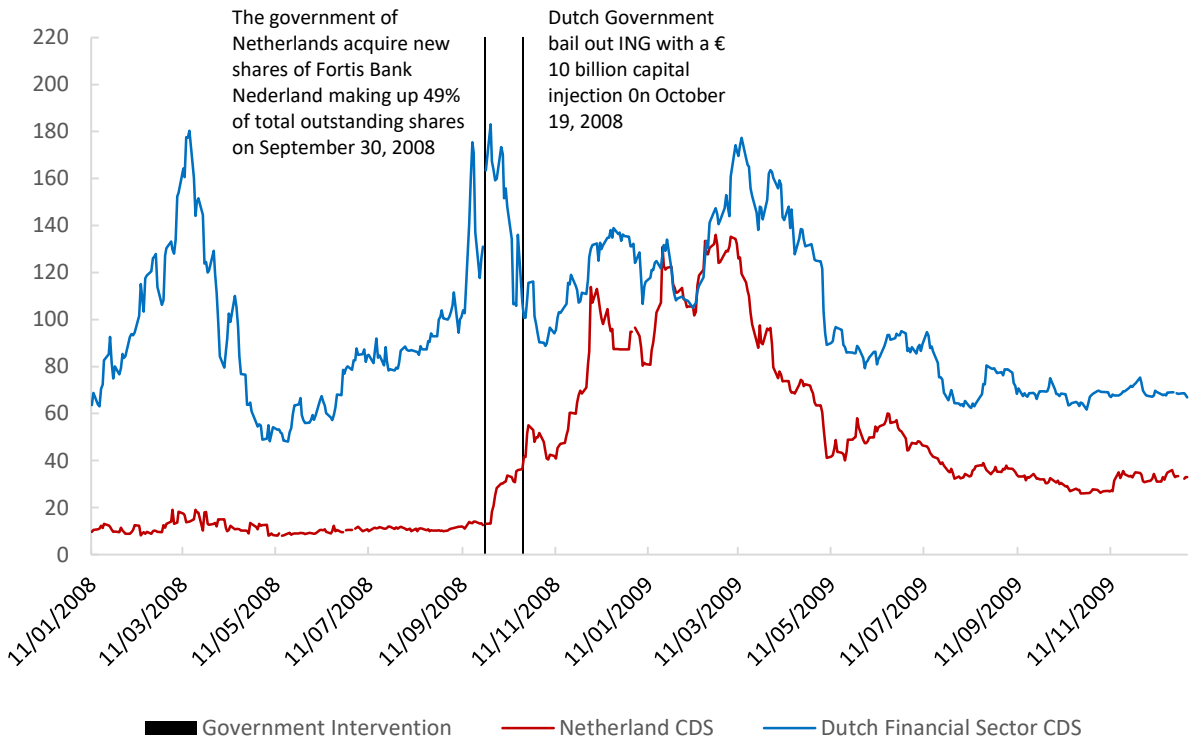
The immediate reaction that grabbed newspaper headlines the next day was whether such a policy of a full savings guarantee was anticompetitive in. It is evident by the graph above that the Ireland announcement meant that a portion of the risk borne by the BOI bondholders has moved to the Irish government bondholder.

Another example of risk transmission is provided by the support measures in Netherland. The Dutch case is different from the Ireland one in that there have been several government interventions aimed at preventing bank failures. The first government action has taken place in September 29, 2008. Indeed, after a talk with the European Central Bank (ECB), the governments of Netherland, Luxemburg and Belgium agreed to put 11.2bn euros ($16.1bn; £8.9bn) into Fortis. The bank, originally based in the Benelux countries[9], was broken up after having critical difficulty financing

[9] The term Benelux refers to the a politico-economic union of three neighbouring states in western Europe: Belgium, the Netherlands, and Luxembourg.

its part of a joint acquisition of ABN AMRO (as a member of a consortium which also included Royal Bank of Scotland Group and Banco Santander). Several preliminary take-over bids were made by other banks[10] but these talks were curtailed, as governments took central place. In Figure 3 the first vertical line indicates the September 29, 2008. government intervention. As the government has stepped in the two series have inverted their trends witnessing that part of the credit risk associated with the Dutch financial sector has been transferred to the sovereign sector.

Figure 3- Risk transfer: Dutch case



Source: Bloomberg, December 2016

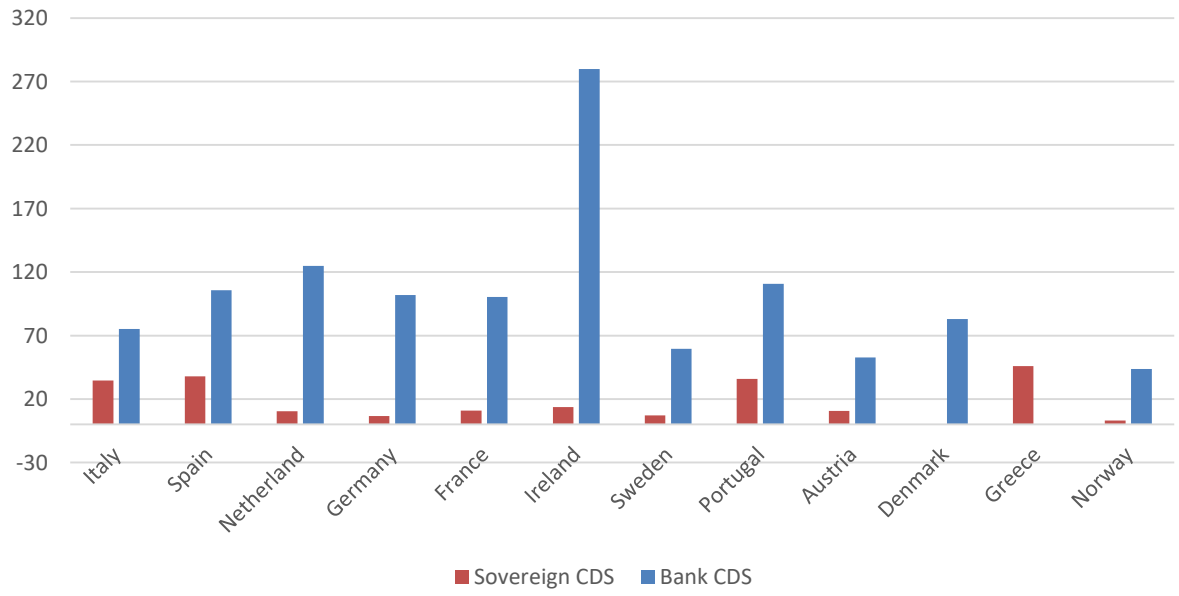
The second line refers, instead, to the government bailout of ING bank. The case of the Dutch bank ING is particular in that the government used a rescue package containing different support measures. The rescue package for ING comprised recapitalisations, government guarantees and asset relief measures. In sum, ING received €10 billion in capital, €17 billion in government-guaranteed bonds and asset guarantees on an Alt-A portfolio of €27 billion, of which the government guaranteed 80%, i.e. €21 billion.

[10] ING offered €1.50 per share and BNP Paribas €2.

Anyway, 0n October 19,2008 the Dutch State intervened for the first time purchasing €10 billion worth of subordinated bonds to bolster the bank's Tier 1 capital. One important consideration to be made is that after the banks bailouts correlation between the two series has evidently increased. Indeed, if on one side the governments' financial support measures can be considered as an explaining factor in the rise of the sovereign credit risk, on the other side the correlation between the sovereign and bank credit risk premium seems to be higher after their announcement or inception.

These cases are not isolated, even if probably they are the most evident fact that the bank bailouts were an important factor behind the rise in sovereign credit risk. Let' s now consider all the other countries in sample. As well as before, in order to catch the evolution over time of the relation between the two CDS premia, the period from 1/02/2001 to 30/04/2011 will be divided into three sub-periods as well as in the pargraph 2.2. Starting from the pre-bailout period, Figure 4 plots the change in the average bank and sovereign CDS from 1/02/2001 to 25/09/2008.

Figure 4 - Change in sovereign and bank CDS before bank bailouts

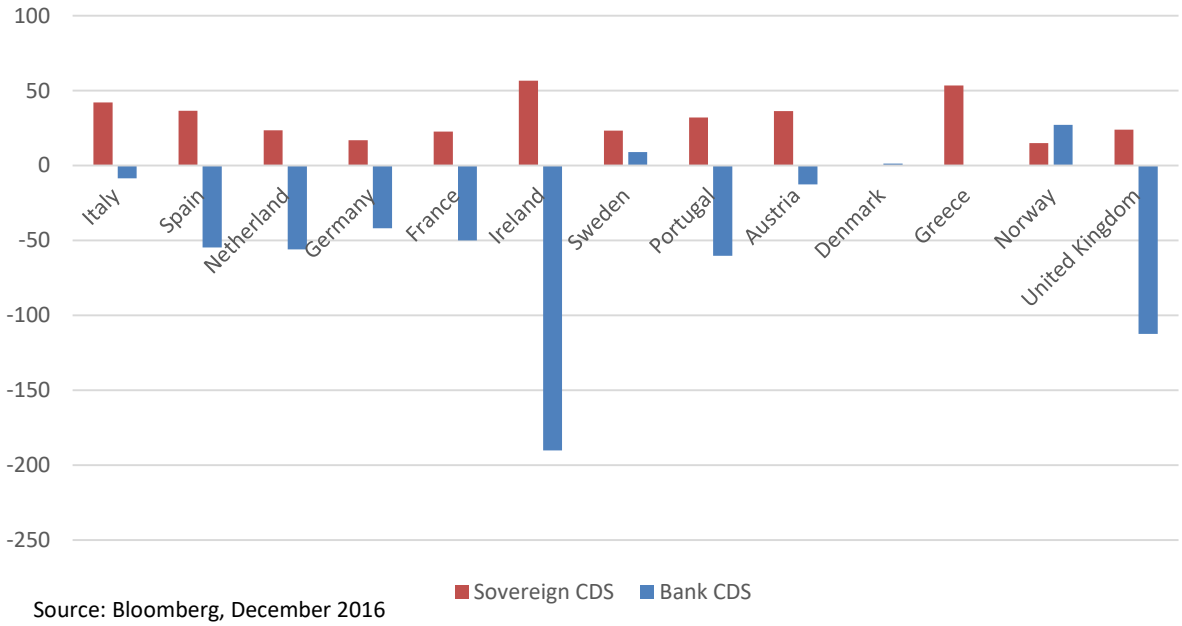


Source: Bloomberg, December 2016

The figure shows a large increase in in average bank CDS while almost no significant increase in sovereign credit risk. For example, in Ireland during the pre-bailout period the average bank CDS has increased of 279.9 basis points whereas there was a 13.8 basis points increase in the sovereign CDS spread (less than 5%). Even if not quantitatively, the pattern is qualitatively common to all the countries in the sample. This confirms that in a first period investors weren't concerned that the distress in the financial sector might spread into the sovereign. The modest increase in the sovereign credit risk that can be noticed in Figure 4 can be explained by the presence of some investors who may have expected bank bailout even before the official announcement. In this case part of the equilibrium level of bank credit risk can be shifted forward in time to the sovereign CDS. Probably, investors have perceived the level of the financial sector credit risk as too high to avoid governments' interventions. In any case, the extent of the increase in the sovereign credit risk is such to suggest that the banking sector bailouts were a surprise to many investors.

Figure 5 shows the change in average bank and sovereign CDS during the bailout period.

Figure 5 - Change in sovereign and bank CDS during bank bailouts

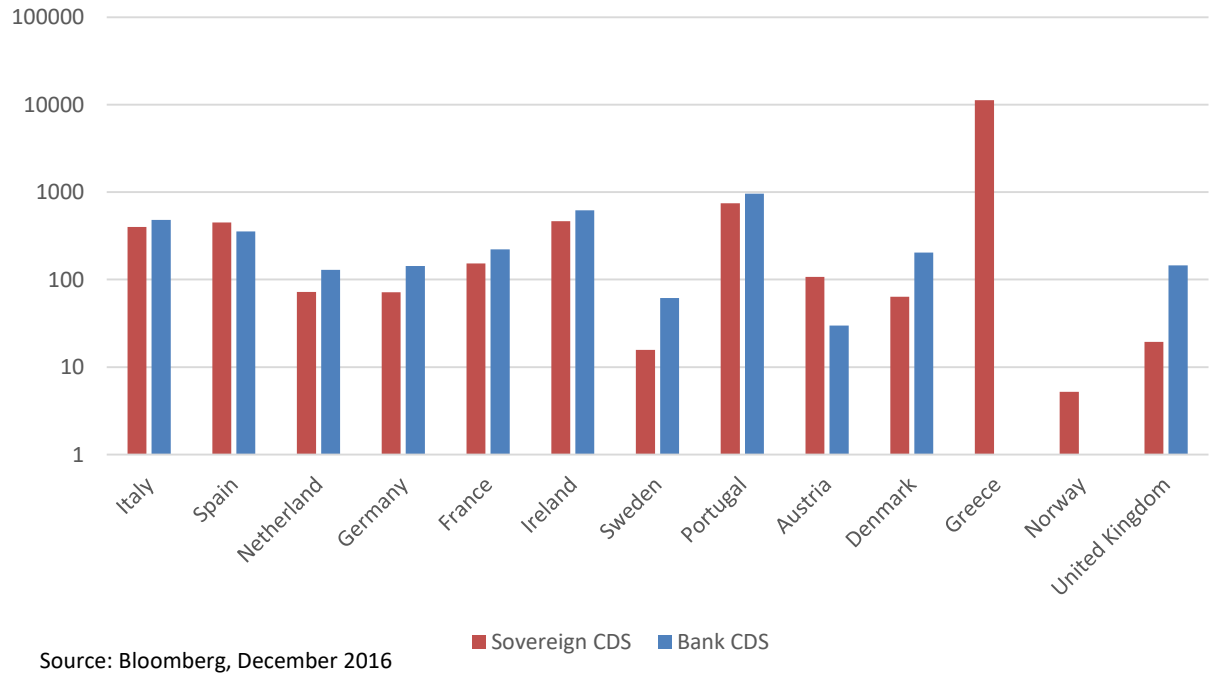


Source: Bloomberg, December 2016

Within one month of the Irish and Dutch bailouts on September 30, 2008, almost every Western European country also announced a bailout. In fact, many countries followed their example, in part to offset outflows from their own financial sectors to newly secured financial sectors. As it can be seen from the above figure, investors realized that, through the bailout measures, portion of the credit risk was transferred toward the governments' balance sheets: with all the capital injections, the impaired asset purchase programs and the explicit guarantees to the financial sector the governments were bearing several risks. In a one-month period the average bank CDS for almost all the countries[11] in the sample has experienced a huge decrease. In the meanwhile, we can notice that the sovereign credit risk has increased as we would have expected. Coming back to the Ireland case, the Irish average bank CDS has decrease by over 190 basis points, while the sovereign CDS has increased by about 56 basis points.

Figure 6 plots the same variables for the post bailout period, that is from 27/10/2008 to 30/04/2011.

Figure 6 - Change in sovereign and bank CDS during bank bailouts



Source: Bloomberg, December 2016

[11] If we exclude the Northern countries such as Norway, Sweden and Denmark, every average bank CDS has decreased during the bailout period.

The plot in Figure 6 is different from the previous two in that the vertical axis is measured with a logarithm scale. This has been necessary since the sovereign Greek CDS change in the period is more than 8200 basis points. Of course, the Greek case is particular and, as we know, its huge surge in sovereign credit risk cannot be completely attributed to the local financial sector distress. Anyway, in this period, of particular interest there is that both sovereign and bank CDS increased in most countries and that the magnitude of the movements is quite similar within countries. This is a further proof that correlation increased after government stepped in after the financial crises. Table 4 reports correlation between the daily changes in sovereign CDS and the daily changes in banking sector CDS over the three periods of interest. Correlations are sorted by country. Notice that, on average, the correlation between the sovereign CDS changes and the banking sector CDS changes has increased after the bailout period as we have conjected before. Furthermore, during the bailout period, we observe a negative correlation mainly in those countries where support measures have had a relatively higher size.

Table 4 –Correlation between Sovereign and Banking Sector CDS

This table shows the correlation between the daily percentage change in sovereign CDS and the daily percentage change in banking sector CDS. Correlations are sorted by country (rows) and by period (columns). The Pre-Bailout period goes from 2/1/2007 to 9/25/2008. The bailout period goes from 9/26/2008 to 10/21/2008. The Post-Bailout period goes from 10/22/2008 to 06/29/2012. Correlations for Denmark and Greece are missing in the first two periods since data on CDS are not available for the Danish Sovereign and for the Greek banking sector. Data on both sovereign and bank CDS are missing during the bailout period relatively to Norway.

Country	Pre Bailout Period	Bailout period	Post Bailout Period
Austria	0.065	0.542	0.354
Denmark	-	-	0.321
France	0.005	0.267	0.489
Germany	0.008	0.259	0.422
Greece	-	-	0.053
Ireland	0.072	-0.780	0.331
Italy	0.130	0.386	0.651

Netherland	0.036	-0.022	0.511
Norway	0.117	-	0.172
Portugal	0.094	0.474	0.627
Spain	0.107	0.536	0.606
Sweden	0.258	0.794	0.269
United Kingdom	0.017	-0.271	0.511
Mean	**0.083**	**0.218**	**0.409**

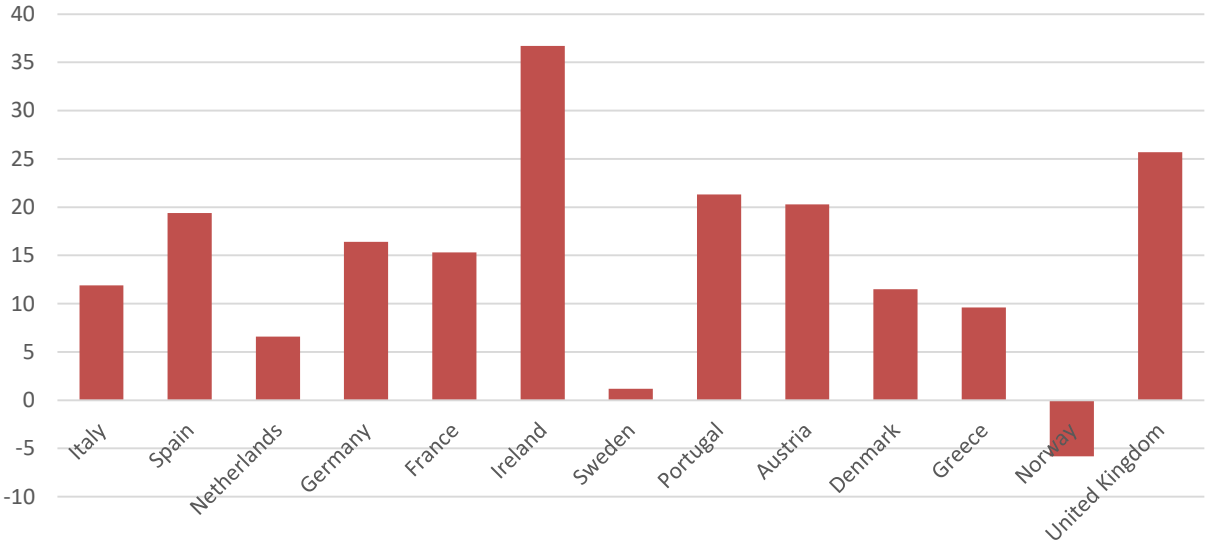
3.2. Determining the Sovereign Credit Risk

By looking at the sharp rise in sovereign credit risk upon the bailout period all over Europe, analysts have raised a question: what investors look at when pricing the credit risk associated with government bonds?

Alessandro Fontana and Martin Scheicher (2010), in their working paper for the European Central Bank (ECB) have argued that the huge increase in the sovereign CDS after banking sector bailout may be due to several factors as declining risk appetite and falling market liquidity, but also to concerns about an increasing number of credit rating downgrades, rather than to the common increase in the public debt all over European countries.

Assuming a fundamental approach, investors should be worried about the degree of leverage of an entity when pricing its credit risk. Therefore, an important determinant in the sovereign CDS could be the debt level of the respective country. The higher is the public debt of a country, the riskier should be to keep investing in government bonds of that country. As a measure of the leverage of the governments balance sheets we will consider the public debt-to-GDP ratio since it is extremely easy to check in the OECD-statistics website. I have collected such data for all countries in the sample in two different moments: before bank bailouts and after them. From Figure 7, it can be notice that from June 2008 to march 2010 almost every country in the sample has been subjected to an important increase in the debt to GDP ratio.

Figure 7 - Change in Debt-to-GDP ratio



Source: OECD, March 2017

The evident rise in the level of public debt in Europe not necessarily has to be attributed to bailout measures employed to ensure the soundness of the financial sector. However, is quite indicative that the most significant increases have been observed in those countries whose financial sectors count for a big portion of their national GDPs (United Kingdom) or whose biggest banks have been all guaranteed by the government (Ireland). Hence, let's look at how debt-to-GDP and sovereign credit risk comove cross country. Figure 8 and 9 show the relationship between sovereign credit risk and public debt-to-GDP ratio in June 2008 and March 2010, respectively. Let' s first give a glance to the scatter plots and then make some comments.

Figure 8 - Correlation between soverein CDS and Debt-to GDP ratio before bank bailout

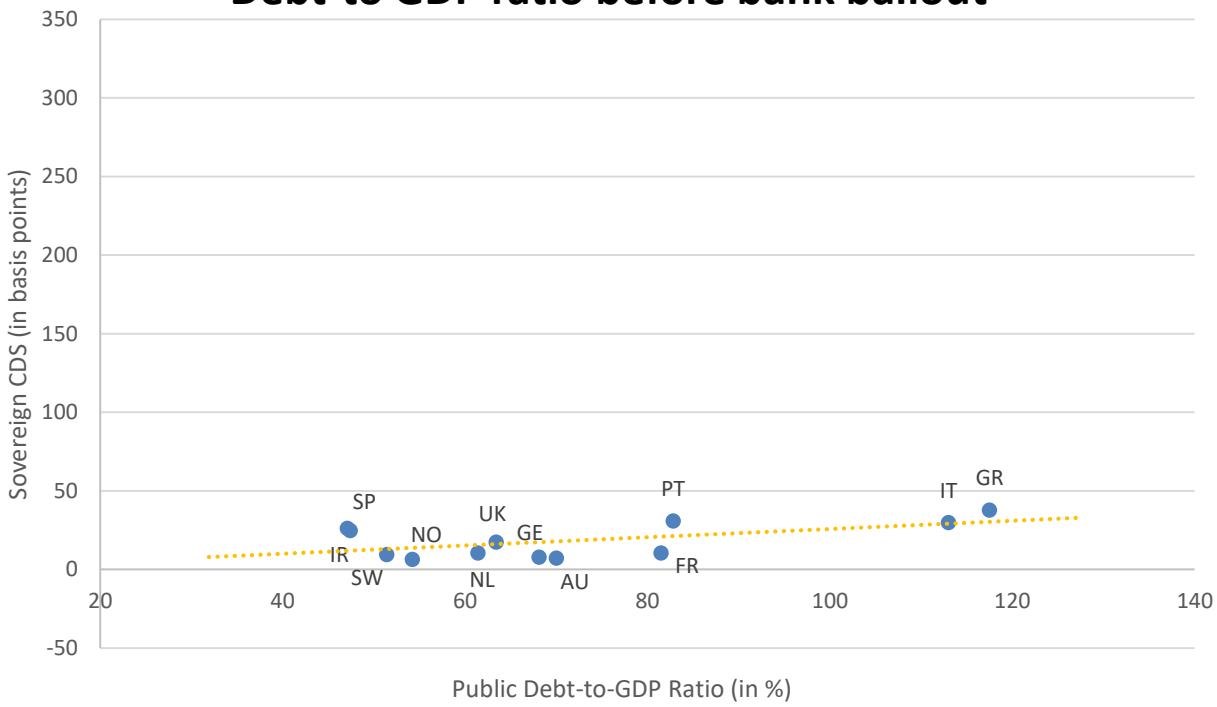
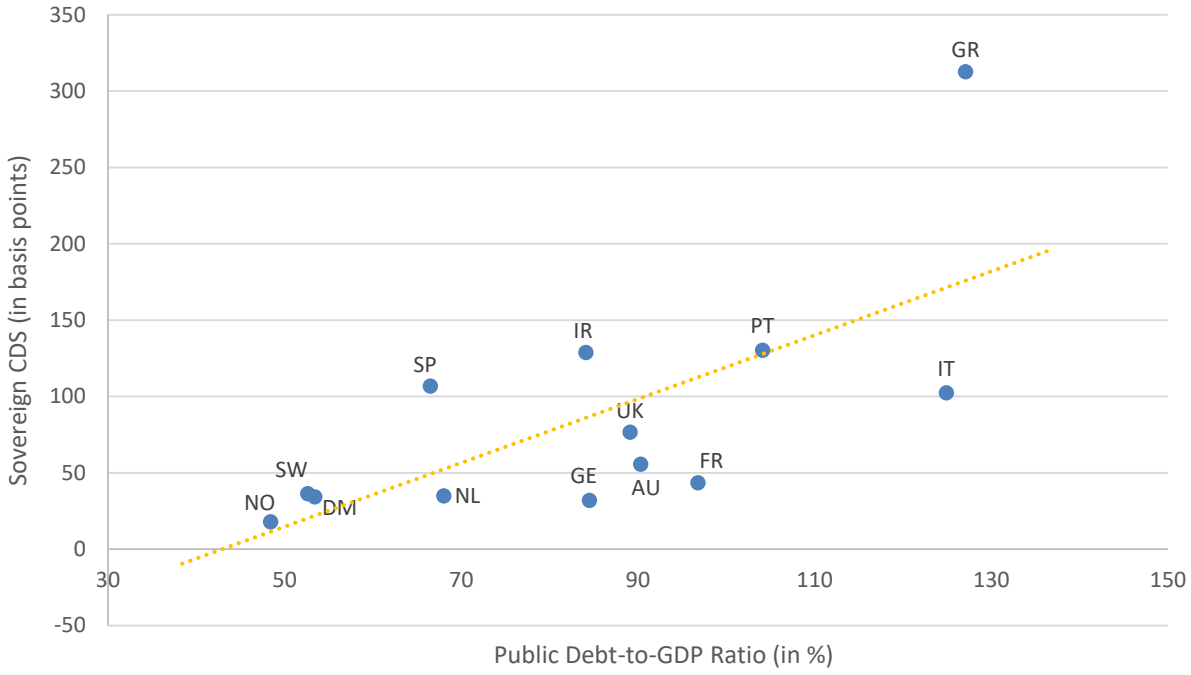


Figure 8 represents observations for each country in the sample[12] concerning sovereign CDS and public debt-to-GDP before of the bank bailouts (June 2008). The trend line, even if upward sloped, is quite flat and does not suggest an high correlation. This means that investors, even if looking at the debt-to-GDP ratio in order to price the risk associated with investing in government bonds, don' t see the country' s debt level as an dominating reason for a default. After the bank bailouts something changed. Figure 9 plots the same observations of Figure 7 but after the bank bailouts, as of march 2010.

[12] Denmark has been excluded since there is no observation on Sovereign CDS before of 12/06/2009.

Figure 9 - Correlation between soverein CDS and Debt-to GDP ratio after bank bailout



Notice that both the figures have the same vertical line's scale. Nonetheless, the post-bailout trend line is much steeper with respect to the pre-bailout one. A possible explanation could be that the bailout programs have raised investors' concerns on public debt-to-GDP ratio as one of the factor determining the sovereign credit risk. A second hypothesis is that the relation between the market-perceived sovereign credit risk and the level of debt of a country is not linear: if the sovereign CDS would be increasing at increasing rate with respect to country's debt level then it would explain why after the bank bailout we notice a higher correlation among the two variables than before.

Table 5
Which is the best fitting model?

		Pre Bailout Period January 2008			Post Bailout Period March 2010		
Model	Equation	β	SSE	R^2	β	SSE	R^2
Linear	$CDS_{sov} = \alpha + \beta \frac{Debt}{GDP} + \epsilon$	0.263	925.64	0.3137	2.1	39406.44	0.4673
Exponential	$CDS_{sov} = \alpha e^{\beta \frac{Debt}{GDP}} + \epsilon$	0.013	919.91	0.2253	0.0227	36657.38	0.5529
Polynomial	$CDS_{sov} = \beta_1 (\frac{Debt}{GDP})^2 + \beta_2 \frac{Debt}{GDP} + \epsilon$	$\widehat{\beta_1}$ = 0.0111 $\widehat{\beta_2} = -1.55$	602.75	0.50885	$\widehat{\beta_1} = 0.035$ $\widehat{\beta_2} = -4.014$	23675.98	0.5092
Power	$CDS_{sov} = \alpha (\frac{Debt}{GDP})^{\beta} + \epsilon$	0.837	1058.30	0.1588	1.82	41637.83	0.5414

Above, Table 4 shows the betas, the sum of Squared Error (SSE) and the R^2[13] for different models applied to the data in both pre and post-bailout periods. First of all, we notice that, no matter which model we decide to apply, in the post bailout period the relationship between the sovereign credit risk and the debt-to-GDP ratio seem to be stronger since each model better fits the data with respect to the previous period. This, in a certain way, confirms the first hypothesis we made before: the bank bailouts have made investors more concerned about the impact that the country debt level can have on the sovereign credit risk. Anyway, coming back to the issue of whether the relation between the sovereign CDS and the level of public debt is or not linear, in the pre-bailout period the answer is not very clear. Indeed, even if the best fitting model is the polynomial, the R^2 of the linear model is higher than those of the others. In the post bailout period we have a different evidence. Indeed the linear model has the lowest R^2, suggesting that, probably, after the bank bailouts the sensitivity of the sovereign CDS to the debt-to-GDP ratio is positive but it is not constant with respect to the deb-to-GDP ratio. Anyway, there is further remarks to be made: the sovereign credit risk could be determined by a variable which is highly correlated with the public debt measure implemented. We can state that whatever the model is, the bank bailouts have modified the relation between the two variables. Investors seem to have updated their risk pricing models and, after the bailouts period, have augmented the weight that the public debt has in determining the sovereign credit risk.

We said that, before the bank bailouts, there is no a such strong relationship between sovereign CDS and public debt as the one we can observe after. To test this hypothesis formally, we estimate the impact of pre bailout debt-to-GDP ratio and financial sector distress on sovereign credit risk. The model is, therefore, the following:

$$y_i = \alpha + \beta(Debt - to - GDPRatio_i) + \log(Financial\ Sector\ Distress_i) + \epsilon_i$$

where the outcome variable y_i is the natural logarithm of sovereign CDS of country *i*. We want to verify if the level of distress in the financial sector of a country affects the relative

[13] Since in the Polynomial model we use one regressor more than in all the other models, the respective R^2 is computed using the formula for the adjusted - R^2 : $R^2_{Adj} = 1 - \frac{n-1}{n-k}\ (1 - R^2)$.

sovereign' s credit risk upon a bailout. Therefore, we regress the natural logarithm of sovereign CDS on the natural logarithm of a measure of financial distress, prior to the bailouts, and controlling for the level of debt to GDP ratio. As measure of financial distress of each country I use the equally weighted average bank CDS up to September 18, 2008. The data concerning the level of debt, before the bailout period, of each European country have been downloaded from the OECD web-site.

In each regression I will keep the same independent variable. What is going to change is only the dependent variable. Indeed, the first regression considers the level of sovereign credit risk far before the crises and the subsequent bailout measures in Europe (January 31, 2008), while the second regression considers the level of sovereign credit risk up to March 20, 2010. Finally, in the third case I use as dependent variable the change in debt-to-GDP ratio over the period considered. Table 6 shows the results obtained applying the above model in such way.

Table 6
Sovereign Credit Risk Sensibility to Financial Distress

This table analyses the relationship between the financial sector distress and government credit risk. The sample covers the Eurozone countries and Denmark, Norway, Sweden and the United Kingdom. Financial sector Distress is the natural logarithm of the average national banks CDS as of 18/09/2008 (prior to the bailout). Debt/GDP is the ratio of government liabilities to GDP as of June 2008 (collected from the OECD Economic Outlook). Log (Sovereign CDS) is the log of the sovereign CDS. Δ Debt/GDP ratio is the increase in the public debt to GDP ratio from June 2008 to March 2010 Standard errors are reported in parentheses. ***, ** and * indicate, respectively, statistical significance at the 1%,5% and 10% level.

	LOG SOVEREIGN CDS		LOG SOVEREIGN CDS		$\Delta \frac{Debt}{GDP}$ Ratio	
	January 2008		March 2010		From January 2008 to March 2010	
	(1)	(2)	(3)	(4)	(5)	(6)
$Financial\ Distress_{08}$	0.2957	0.0006	1.3008**	1.0797*	34.108***	34.936***
	(0.6991)	(0.6078)	(0.5405)	(0.5074)	(4.784)	(4.726)

$\frac{Debt}{GDP}\%_{08}$	-	0.0123 (0.0058)	-	0.0076 (0.0043)	-	0.0862 (0.0710)
Observations	11	11	12	12	12	12
R-squared	0.019	0.375	0.367	0.529	0.835	0.827

As it can be seen from column (1), we find a weak relationship between financial sector distress and sovereign CDS; the coefficient is small and statistically insignificant. In column (2), by adding the public debt-to-GDP ratio as explanatory variable, the coefficient on financial sector distress is almost unchanged and there is no economically or statistically significant effect of the country's level of debt on sovereign CDS. Hence, the level of government debt and financial sector distress have no predictive power for the level of sovereign credit risk before the bailout. Let' s give a look to the impact of the financial sector distress and government debt level on sovereign CDS after the bank bailouts. Column (3) finds that a 10% increase in the pre-bailout financial sector distress leads to almost a 10% increase in the sovereign CDS[14]. Last column, the one regressing the sovereign credit risk on both explanatory variables, shows that the financial sector distress has a statistically significant effect on sovereign CDS even by controlling for the debt-to-GDP ratio. Furthermore, column (4) presents an high R^2 of almost 53%. Columns (5) and (6) show the coefficient obtained regressing the change in debt-to-GDP from January 2008 to March 2010 on the variables that we have used before. Results show that the financial sector distress has an important (and statistically significant) effect on the change in debt-to-GDP ratio over the period. Table 6, in summary, suggests that pre-bailout financial sector distress is highly predictive of post-bailout sovereign credit risk. Till now, we haven' t made any assumption on the nature of the channels through which the bank bailouts have affected the sovereign credit risk. We know that from the public

[14] When a OLS regression has a logarithm-logarithm specification the estimated coefficient can be seen as the elasticity of the outcome variable with respect to the independent variable.

finance' s point of view the bailout mechanism has been quite expensive and financed through debt's issuing, taxation or a mix of the two. Hence, a model able to explain the movement of the sovereign CDS could suggest that the bank bailouts have determined the surge in sovereign credit risk through an increase in the public debt-to-GDP. Column (5), therefore, examines whether financial sector distress predicts the change in public debt-to-GDP ratios after the bailouts. The dependent variable is the change in the debt-to-GDP ratio from June 2008 to march 2010. The coefficient is highly statistically significant: in this sample a 1% increase in the financial sector distress predicts a 0.34% increase in the public debt-to-GDP ratio.[15] As shown in column(6), this result is robust to controlling for the public debt-to-GDP ratio before the bailouts.

[15] When a OLS regression has a linear-logarithm specification the estimated coefficient (β) can be seen as the semi-elasticity of the outcome variable (Y) with respect to the independent variable (X), such that an 1% increase in X leads to a 0.01*β increase in Y.

4. The Sovereign-Bank Feedback Loop

The link between the conditions of sovereign sector and that of their relative domestic banking systems has been a key feature of the global financial crisis. In both the sub-prime-triggered crisis of 2007/2008 and the more recent euro-area sovereign debt crisis, we have observed an increasing number of times governments have had intervened in the private banking sector. As already said before, in the first case, after the collapse of Lehman Brothers in September 2008, most governments in the euro area adopted financial sector rescue packages of unprecedented size. Related to this event, thanks to various factors including their solid initial fiscal position, some country succeeded although at an high costs in terms of fiscal deterioration. Some other countries, instead, has paid the rescue of its financial sector even in terms of long stagnation. Moving forward in time, in the most recent and Europe-located crisis, the connection between the two sides has a different causality direction but it still preserves its evidence. The crisis, indeed, started in Greece at the end of 2009, when news came out about errors in public finance figures. The sovereign difficulties spread rapidly to the domestic banking system via a sharp deterioration of the economic outlook, depreciation of government bond portfolios and funding problems. These events acted as catalysts, accelerating the emergence of problems that had been brewing in other economies. Between April 2010 and April 2011, Greece and then Ireland and Portugal became unable to tap bond markets and received international financial assistance. In the summer of 2011 the tensions spread to Italian and Spanish government securities.

In these two recent crisis there are some points in common and others which differ. In both cases the relation between the banking sector and the sovereign sector is quite strong and evident. Furthermore, in both cases, some countries fell into a self-reinforcing negative spiral involving sovereign difficulties, bank fragility and economic recession. The two crises differ in the direction of the causality: in some countries, such as Ireland and Spain, the public finances were regarded as sound before the 2008 crisis, but suffered from the difficulties of the domestic banking sector; in Greece, instead, the sovereign situation was the main fragility factor.

In this section I will first breaking down the sovereign–banking channels, considering the bank trigger as well as the sovereign trigger. Then I will employ an empirical analysis on such loop in credit risk in order to spot, if any, the phenomenon and measure it.

4.1. The Sovereign-Bank Channels

As said before, and as remarked by Acharya et al. (2014), the relation between the sovereign credit risk and the bank credit risk can be seen as a two-way feedback loop. Once an event triggers a significant move in one side' s creditworthiness, the risk is transmitted to the other side through several channels. This, on its turn, feeds a further movement in the first sector' s credit risk. Thus, let' s, explain the channels transmitting the bank risk to the sovereign and those transmitting sovereign risk to the banks.

4.1.1. Factors Transmitting Bank Risks to the Sovereign

Actually, we have, already and largely, discussed this channel in section 3.1 when we have observed that a huge portion of credit risk can be transferred form the financial sector to the sovereign sector practically overnight. However, the surge in sovereign credit risk has to be seen as a market response to both the government financial support measures and to the expected impact of these actions on the public finances. The 2008 financial crisis has obliged governments, not only in Europe, to support banks and other financial institutions. Given the unprecedented extent of the bailout measures, countries had to deal with the subsequent recession and with the increase in taxation typically implemented to deal with them.

4.1.2. Factors Transmitting Sovereign Risks to the Banks

Sovereign risk affects banks through several channels. Some work via the asset side of banks' balance sheets. Concerning the asset side, as literature suggests, the link between the credit risk of the banking sector and the one of the sovereign could be partially explained through the higher (relatively to other borrowers) exposure banks have with respect to their national government. Indeed, a deterioration or improvement in government's creditworthiness, as perceived by the markets, may cause losses or gains on banks' portfolios of sovereign securities. Whether securities are booked at market value or

not makes little difference when bank's creditors become concerned about a possible default of the bank. In that case creditors will look through accounting conventions, assessing the solidity of the bank based on the market value of its assets. From this point of view, sovereign exposures are not conceptually different from claims on any other debtor. What makes this kind of exposures differing from the others is that they are often substantial, typically reflecting large holdings of domestic government debt (direct exposure to foreign sovereign debt is ordinarily limited). This typical banking feature has been named "home bias". The home bias is typically result of several factors. Among these we find hedging motives, transaction costs, legal risk and informational frictions. Regarding the hedging motives, we find quite natural that banks, within the government bond asset class, keep buying securities issued by the domestic country since, doing so, they can mitigate several risks. For example, the exchange rate risk, that is the risk that the return on investments in foreign countries may be affected by movements in the exchange markets during the investment period, can be mitigated by investing in securities denominated in the home-country currency. Furthermore, it is a common practice of Asset-Liability Management to match the asset side and the liability side from a currency point of view (this, in turn, implies that the banks' asset sides are mainly denominated in the national currency). This motives may explain why the home bias is present for different financial operators and a broad range of asset classes (equity holdings, bond holding and bank loans). Moreover, as bond markets are relatively less volatile and more globally integrated than markets for other financial assets, diversification out of domestic bonds might be relatively less beneficial. A further factor can be traced to current regulations, which give at government securities a preferential treatment over those on private borrowers when assessing capital charges. Indeed, the first pillar, the one on capital requirements, of the Basel Committee on Banking Supervision of 2006 states at number 54:

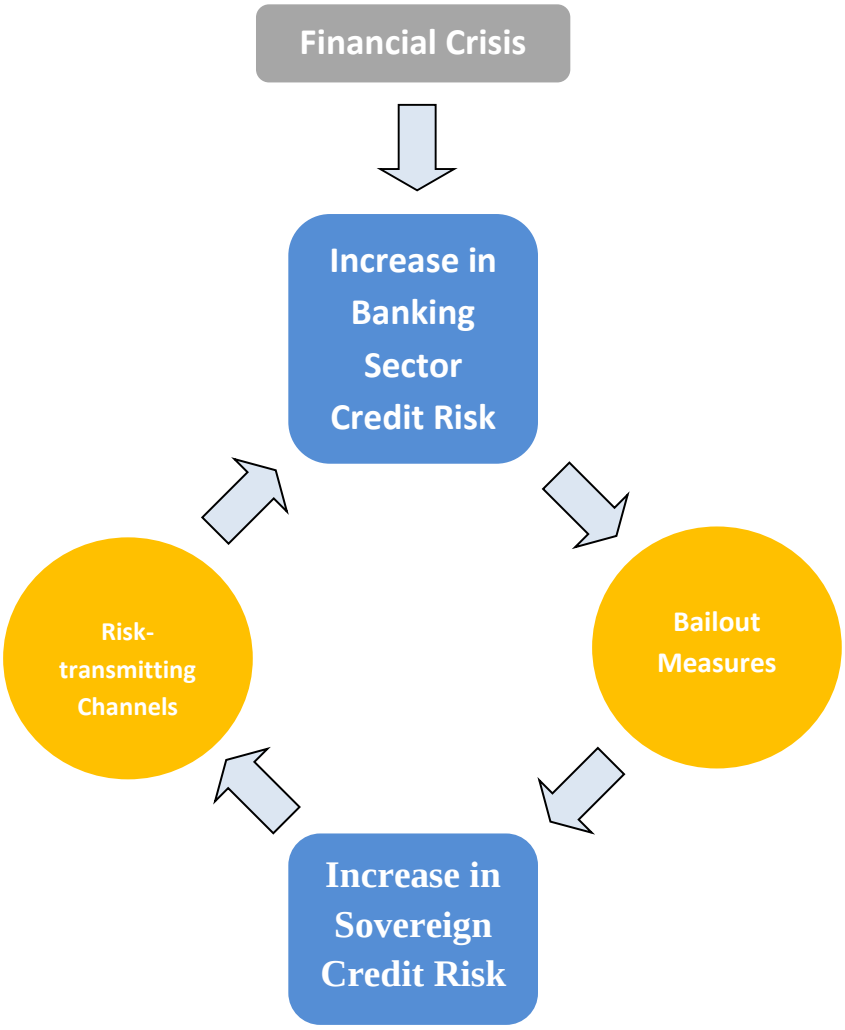
> "At national discretion, a lower risk weight may be applied to banks' exposures to their sovereign (or central bank) of incorporation denominated in domestic currency and funded in that currency"

In particular, in the so-called Standardized Approach, the Basel II rules imply risk weights ranging from 0% to 150%, depending on the external rating assigned by a recognized agency, or a 100% weight by default where no rating is available. However, national authorities are allowed to apply a zero risk weight for exposures to the domestic sovereign denominated and funded in domestic currency, if national regulations allow it. In the Internal Ratings Based Approach, typically used by large and sophisticated banks, risk weights are calculated according to banks own internal rating models. Since these models are typically estimated using historical data, which, as we have seen, show few or no sovereign defaults, they tend to yield very low or zero risk weights on sovereign exposures.
Concerning the EU regulation, we do not move far away from the Basel rules. In the attempt to foster the single market for financial services, Directive 2006/48/EC extended the Standardized Approach exemption – and therefore the zero risk weight regime – to all banks within the euro area that finance euro-denominated government debt, regardless of whether they adopt the Standardized or the IRB approach. Notice that in this sense, in the euro area, unlike elsewhere, prudential regulations do not produce a bias in favor of domestic sovereign exposure, as the preferential treatment is extended to the euro-denominated debt issued by most of EU countries.
Sovereign-bank dependence is also created via other mechanisms that work on banks' liabilities side. Several governments introduced explicit guarantee schemes on banks' bonds after the collapse of Lehman Brothers in October 2008. There is evidence that these guarantees helped reduce risk premium on banks' liabilities, and that their effect was proportional to the creditworthiness of the sovereign.
Furthermore, as highlighted by Paolo Angelini, Giuseppe Grande and Fabio Panetta (2014), the impact of sovereign strains on bank funding conditions is not only in terms of credit risk, but also in terms of liquidity/funding risk. Since government bonds are typically used as collateral (mainly in repos), a fall in their price can trigger margin calls or larger haircuts, thus reducing the liquidity that can be obtained via a given nominal amount of sovereign paper.

4.2. Empirical Analysis

In this section I will provide empirical evidence on the feedback loop between sovereign and bank credit risk. As said before, once one sector opens itself up to credit risk, the relation between sovereign and bank can be self-reinforcing. Theoretically, the loop is fed through several channels and factors regardless of whether the shock in credit risk has been triggered by the public or private sector. However, my analysis will consider just a "one-way" feedback loop: I assume that the 2007/2008 financial crisis sparked the self-feeding spiral in credit risk. Figure 10 summarize the basic idea behind the SBF loop as analyzed in this section.

Figure 10 – The Sovereign-Bank Feedback Loop



The idea is that the financial crisis has caused a shock in the sovereign CDS market. Through the bailout measure employed by governments in Europe the credit risk has been transferred from the banking sector to the sovereign sector. The increase in sovereign credit risk has caused, on its turn, an increase in the banking sector CDS which can be explained with the risk-transmitting channels discussed before. Section 3 has shown that the huge surge in the sovereign credit risk observed at the end of 2008 can be attributed to a risk transfer mechanism form the distressed financial sector. Therefore, in this case the direction of causality is evident: the bailout measures employed by European countries have triggered the transmission of risk from the private sector to the public. In the following sections I will look at the feedback effect trying to answer at the following question: has the sovereign credit risk an effect on the banking sector credit risk in the aftermath of a bailout? If changes in the sovereign's credit risk impact the financial sector credit risk, then it would mean that the risk-transmitting channels, via direct holdings of government debt and explicit and implicit government guarantees as discussed in section 4.1.2, actually work. Part 4 is, therefore, organized as follow. Section 4.2.1 presents the basic model used in order to measure the feedback loop. From Section 4.2.2 to 4.2.5 I report several empirical results.

4.2.1. Model Specification

One of the main issue in assessing the impact of an independent variable over a dependent variable is that there may be another (unobserved) factor that affects both variables. Since in economics and finance variables tend to strictly commove, we should be very concerned with this issue. The presence in the "real" model of a factor that affects both bank and sovereign credit risk could explain the comovement we observe after the bailout period. This would mean that even if the two variables appear to me related, not necessarily there has to be an underlying direct channel between sovereign and bank credit risk. The bias should depend on the two relations: the one linking the unobserved factor with the change in banking sector and the other linking the unobserved factor with the change in sovereign

sector [16]. For example, sovereign credit risk reflects changes in expectations about macroeconomic fundamentals, such as employment, economic growth, and productivity. These fundamentals also have a direct effect on the value of bank assets such as mortgages or bank loans. Therefore, for a macroeconomic factor having a directional equal effect on both banks and sovereign CDS we should expect a positive bias and, alternatively, a macroeconomic factor having different directional effects on the two variables should produce a negative bias. However, changes in macroeconomic conditions may generate a correlation between sovereign and bank credit risk even in the absence of a direct feedback mechanism.

We can address this concern by including some control variable in order to capture the direct effect of macroeconomic fundamentals on bank and sovereign credit risk. In particular, three sets of control variables can be detected. First, I include day fixed effects to capture market-wide changes in macroeconomic fundamentals that directly affect both bank and sovereign credit risk. These fixed effects capture all macro-fundamentals that have a common effect on the financial sector. By doing this, we assume that we are not aware of what the macro factor could be but, at least, it should have an effect at the same moment cross banks as well as cross countries.

I further control for country specific effects, in order to check whether there is or not a sort of heterogeneity among banking sector. In this way, I can catch the effect of a country specific shock that may be affecting both sovereign CDS and banking sector CDS.

A third set of control variables is represented by determinants of banks fundamentals. In the basic model this set is composed by only an aggregate measure of volatility. Following the empirical literature, I chose a VIX-like index, the VDAX, which is the German counterpart to the VIX index for the S&P 500. Since in this sample there are only European banks, this choice seems quite reasonable. This index captures changes in aggregate volatility, which is an important factor in the pricing of credit risk. In the following sub-section, I will add some further control variables in order to get an idea if the SBF loop is affected by these determinants.

[16] It is easy to show that the bias, in this case, can be measured as the product between β_{unobs}, which is the coefficient linking the unobserved factor to the banking sector credit risk, and the covariance between the change in the unobserved factor and the change in the sovereign credit risk.

Specifically, we estimate the following OLS regression:

$$\Delta \log Bank\ CDS_{it} = \alpha_i + \delta_t + \beta \Delta \log Sovereign\ CDS_{it} + \gamma \Delta X_{it} + \varepsilon_{it}$$

where $\Delta \log Bank\ CDS_{it}$ is the daily change in the natural logarithm of the CDS spread of banking sector of country i, $\log Sovereign\ CDS_{it}$ is the daily change in the natural logarithm of the sovereign CDS of country i, ΔX_{it} are daily changes in the control variables, γ is the set of coefficient relating changes in the banking sector credit risk to the daily changes in control variables, δ_t are day fixed effects, and α_i are banking sector specific effects.

4.2.2. Basic Model

Table 7 shows the results obtained by estimating the above presented model. I have run the OLS regression for the period before, during and after the bank bailouts. In each period we can find results with and without the use of a country fixed effect. In each column the time fixed effect is present.

Table 7
Change in Bank and Sovereign Credit Risk

This table shows the effect of sovereign credit risk on bank credit risk during the financial crisis. The sample covers all banks with publicly traded credit default swaps (CDS) headquartered in Eurozone countries plus Denmark, Great Britain, Norway and Sweden. Columns (1) to (2) cover the pre-bailout period (2/1/2007-9/25/2008), Columns (3) to (4) cover the bailout period (9/26/2008-10/21/2008), and Columns (5) to (6) cover the post-bailout period (10/22/2008-06/29/2012). *Δ Log(Bank CDS)* is the daily change in the natural logarithm of bank CDS. *Δ Log(Sovereign CDS)* is the daily change in the sovereign CDS of the country in which the bank is headquartered. Δ Volatility index is the daily change in the VDAX volatility index. All columns include time fixed effects. Columns (2), (4), and (6) include country fixed effect. ***, ** and * indicate, respectively, statistical significance at the 1%,5% and 10% level.

	$\Delta\text{Log}(Bank\ CDS)$					
	Pre-Bailout		Bailout		Post-bailout	
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta Log(Sovereign\ CDS)$	-0.0075***	-0.0074***	-0.434***	-0.473***	0.078***	0.077***
	(0.001)	(0.001)	(0.113)	(0.119)	(0.009)	(0.009)

$\Delta\, Volatility\ Index$	-0.005 (0.042)	0.003 (0.043)	-0.173*** (0.023)	-0.163*** (0.034)	0.011 (0.008)	0.230*** (0.025)
Time FE	YES	YES	YES	YES	YES	YES
Country FE	NO	YES	NO	YES	NO	YES
Observations	15,910	15,910	666	666	36,297	36,297
Banks	23	23	23	23	23	23
R^2	0.541	0.539	0.457	0.447	0.513	0.513

Let' s examine the first period. At first glance, we can notice that both the coefficients capturing the relationship between sovereign CDS changes and banks CDS changes are economically small even if they are statistically significant. Furthermore, there is no evident change by including a country fixed effect, since the coefficient appear to be very close to each other. Thus, in the first two columns, there is no evidence of an economically significant relation between sovereign and banks credit risk during the pre-bailout period. In the same way does not seem to be a statistically and economically significant effect of the volatility index on banking sector credit risk.

Next, in the following two columns, the relation during the bailout period, which, as said before, is an 18-days-long period, is analyzed. In both column (3) and column (4) we can find large, negative and statistically significant coefficients. Hence, in my sample, a 10% increase in the sovereign CDS rate produce to a 4.3% decrease in the banking sector CDS rate. The result is robust to including country-specific controls. Moreover, in this case, controlling for the country where the banking sectors are located, leads to a slightly negative effect on the coefficient. These results support the view that bank bailouts triggered the rise in sovereign CDS and that banks transferred some of their credit risk to their sovereign. Unlike the previous period, during the banks bailout the changes in the volatility seem to be an important determinant of the banking sector CDS. Nevertheless, even if highly significant, the coefficients on the volatility index appear to be negative. This is a result quite unusual since, in theory, an higher volatility should lead investors to

demand higher protection against banking sector default. However, I believe that this result is driven by the particular period in which the analysis is ran. Indeed, during this period volatility is increasing due to the effects subsequent of the financial crisis and the failure of Lehmann Brothers while banks' credit risk has experienced an important decrease after governments have adopted some of the banks' liabilities.

Concerning the last, post banks bailout, period, results on the sovereign-bank feedback loop are still highly statistically significant. Controlling for country specific effect does not make an important difference in the magnitude of the coefficient. In column (5), as well as in column (6), an increase of 10% in the sovereign CDS leads to an increase of almost 0.8% in the banking sector CDS. Notice that, in this period, the coefficient on the volatility index changes is highly sensible to the country control: the coefficient, after controlling for a country specific effect, appears to be 20 times higher and much more significant than the one excluding the county fixed effect. This could mean that, after the bank bailouts, investors have become concerned about changes in volatility index when pricing the credit risk of particular countries[17]. Furthermore, this time the coefficients are positive as we expected: in column (6), an increase in the volatility index of 10% leads to an increase in the banking sector CDS of 2.3%.

These results seem to confirm the mechanism of the sovereign-bank feedback loop as presented in Figure 10. Indeed, before the bank bailouts there is no evidence of a significant relationship between the banking sector and sovereign sector credit risk. However, the financial support measure employed by European governments aimed at supporting financial institutions may have triggered the transmission of risk from sovereign to the banking sector. Furthermore, the presence of a statistically and economically significant coefficient in the post bailout period may be reflecting the presence of risk transmitting channels that feedback the loop.

However, comparing my results with those obtained by Acharya et al. (2014), there are no qualitative divergences and very few qualitative differences in the coefficients computed.

[17] Another interpretation is that changes in volatility index have not the same effect on the banking sector CDS over countries. Indeed, credit risk in peripheral countries seems to be much more sensible to changes in volatility with respect to inner European countries.

4.2.3. Controlling for Banking Sector Fundamentals

Someone could be concerned that the banking sector credit risk may be driven by an unobserved factor that has an effect even on the sovereign sector credit risk and that has not been caught by the time fixed effect and the country fixed effect. Although, there is no particular reason to believe this is the case, I try to fix this by introducing a further control variable.

An alternative specification could be to control for equity returns. If there is no a direct feedback loop, then controlling for banking sector's own equity returns will control for the impact of any country-level and time specific shocks and eliminate sovereign CDS as an explanatory variable. Table 8, which is structured as Table 7, shows the results according with this specification.

Table 8
Change in Bank and Sovereign Credit Risk (Controlling for Equity Returns)

This table shows the effect of sovereign credit risk on bank credit risk during the financial crisis. The sample covers all banks with publicly traded credit default swaps (CDS) headquartered in Eurozone countries plus Denmark, Great Britain, Norway and Sweden. Columns (1) to (2) cover the pre-bailout period (2/1/2007-9/25/2008), Columns (3) to (4) cover the bailout period (9/26/2008-10/21/2008), and Columns (5) to (6) cover the post-bailout period (10/22/2008-06/29/2012). *Δ Log(Bank CDS)* is the daily change in the natural logarithm of bank CDS. *Δ Log(Sovereign CDS)* is the daily change in the sovereign CDS of the country in which the bank is headquartered. Δ Volatility index is the daily change in the VDAX volatility index. *Δ Equity is the daily average banking sector equity return.* All columns include time fixed effects. Columns (2), (4), and (6) include country fixed effect. ***, ** and * indicate, respectively, statistical significance at the 1%,5% and 10% level.

	$\Delta\text{Log}(Bank\ CDS)$					
	Pre-Bailout		Bailout		Post-bailout	
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta\ Log(Sovereign\ CDS)$	-0.0085***	-0.0081***	-0.496***	-0.489***	0.075***	0.074***
	(0.001)	(0.001)	(0.114)	(0.119)	(0.009)	(0.009)

$\Delta\, Volatility\ Index$	-0.007 (0.042)	-0.021 (0.044)	-0. 181*** (0.023)	-0.164*** (0.034)	0.118*** (0.011)	0.226*** (0.025)
$\Delta\, Equity$	-0.073 (0.053)	-0.073 (0.053)	-0.232* (0.136)	-0.261* (0.141)	-0.015** (0.007)	-0.014** (0.007)
Time FE	YES	YES	YES	YES	YES	YES
Country FE	NO	YES	NO	YES	NO	YES
Observations	24,510	24,510	1,026	1,026	37,677	37,677
Banks	23	23	23	23	23	23
R^2	0.541	0.539	0.538	0.523	0.522	0.522

As it can be seen, daily sovereign CDS changes still have a statistically significant effect on daily banking sector CDS changes all over the three periods. Column (1) finds that the coefficient on sovereign CDS remains economically small during the pre-bailout period. The coefficient on the equity returns is statistically insignificant. Column (2) allows for country specific controls, but the coefficient on the sovereign CDS remains basically unchanged. Column (3) and (4) analyzes the banks bailout period. The coefficients on the daily sovereign CDS changes are very similar to the ones in Table 7.

Columns (5) and (6) present the result for the post-bailout period. Even in this case the coefficients on the sovereign-bank feedback loop are, in practice, unchanged with respect to the first specification.

Sovereign CDS changes continue to have an explanatory power for banking sector CDS after controlling for equity returns. This is further evidence in support of a direct sovereign-to-bank risk dependence. As expected, the coefficients on the equity control are negative and their statistical significance keep increasing as we move from the pre-bailout period to the post-bailout period.

4.2.4. Estimation Using Government Bond Yield

As already said in section 2.1, the use of CDS rates, as measures of credit risk, has several advantages in terms of liquidity, availability and standardization with respect to other market variables, such as government bond yields. Nevertheless, since CDS rates and bond yield spreads sometimes diverge in practice, one may be concerned that the use of CDS rate somehow drives our results. To overcome this concern, I have reestimated the regressions' results of the above Table 8 replacing each country's sovereign CDS rate with its government bond yield. I have focused on five-year government bond yields since they are highly available. The data has been collected from Bloomberg which provides five-year government bond yields for all countries in our sample with the exception of Austria, Portugal and Greece. Notice that there is no presence of a control for the risk-free rate. Indeed, changes in the monetary policy, which have the same effect cross country, are caught by time fixed effects included in all regressions.

Table 9
Change in Bank and Sovereign Credit Risk (Using Government Bonds Yields)

This table shows the effect of sovereign credit risk on bank credit risk during the financial crisis. The sample covers all banks with publicly traded credit default swaps (CDS) headquartered in Eurozone countries with the exception of Austria, Portugal and Greece, and plus Denmark, Great Britain, Norway and Sweden. Columns (1) to (2) cover the pre-bailout period (2/1/2007-9/25/2008), Columns (3) to (4) cover the bailout period (9/26/2008-10/21/2008), and Columns (5) to (6) cover the post-bailout period (10/22/2008-06/29/2012). *Δ Log(Bank CDS)* is the daily log change in the yield of the five-year government bond of the country where the banking sector is located. *Δ Log(Bond Yield)* is the daily change in the sovereign CDS of the country in which the bank is headquartered. Δ Volatility index is the daily change in the VDAX volatility index. *Δ Equity is the daily average banking sector equity return.* All columns include time fixed effects. Columns (2), (4), and (6) include country fixed effect. ***, ** and * indicate, respectively, statistical significance at the 1%,5% and 10% level.

	$\Delta\text{Log}(Bank\ CDS)$					
	Pre-Bailout		Bailout		Post-bailout	
	(1)	(2)	(3)	(4)	(5)	(6)

$\Delta\, Log(Bond\ Yield)$	0.125 (0.185)	0.149 (0.186)	0.402 (0.747)	0.366 (0.776)	0.113*** (0.012)	0.113*** (0.012)
$\Delta\, Volatility\ Index$	0.155 (0.016)	0.157 (0.017)	-0. 182*** (0.035)	-0.176** (0.065)	0.021** (0.008)	0.563*** (0.024)
$\Delta\, Equity$	-0.029 (0.032)	-0.028 (0.032)	-0.456*** (0.164)	-0.507*** (0.169)	-0.009 (0.007)	-0.009 (0.007)
Time FE	YES	YES	YES	YES	YES	YES
Country FE	NO	YES	NO	YES	NO	YES
Observations	15,910	15,910	558	558	29,853	29,853
Banks	19	19	19	19	19	19
R^2	0.636	0.635	0.397	0.377	0.553	0.552

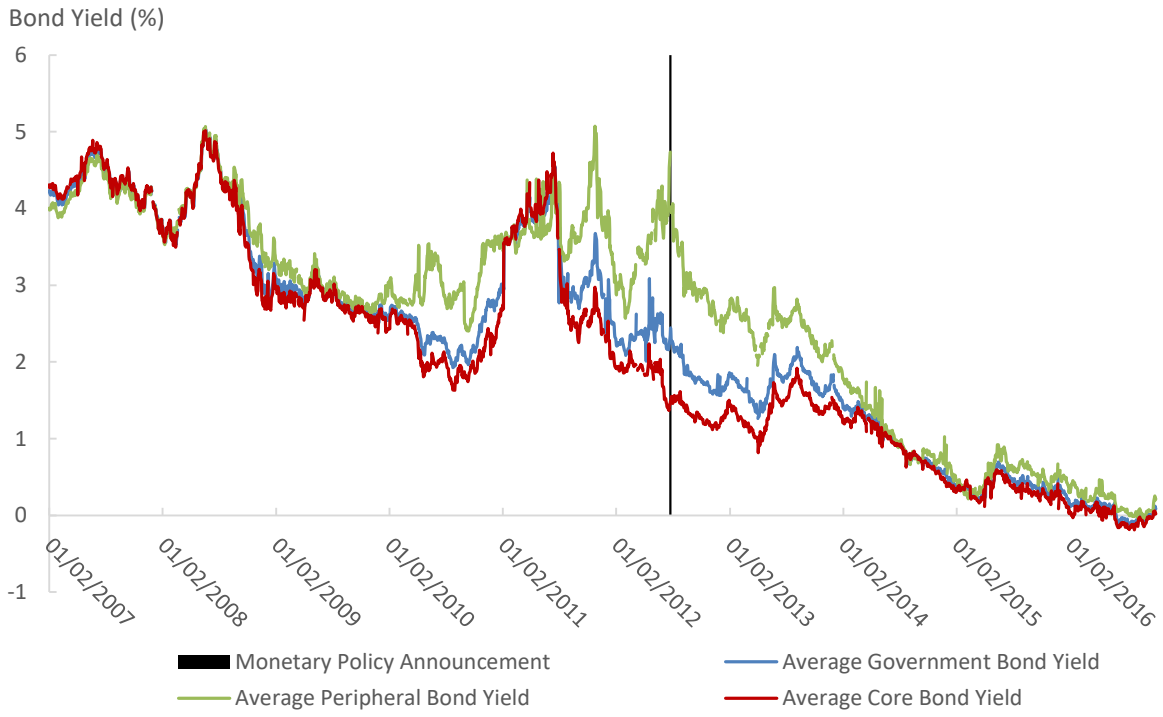
The coefficients linking the government bond yield changes to the banking sector credit risk are very similar to the ones got in Table 8 except for the first period. However, even if the coefficients for the pre-bailout period are very different from the result obtained in the previous regression, they are not statistically significant. Regarding the columns (3) and (4), the lack of statistical significance for the coefficient on the log change in the government bond yield may be caused by the short duration of the bailout period. Most important, coefficient for the post-bailout period, in column (5) and (6), are statistically significant and economically important. Since, as said at beginning of this chapter, government bond banks' holdings are an important factor in explaining the channels transmitting risk from the sovereign sector to the banking sector, these results are quite meaningful and they provide strong evidence that our main results are robust.

4.2.5. Quantitative Easing

It is not a case if the post-bailout period ends almost at the end of July 2012. The period going from half 2011 to the beginning of August 2012 has been characterized by a deep turmoil in the European government bond market. In particular, peripheral government securities have been subject to high bearish and speculative pressures. In my sample, in a

one-year-long period, from 25/07/2011 to 25/07/2012, the spread of the average peripheral bond yield with respect to the average core bond yield has moved from almost 8 basis point to over 300 basis points. In order to bring down the market interest rates faced by countries subject to speculation and to preserve the Euro, the 26th July of 2012, the ECB's president Mario Draghi announced that the Central Bank would offer to purchase Eurozone countries' short-term bonds in the secondary market[18]. From that moment forward, the ECB has implemented non-standard monetary policy measures aimed at both reducing the short-term debt's cost of several countries and to achieving the general objective of an inflation rate of 2% in the medium-long term[19]. Indeed, in 2015 has started an Asset Purchasing Program, known as Quantitative Easing, which is still lasting.

Figure 11 - Government Bond Yield in Europe



Source: Bloomberg, March 2017

[18] The size of the programme is unlimited , lending credence to Mr Draghi's remarks that he would do "whatever it takes" to save the euro.

[19]These measures should be considered as complement, rather than a substitute, of the standard interest-rate policy.

From Figure 11, it can be seen that the unconventional monetary policies of the ECB have been, somehow, effective in reducing the relative peripheral bond yield: from the late July 2012, the spread has noticeably decreased. Hence, I ended the post-bailout period just when the ECB has announced this further measure. From July 2012 to date, it is possible to spot an additional period that we can call "Quantitative-Easing Period". Have these non-standard monetary policy measures had, somehow, an effect even on the relationship between the sovereign and banking sector credit risk? Table 10 is structured as the precedent ones but it relates the Quantitative Easing period.

Table 10
Change in Bank and Sovereign Credit Risk (Quantitative Easing Period)

This table shows the effect of sovereign credit risk on bank credit risk during the latest period going from 7/26/2012 to 11/04/2016. The sample covers all banks with publicly traded credit default swaps (CDS) headquartered in Eurozone countries plus Denmark, Great Britain, Norway and Sweden. *ΔLog(Bank CDS)* is the daily change in the natural logarithm of bank CDS. *Δ Log(Sovereign CDS)* is the daily change in the sovereign CDS of the country in which the bank is headquartered. Δ Volatility index is the daily change in the VDAX volatility index. *Δ Equity* is the daily average banking sector equity return. All columns include time fixed effects. Columns (2) and (4) include country fixed effect. ***, ** and * indicate, respectively, statistical significance at the 1%,5% and 10% level.

	ΔLog($Bank\ CDS$)			
	Quantitative Easing Period			
	(1)	(2)	(3)	(4)
Δ $Log(Sovereign\ CDS)$	0.0360***	0.0360***	0.0258***	0.0258***
	(0.0095)	(0.0095)	(0.0092)	(0.0092)
Δ $Volatility\ Index$	0.0286*	0.0832*	-0.0044	0.0835*
	(0.0139)	(0.0447)	(0.0141)	(0.0447)
Δ $Equity$	-	-	-0.0004	-0.0006
			(0.0064)	(0.0064)
Time FE	YES	YES	YES	YES

Country FE	NO	YES	NO	YES
Observations	41,366	41,366	42,484	42,484
Banks	23	23	23	23
R^2	0.225	0.224	0.245	0.244

As it can be seen, in all columns the effect of the daily sovereign CDS changes on the banking sector credit risk is statistically significant and has sensibly decreased with respect to the previous estimates of the post-bailout period. In this case a 10% increase in the sovereign CDS leads to just a 0.36% increase in the banking sector CDS rate, while considering the last to columns this effect is even lower. Moving from the post-bailout period to the next one the relationship between the two sector appears to be weakened. If the non-standard monetary policy measure, implemented by the ECB, have had an effect on the sovereign-bank feedback loop, the ways through which this has been possible should be researched in the way such programmes work. These unconventional monetary policies consist in the ECB buying, mostly from banks, government or other securities in the secondary market in order to lower interest rates and increase the money supply. The assets purchased are mainly government bonds. This means that, all over the quantitative easing period, banks, in Europe, have moved their government bond holdings form their balance sheets to the Euro-system balance sheet. Considering what we have said in section 4.1.2, this could in theory explain why we observe reduced coefficients when regressing our model in the "QE period". Actually, the ECB monetary policy has been subject to some criticism in such sense: the increasing concentration of risk on the ECB's portfolio is raising some concerns.

4.3. Regulatory Framework and Recent Italian Environment

As history has several times shown, in the aftermath of a financial crisis the regulatory authorities try to recognize the failures in the system and to fix them through the composition of a better and more thorough legal framework. In Europe, relating to the above discussion, much work has been dedicated to the drawing up of a legal system able

to prevent a contagion effect and to protect public funds while ensuring the continuity of the critical economic and financial functions. In accordance with these principles the "bail-in" tool has been introduced at the beginning of 2016. However, in almost one year and half, there have been so few cases of application of the bail-in system. Indeed, even if the bail-in mechanism is the one suggested by the regulatory authorities the bailout measure is still a viable alternative.

As highlighted in section 4.1, some of the channels interconnecting the banking sector credit risk to the sovereign sector credit risk are influenced by the European regulation. In particular, we said that the channels transmitting risk from the sovereign sector to the banking sector can be explained also with the preferential treatment for the banks' holding of government securities when computing the capital requirements. Anyway, with the introduction of the Bank Recovery and Resolution Directive (BRRD), the legal framework could influence even the right-hand side channel of the sovereign-bank feedback loop: the one transmitting risk from the banking sector to the sovereign sector. Hence, let' s look at how the new regulation works. First of all, it is important to keep in mind those there are the objectives of the resolution, and, in turn, of the bail in, mechanism. Article 31 of BRRD states:

> The resolution objectives referred to in paragraph 1 are:
>
> - to ensure the continuity of critical functions;
> - to avoid a significant adverse effect on the financial system, in particular by preventing contagion, including to market infrastructures, and by maintaining market discipline;
> - to protect public funds by minimizing reliance on extraordinary public financial support;
> - to protect covered depositors and investors;
> - to protect client funds and client assets.

Therefore, the BRR directive could break, or at least reduce, the loop by making unlikely the use of public funds in supporting financial distressed sectors. In particular, the BRRD oppose to the bailout system the bail-in system. Thus, if during the financial crisis the

losses of a distressed financial institution were absorbed by governments before to damage the subordinated debt, then with the application of the directive the resources needed to bear losses are found internally. The fundamental principles of the functioning of the bail-in mechanism are stated in the Article 34, paragraph 1, of the BRRD. It states:

> Member States shall ensure that, when applying the resolution tools and exercising the resolution powers, resolution authorities take all appropriate measures to ensure that the resolution action is taken in accordance with the following principles:
> (a) the shareholders of the institution under resolution bear first losses;
> (b) creditors of the institution under resolution bear losses after the shareholders in accordance with the order of priority of their claims under normal insolvency proceedings, save as expressly provided otherwise in this Directive;
> (f) except where otherwise provided in this Directive, creditors of the same class are treated in an equitable manner;
> (g) no creditor shall incur greater losses than would have been incurred if the institution or entity referred to in point (b), (c) or (d) of Article 1(1) had been wound up under normal insolvency proceedings in accordance with the safeguards.

Basically, the bail-in tool define a sort of hierarchy among the liabilities of a distressed bank: the first to take the hit are the shareholders and the last ones are the covered depositors.

According to the model till now discussed, the new regulation could, in theory, intervene in the sovereign-bank loop by operating over the "bailout channel" and, therefore, reducing the effect of the banking sector credit risk on the sovereign credit risk.

Nevertheless, the BRR directive does not exclude financial support measure of a State in favour of a bank. Indeed, the legislative body of the directive states that Member States may provide extraordinary public financial support for the purpose of participating in the resolution of an institution or an entity. Furthermore, this action has to be carried out under the leadership of the competent ministry or the government in close cooperation with the resolution authority. The regulator, moreover, stress that the government financial

stabilisation tools shall be used as a last resort after having assessed and exploited the other resolution tools to the maximum extent practicable while maintaining financial stability. So, as it happens, the bail-in mechanism can be often avoided as, from a political point of view, it is not a very comfortable alternative. This makes the effect of the legal framework on the sovereign feedback loop not very clear, even considering, as said before that very few cases of the new directive' s application have been observed.

Relatively to Italy, in recent years, the Italian banking sector has been through an animated period, as it has to managed to resist difficulties and to adapt to changes. Even if the Italian banking sector, as whole, has demonstrated a good capacity of resilience, the severe economic and financial crisis, intensified at the end of 2011 and extended all over the next years, had the effect of impairing the banks' balance sheets. Figure 11 shows the Italian GDP ratio, as collected from the OECD-statistics website, over the period 2007-2016.

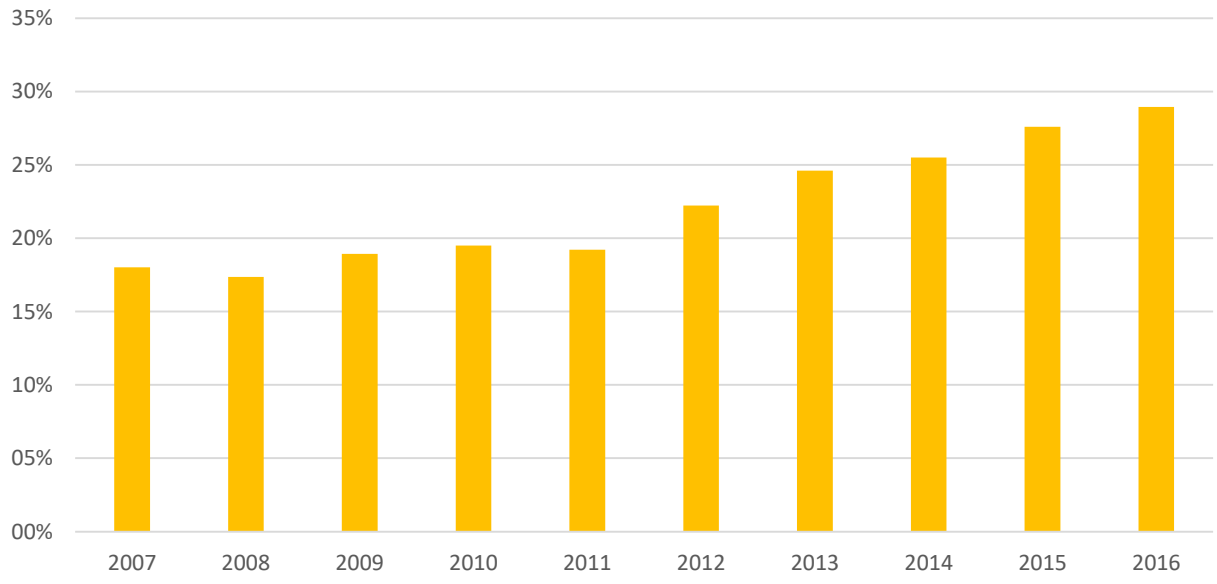
Figure 12 - Italian Real GDP Growth Ratio

Source: OECD Stats, March 2017

Notice that from 2011 to date the real economic growth, when positive, has been very low. In particular, this period of economic weakness has had the effect of amassing non-performing loans (NPLs) in banks' balance sheets well above the level of other European peers. According to Bank of Italy data, up to 31 may 2016, the gross NPLs amount to €360 billion which can be subdivided in probable default and "bad" loans. Probable default, the category containing loans for which the return to "performing" status is possible, amount

to €160 billion; bad loans, those with insolvent counterparties, amount, instead, to €200 billion. This issue started to raise concerns on the Italian banking sector across the European markets. The situation got even worse when the third largest Italian bank, Banca Monte dei Paschi di Siena (MPS), was found to be the weakest performing of 51 European banks subjected to stress tests in July 2016 result. As consequence, MPS and other Italian struggling banks have to boost their capital in accordance with the levels imposed by EU. In addition, in December 2016, Moody's has changed outlook on Italian banking sector to negative from stable. Recently, public intervention of the Italian government in the domestic banking sector has become a very realistic outcome. Of course, the impact of a public intervention depends on the measures implemented. However, if it not possible assess the presence of the risk-transmitting channel from bank to sovereign (the left branch of the diagram in figure 10), it is possible to assess the presence of the other channel (the right branch). Figure 13 shows the exposure of the Italian banking sector on government securities.

Figure 13 - Italian Banking Sector' s Government Holdings



Source: *Supplement to the Statistical Bulletin*, Banca d' Italia, January 2017

As the figure shows, Italian banks have an high exposure on euro-area government securities. Much of this exposure is over the Italian government. Indeed, as highlighted by Paolo Angelini, Giuseppe Grande and Fabio Panetta (2014), the QE has had the indirect

effect of increasing the banks' exposures to domestic government bonds: banks have engaged in a sort of carry trade strategy, getting cheap liquidity from the ECB and investing it in high-yielding bonds, which absorbed little if any capital. This is particularly true in peripheral countries where the government yields, as we have seen, are slightly higher than core countries' yields. Notice that the Italian banking sector's governments holdings are increasing over the period.

Concluding, even if we cannot state that a feedback loop in the Italian banking sector is currently active, we can state that a channel transmitting credit risk from the government to the banks is actually present (at least according to all the discussion above).

5. Conclusion

The relation between sovereign and banking sector credit risk has raised a lot of concerns in the last decade. The interconnectedness among these two sectors can be studied from different perspectives. This paper has mainly considered this link structured as a loop in which the credit risk can circulate from a sector to the other and then back again. In particular, in the model here engaged, the financial crisis has caused a shock in the sovereign CDS market. Through the bailout measure employed by governments in Europe the credit risk has been transferred from the banking sector to the sovereign sector. The increase in sovereign credit risk has caused, on its turn, an increase in the banking sector CDS which can be explained with several channels. Among these, some work via the asset side, other through the liability side of the banks' balance sheets. Concerning the asset side, I found that a possible channel acts through the portfolio of government bonds and securities holdings of the banking sector. Concerning the liability side, the sovereign credit risk can affect the banks credit risk through the explicit and implicit guarantees of the government over the financial sector.

Using bank- and country-level data from 2007 to 2016, I have reported some empirical evidence. First, I have shown that the bailout measures implemented by European countries in the late 2008 are a main factor in explaining the transmission of credit risk from the banking sector to the sovereign. Then, using bank and sovereign CDS data, I further show that changes in sovereign CDS explain changes in bank CDS after the bank bailouts. Using control variables for aggregate and country-specific determinants of credit spreads, results are still robust. Hence, these results indicate that bank bailouts triggered sovereign credit risk in Eurozone countries and in turn weakened the financial sector, confirming the sovereign-bank feedback loop. Furthermore, I have analysed the effect of the non-standard monetary policies applied by the ECB starting from the second half of 2012, concluding that the OMT programme and the Quantitative Easing have had the effect of reducing such link between Sovereign CDS and Bank CDS.

Overall, one of the main conclusion of this work is that the bailout measures are not just questionable from a moral hazard point of view but, instead, they are costly even in terms of credit risk.

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Sitography:

- OECD STAT, "stats.oecd.org/"

Legislative acts:

- Directive 2006/48/EC of the European Parliament and of the Council relating to the taking up and pursuit of the business of credit institutions, 14 June 2006
- Treaty on the Functioning of the European Union (2007), art. 107, 108 and 109.
- Directive 2014/59/EU of the European Parliament and of the Council establishing a framework for the recovery and resolution of credit institutions and investment firms, of 15 May 2014

Code

Almost every result reported and discussed in this study has been the outcome of a quantitative analysis ran with the software package MATLAB. Here below I report the code used and some comments.

```
SOVR=xlsread('Data-thesis.xlsx');
Banks=xlsread('Data-thesis.xlsx',2);
VDAX=xlsread('Data-thesis.xlsx',3);
bond_yield=xlsread('Data-thesis.xlsx',4);
equity=xlsread('Data-thesis.xlsx',5);
T=size(SOVR,1);J=size(SOVR,2);
%Let's divide our timeframe in four sub-periods. The first period goes from
%2/1/2007 to 9/25/2008. This is the pre-Bailout period. The second period it
%is a one-month period going from 9/26/2008 to 10/21/2008. This is the
%Bailout period. The third period goes from 10/22/2008 to 6/29/2012. This
%is the post-Bailout period. Finally, we have the most recent period which
%we will consider later.
T1=430; %The first period counts for 430 days
T2=18; %The one-month Bailout period contains 18 days
T3=981;%The post-Bailout period is 981 days long
%for each period I want to compute the change in the CDS spread for both
%sovreing and banks.
%% Chapter 3 - Section 3.1 Risk Transfer - Figure 4
changeS1=SOVR(T-T1,:)-SOVR(T,:);
changeS1(1,7)=SOVR(T-T1,7)-SOVR(2338,7); %For Sweden observation start
%from 11/21/2007.
changeS1(1,3)=SOVR(T-T1,3)-SOVR(T-1,3);%For Netherlands observation start
%from 2/2/2007.
changeS1(1,6)=SOVR(T-T1,6)-SOVR(2304,6);% For Ireland observations start
%from 1/8/2008.
changeS1(1,12)=SOVR(T-T1,12)-SOVR(2302,12);% For Norway observations start
%from 1/10/2008.
changeS1(1,13)=SOVR(T-T1,13)-SOVR(2374,13);% For United Kingdom observations
%start from 2/10/2007.
%Notice that for Denmark observations are missing in this first period.
changeB1=Banks(T-T1,:)-Banks(T,:);
changeB1(1,12)=Banks(T-T1,12)-Banks(2473,12);%CDS spread for BOI starts
%from 5/16/2007.
changeB1(1,14)=Banks(T-T1,14)-Banks(2213,14);%CDS spread for SVENSKA Bank
%starts from 5/14/2008.
changeB1(1,15)=Banks(T-T1,15)-Banks(2302,15);%CDS spread for Nordea Bank
%starts from 10/1/2008.
changeB1(1,17)=Banks(T-T1,17)-Banks(2301,17);%CDS spread for EBS Bank
%starts from 1/11/2008.
changeB1(1,18)=Banks(T-T1,18)-Banks(2301,18);%CDS spread for RL Bank
%starts from 1/11/2008.
changeB1(1,21)=Banks(T-T1,21)-Banks(2219,21);%CDS spread for DNB starts
%from 5/6/2008.
%Notice that for rhe National Bank of Greece observations are missing for
%the whole period.
avchangeB1=NaN(1,J);
%Let' s compute the average change, in the first period, for banks belonging
a same country.
avchangeIT1=mean(changeB1(1,1:3));%Equally weighted average for ISP, UC and
MPS
```

```
avchangeSP1=mean(changeB1(1,4:5));%Equally weighted average for SAN and BBVA
avchangeGE1=mean(changeB1(1,7:8));%Equally weighted average for DB and CBK
avchangeFR1=mean(changeB1(1,9:11));%Equally weighted average for BNP, ACA and
SOCGEN
avchangeIR1=mean(changeB1(1,12:13));%Equally weighted average for BOI and AIB
avchangeSW1=mean(changeB1(1,14:15));%Equally weighted average for SVH and NDA
avchangeAU1=mean(changeB1(1,17:18));%Equally weighted average for EBS and RLB
avchangeUK1=mean(changeB1(1,22:23));%Equally weighted average for BARC and
LLOY
avchangeB1(1,:)=[avchangeIT1 avchangeSP1 changeB1(1,6) avchangeGE1
avchangeFR1 avchangeIR1 avchangeSW1 changeB1(1,16) avchangeAU1 changeB1(1,19)
changeB1(1,20) changeB1(1,21) avchangeUK1];
%Let' s draw a table (Figure 4) for the Pre-Bailout Period change in
Sovereign an bank
%CDS Spread
Italy=[changeS1(1,1; avchangeB1(1,1)];
Spain=[changeS1(1,2); avchangeB1(1,2)];
Netherlands=[changeS1(1,3); avchangeB1(1,3)];
Germany=[changeS1(1,4); avchangeB1(1,4)];
France=[changeS1(1,5); avchangeB1(1,5)];
Ireland=[changeS1(1,6); avchangeB1(1,6)];
Sweden=[changeS1(1,7); avchangeB1(1,7)];
Portugal=[changeS1(1,8); avchangeB1(1,8)];
Austria=[changeS1(1,9); avchangeB1(1,9)];
Denmark=[changeS1(1,10); avchangeB1(1,10)];
Greece=[changeS1(1,11); avchangeB1(1,11)];
Norway=[changeS1(1,12); avchangeB1(1,12)];
GreatBritain=[changeS1(1,13); avchangeB1(1,13)];
BS={'Sovereign';'Banks'};
Pre_Bailout_period=table(Italy,Spain,Netherlands,Germany,France,Ireland,Swede
n,Portugal,Austria,Denmark,Greece,Norway,GreatBritain, 'RowNames',BS)
%% Chapter 3 - Section 3.1 Risk Transfer - Figure 5
changeS2=SOVR(T-T1-T2,:)-SOVR(T-T1-1,:);%Sovereign CDS change
changeB2=Banks(T-T1-T2,:)-Banks(T-T1-1,:);%Banks CDS change
%Since for DNB, on 10/21/2008, observation is missing, I' ve considered the
%first observation available, that is on 11/04/2008
changeB2(1,21)=Banks(T-T1-T2-10,21)-Banks(T-T1-1,21);
avchangeB2=NaN(1,J);
avchangeIT2=mean(changeB2(1,1:3));
avchangeSP2=mean(changeB2(1,4:5));
avchangeGE2=mean(changeB2(1,7:8));
avchangeFR2=mean(changeB2(1,9:11));
avchangeIR2=mean(changeB2(1,12:13));
avchangeSW2=mean(changeB2(1,14:15));
avchangeAU2=mean(changeB2(1,17:18));
avchangeUK2=mean(changeB2(1,22:23));
avchangeB2(1,:)=[avchangeIT2 avchangeSP2 changeB2(1,6) avchangeGE2
avchangeFR2 avchangeIR2 avchangeSW2 changeB2(1,16) avchangeAU2 changeB2(1,19)
changeB2(1,20) changeB2(1,21) avchangeUK2];
%Table2 (Figure 5) shows the change in Sovereign and Bank CDS spread during
the
%Bailout period
Italy=[changeS2(1,1);avchangeB2(1,1)];
Spain=[changeS2(1,2);avchangeB2(1,2)];
Netherlands=[changeS2(1,3);avchangeB2(1,3)];
Germany=[changeS2(1,4);avchangeB2(1,4)];
France=[changeS2(1,5);avchangeB2(1,5)];
Ireland=[changeS2(1,6);avchangeB2(1,6)];
Sweden=[changeS2(1,7);avchangeB2(1,7)];
Portugal=[changeS2(1,8);avchangeB2(1,8)];
Austria=[changeS2(1,9);avchangeB2(1,9)];
```

```
Denmark=[changeS2(1,10);avchangeB2(1,10)];
Greece=[changeS2(1,11);avchangeB2(1,11)];
Norway=[changeS2(1,12);avchangeB2(1,12)];
GreatBritain=[changeS2(1,13);avchangeB2(1,13)];
BS={'Sovereign';'Banks'};
Bailout_period=table(Italy,Spain,Netherlands,Germany,France,Ireland,Sweden,Po
rtugal,Austria,Denmark,Greece,Norway,GreatBritain, 'RowNames',BS)
%% Chapter 3 - Section 3.1 Risk Transfer - Figure 6
changeS3=SOVR (T-T1-T2-T3,:)-SOVR(T-T1-T2-1,:);
changeS3(1,10) =SOVR(T-T1-T2-T3,10)-SOVR(T-T1-T2-168,10); %Denmark' s
observations
%start on 6/12/2009
changeB3=Banks (T-T1-T2-T3,:)-Banks(T-T1-T2-1,:);%Banks CDS change
changeB3(1,21) =Banks(T-T1-T2-T3,21)-Banks(T-T1-T2-11,21);%DNB
changeB3(1,14) =Banks(T-T1-T2-T3+2,14)-Banks(T-T1-T2-3,14);% 20 october for
SVH
changeB3(1,15) =Banks(T-T1-T2-T3+2,15)-Banks(T-T1-T2-2,15);% Observations for
NDA start from 21/10/2008.Furthermore they are missing at 29/06/2011;I
considered the value observed two days before.
changeB3(1,20) =Banks(T-T1-T2-T3,20)-Banks(T-T1-T2-826,20);% For the NBG
observations start from 2/12/2011.
changeB3(1,21) =Banks(T-T1-T2-T3+2,21)-Banks(T-T1-T2-826,21);% Observations
for DNB are missing at 29/06/2011,I considered the value observed two days
before.
avchangeB3=NaN(1, J);
avchangeIT3=mean(changeB3(1,1:3));
avchangeSP3=mean(changeB3(1,4:5));
avchangeGE3=mean(changeB3(1,7:8));
avchangeFR3=mean(changeB3(1,9:11));
avchangeIR3=nanmean(changeB3(1,12:13));
avchangeSW3=mean(changeB3(1,14:15));
avchangeAU3=mean(changeB3(1,17:18));
avchangeUK3=mean(changeB3(1,22:23));
avchangeB3(1, :)=[avchangeIT3 avchangeSP3 changeB3(1,6) avchangeGE3
avchangeFR3 avchangeIR3 avchangeSW3 changeB3(1,16) avchangeAU3 changeB3(1,19)
changeB3(1,20) changeB3(1,21) avchangeUK3];
%Figure 6
Italy=[changeS3(1,1); avchangeB3(1,1)];
Spain=[changeS3(1,2); avchangeB3(1,2)];
Netherlands=[changeS3(1,3); avchangeB3(1,3)];
Germany=[changeS3(1,4); avchangeB3(1,4)];
France=[changeS3(1,5); avchangeB3(1,5)];
Ireland=[changeS3(1,6); avchangeB3(1,6)];
Sweden=[changeS3(1,7); avchangeB3(1,7)];
Portugal=[changeS3(1,8); avchangeB3(1,8)];
Austria=[changeS3(1,9); avchangeB3(1,9)];
Denmark=[changeS3(1,10); avchangeB3(1,10)];
Greece=[changeS3(1,11); avchangeB3(1,11)];
Norway=[changeS3(1,12); avchangeB3(1,12)];
GreatBritain=[changeS3(1,13); avchangeB3(1,13)];
BS={'Sovereign';'Banks'};
Post_Bailout_period=table(Italy,Spain,Netherlands,Germany,France,Ireland,Swed
en,Portugal,Austria,Denmark,Greece,Norway,GreatBritain, 'RowNames',BS)
%%
%We want to verify if the level of distress in the financial sector of a
%country affects the relative sovereign' s credit risk upon a bailout.
%Therefore we regress the natural logarithm of sovereign CDS on the
%natural logarithm of a measure of financial distress, prior to the
%bailouts, and controlling for the level of debt to GDP ratio. As financial
%sector distress measure we use the average of banks CDS up to September
%18, 2008. Let' s consider the sovreign credit risk prior to the bailout
```

```
%and after the bailout. In the first case we use Sovereign' CDSs
%%
%% Chapter 3 - Section 3.2 determining the Sovereign Credit Risk - Table 6 %%
Debt=xlsread('Debt-to-GDP Ratio.xlsx')';
FSD=NaN(J,1);
Distress=Banks(T-T1+6,:);
Distress_it=mean(Distress(1,1:3));
Distress_sp=mean(Distress(1,4:5));
Distress_nl=Distress(1,6);
Distress_ge=mean(Distress(1,7:8));
Distress_fr=mean(Distress(1,9:11));
Distress_ir=mean(Distress(1,12:13));
Distress_sw=mean(Distress(1,14:15));
Distress_pg=Distress(1,16);
Distress_dm=Distress(1,17);
Distress_au=mean(Distress(1,18:19));
Distress_gr=Distress(1,20);
Distress_nr=Distress(1,21);
Distress_uk=mean(Distress(1,22:23));
FSD(:,1)=[Distress_it; Distress_sp; Distress_nl; Distress_ge; Distress_fr;
Distress_ir; Distress_sw; Distress_pg; Distress_dm; Distress_au; Distress_gr;
Distress_nr; Distress_uk];
%Let' s denote with Y the sovereign CDS spread. We want to use Y as dependent
%variable considering it both at January 2008 and at march 2010.
%In the first case,we consider the data up to 31/01/2008.
Y_J_2008=SOVR(T-265,:)'; %The observations corrispoding to the 31/01/2008 are
the T-260th
%In the second case,we consider the data up to 19/03/2010.
Y_M_2010=SOVR(T-815,:)';%The observations corrispoding to the 19/03/2010 are
the T-815th
y_j_2008=log(Y_J_2008);
y_m_2010=log(Y_M_2010);
fsd=log(FSD);
x=[Debt fsd];
reg1=fitlm(fsd,y_j_2008)
reg2=fitlm(x,y_j_2008)
reg3=fitlm(fsd,y_m_2010)
reg4=fitlm(x,y_m_2010)
%% Chapter 4 - Sections 4.2 Empirical analysis - Tables 7-8 %%
% We want to measure the effect of the sovereign CDS change on the  bank
% CDS  while controlling for volatility, country fixed effect and time
% fixed effect.
%let's compute the equally weighted banks CDS spread average for each country
avIT_BankCDS=nanmean(Banks(:,1:3),2);
avSP_BankCDS=nanmean(Banks(:,4:5),2);
avGE_BankCDS=nanmean(Banks(:,7:8),2);
avFR_BankCDS=nanmean(Banks(:,9:11),2);
avIR_BankCDS=nanmean(Banks(:,12:13),2);
avSW_BankCDS=nanmean(Banks(:,14:15),2);
avAU_BankCDS=nanmean(Banks(:,17:18),2);
avUK_BankCDS=nanmean(Banks(:,22:23),2);
BanksCDS=[avIT_BankCDS avSP_BankCDS Banks(:,6) avGE_BankCDS avFR_BankCDS
avIR_BankCDS avSW_BankCDS Banks(:,16) avAU_BankCDS Banks(:,19) Banks(:,20)
Banks(:,21) avUK_BankCDS];
D_SovCDS=NaN(T-1,J);
D_BankCDS=NaN(T-1,J);
for i=1:J
    D_SovCDS(:,i)=SOVR(1:T-1,i)./SOVR(2:T,i);
end
for i=1:J
    D_BankCDS(:,i)=BanksCDS(1:T-1,i)./BanksCDS(2:T,i);
```

```
end
log_S_CDS=log(D_SovCDS);
log_B_CDS=log(D_BankCDS);
vdax=NaN(T-1,1);
vdax(1:T-1,1)=VDAX(1:T-1,1)./VDAX(2:T,1);%We consider the gross return on the
volatility index
av_eq_it=nanmean(equity(:,1:3),2);
av_eq_sp=nanmean(equity(:,4:5),2);
av_eq_ge=nanmean(equity(:,7:8),2);
av_eq_fr=nanmean(equity(:,9:11),2);
av_eq_sw=nanmean(equity(:,13:14),2);
av_eq_au=nanmean(equity(:,16:17),2);
av_eq_uk=nanmean(equity(:,21:22),2);
av_eq=[av_eq_it av_eq_sp equity(:,6) av_eq_ge av_eq_fr equity(:,12) av_eq_sw
equity(:,15)  av_eq_au equity(:,18) equity(:,19) equity(:,20) av_eq_uk ];
R_e=NaN(T-1,size(av_eq,2));
for i=1:size(av_eq,2)
R_e(:,i)=av_eq(1:T-1,i)./av_eq(2:T,i)-1;
end %These are the returns on the average banks' equities

% Pre-Bailout period % -- 1/2/2007 to 9/25/2008 -- 430 days
N1=T1*J;
Pre_BP_S=log_S_CDS(T-T1:T-1,:);
log_SovCDS=Pre_BP_S(:);
Pre_BP_B=log_B_CDS(T-T1:T-1,:);
log_BankCDS=Pre_BP_B(:);
VDAX_Pre_BP=vdax(T-T1:T-1,1);
vdax_Pre_BP=repmat(VDAX_Pre_BP,[J 1]);
Pre_BP_eq=R_e(T-T1:T-1,:);
eq_r=Pre_BP_eq(:);
alpha=zeros(N1,J);
for i=1:J
    alpha(T1*i-T1+1:T1*i,i)=ones(T1,1);
end
delta=zeros(N1,J);
for i=1:T1
    delta_i=zeros(T1,1);
    delta_i(i,:)=1;
    D_i=repmat(delta_i,[J 1]);
    delta(:,i)=D_i;
end
X_Y=[log_SovCDS vdax_Pre_BP alpha delta];
X_N=[log_SovCDS vdax_Pre_BP delta];
X_N_eq=[log_SovCDS vdax_Pre_BP eq_r delta];
X_Y_eq=[log_SovCDS vdax_Pre_BP eq_r alpha delta];
sbfl_1= fitlm(X_N,log_BankCDS,'Intercept',false);%It excludes the Country FE
sbfl_2= fitlm(X_Y,log_BankCDS,'Intercept',false);%It includes the Country FE
%Controlling for equity's returns
sbfl_1_eq= fitlm(X_N_eq,log_BankCDS,'Intercept',false);
sbfl_2_eq= fitlm(X_Y_eq,log_BankCDS,'Intercept',false);
% Bailout period %-- 9/26/2008 to 10/21/2008 -- 18 days
N2=T2*J;
BP_S=log_S_CDS(T-T1-T2-1:T-T1-2,:);
log_SovCDS=BP_S(:);
BP_B=log_B_CDS(T-T1-T2-1:T-T1-2,:);
log_BankCDS=BP_B(:);
VDAX_BP=vdax(T-T1-T2-1:T-T1-2,1);
vdax_BP=repmat(VDAX_BP,[J 1]);
BP_eq=R_e(T-T1-T2-1:T-T1-2,:);
eq_r=BP_eq(:);
alpha=zeros(N2,J);
```

```
for i=1:J
    alpha(T2*i-T2+1:T2*i,i)=ones(T2,1);
end
delta=zeros(N2,J);
for i=1:T2
    delta_i=zeros(T2,1);
    delta_i(i,:)=1;
    D_i=repmat(delta_i,[J 1]);
    delta(:,i)=D_i;
end
X_Y=[log_SovCDS vdax_BP alpha delta];
X_N=[log_SovCDS vdax_BP delta];
X_N_eq=[log_SovCDS vdax_BP eq_r delta];
X_Y_eq=[log_SovCDS vdax_BP eq_r alpha delta];
sbfl_3= fitlm(X_N,log_BankCDS,'Intercept',false);%It excludes the Country FE
sbfl_4= fitlm(X_Y,log_BankCDS,'Intercept',false);%It includes the Country FE
%Controlling for equity's returns
sbfl_3_eq= fitlm(X_N_eq,log_BankCDS,'Intercept',false);
sbfl_4_eq= fitlm(X_Y_eq,log_BankCDS,'Intercept',false);
% Post-Bailout period % -- 10/22/2008 to 7/25/2012 -- 981 days
N3=T3*J;
Post_BP_S=log_S_CDS(T-T1-T2-T3:T-T1-T2-1,:);
log_SovCDS=Post_BP_S(:);
Post_BP_B=log_B_CDS(T-T1-T2-T3:T-T1-T2-1,:);
log_BankCDS=Post_BP_B(:);
VDAX_Post_BP=vdax(T-T1-T2-T3:T-T1-T2-1,1);
vdax_Post_BP=repmat(VDAX_Post_BP,[J 1]);
Post_BP_eq=R_e(T-T1-T2-T3:T-T1-T2-1,:);
eq_r=Post_BP_eq(:);
alpha=zeros(N3,J);
for i=1:J
    alpha(T3*i-T3+1:T3*i,i)=ones(T3,1);
end
delta=zeros(N3,J);
for i=1:T3
    delta_i=zeros(T3,1);
    delta_i(i,:)=1;
    D_i=repmat(delta_i,[J 1]);
    delta(:,i)=D_i;
end
X_Y=[log_SovCDS vdax_Post_BP alpha delta];
X_N=[log_SovCDS vdax_Post_BP delta];
X_N_eq=[log_SovCDS vdax_Post_BP eq_r delta];
X_Y_eq=[log_SovCDS vdax_Post_BP eq_r alpha delta];
sbfl_5= fitlm(X_N,log_BankCDS,'Intercept',false);%It excludes the Country FE
sbfl_6= fitlm(X_Y,log_BankCDS,'Intercept',false);%It includes the Country FE
%Controlling for equity's returns
sbfl_5_eq= fitlm(X_N_eq,log_BankCDS,'Intercept',false);
sbfl_6_eq= fitlm(X_Y_eq,log_BankCDS,'Intercept',false);
%% Chapter 4 - Sections 4.2 Empirical analysis - Table 9 %%
T4=T-T1-T2-T3-1;
N4=T4*J;
QE_S=log_S_CDS(1:T4,:);
log_SovCDS=QE_S(:);
QE_B=log_B_CDS(1:T4,:);
log_BankCDS=QE_B(:);
VDAX_QE=vdax(1:T4,1);
vdax_QE=repmat(VDAX_QE,[J 1]);
QE_eq=R_e(1:T4,:);
eq_r=QE_eq(:);
alpha=zeros(N4,J);
```

```
for i=1:J
    alpha(T4*i-T4+1:T4*i,i)=ones(T4,1);
end
delta=zeros(N4,T4);
for i=1:T4
    delta_i=zeros(T4,1);
    delta_i(i,:)=1;
    D_i=repmat(delta_i,[J 1]);
    delta(:,i)=D_i;
end
X_Y=[log_SovCDS vdax_QE alpha delta];
X_N=[log_SovCDS vdax_QE delta];
X_N_eq=[log_SovCDS vdax_QE eq_r delta];
X_Y_eq=[log_SovCDS vdax_QE eq_r alpha delta];
sbfl_QE_1= fitlm(X_N,log_BankCDS,'Intercept',false);%It excludes the Country
FE
sbfl_QE_2= fitlm(X_Y,log_BankCDS,'Intercept',false);%It includes the Country
FE
%Controlling for equity's returns
sbfl_QE_1_eq= fitlm(X_N_eq,log_BankCDS,'Intercept',false);
sbfl_QE_2_eq= fitlm(X_Y_eq,log_BankCDS,'Intercept',false);
%% Chapter 4 - Sections 4.2 Empirical analysis - Table 10 %%
J2=size(bond_yield,2);
BYIELD=NaN(T-1,J2);
for i=1:J2
    BYIELD(:,i)=bond_yield(1:T-1,i)./bond_yield(2:T,i);
end
byield=log(BYIELD);
log_B_CDS_BY=log_B_CDS;
log_B_CDS_BY(:,[8 9 11])=[];
R_E=R_e;
R_E(:,[8 9 11])=[];
%Pre-Bailout Period
N1=T1*J2;
Pre_BP_S=byield(T-T1:T-1,:);
log_Sov_BY=Pre_BP_S(:);
Pre_BP_B=log_B_CDS_BY(T-T1:T-1,:);
log_BankCDS=Pre_BP_B(:);
VDAX_Pre_BP=vdax(T-T1:T-1,1);
vdax_Pre_BP=repmat(VDAX_Pre_BP,[J2 1]);
Pre_BP_eq=R_E(T-T1:T-1,:);
eq_r=Pre_BP_eq(:);
alpha=zeros(N1,J2);
for i=1:J2
    alpha(T1*i-T1+1:T1*i,i)=ones(T1,1);
end
delta=zeros(N1,J2);
for i=1:T1
    delta_i=zeros(T1,1);
    delta_i(i,:)=1;
    D_i=repmat(delta_i,[J2 1]);
    delta(:,i)=D_i;
end
X_N=[log_Sov_BY vdax_Pre_BP eq_r delta];
X_Y=[log_Sov_BY vdax_Pre_BP eq_r alpha delta];
sbfl_1_BY= fitlm(X_N,log_BankCDS,'Intercept',false);%It excludes the Country
FE
sbfl_2_BY= fitlm(X_Y,log_BankCDS,'Intercept',false);%It includes the Country
FE
%Bailout Period
N2=T2*J2;
```

```
BP_S=byield(T-T1-T2-1:T-T1-2,:);
log_Sov_BY=BP_S(:);
BP_B=log_B_CDS_BY(T-T1-T2-1:T-T1-2,:);
log_BankCDS=BP_B(:);
VDAX_BP=vdax(T-T1-T2-1:T-T1-2,:);
vdax_BP=repmat(VDAX_BP,[J2 1]);
BP_eq=R_E(T-T1-T2-1:T-T1-2,:);
eq_r=BP_eq(:);
alpha=zeros(N2,J2);
for i=1:J2
    alpha(T2*i-T2+1:T2*i,i)=ones(T2,1);
end
delta=zeros(N2,J2);
for i=1:T2
    delta_i=zeros(T2,1);
    delta_i(i,:)=1;
    D_i=repmat(delta_i,[J2 1]);
    delta(:,i)=D_i;
end
X_N=[log_Sov_BY vdax_BP eq_r delta];
X_Y=[log_Sov_BY vdax_BP eq_r alpha delta];
sbfl_3_BY= fitlm(X_N,log_BankCDS,'Intercept',false);%It excludes the Country
FE
sbfl_4_BY= fitlm(X_Y,log_BankCDS,'Intercept',false);%It includes the Country
FE
%Post-Bailout Period
N3=T3*J2;
Post_BP_S=byield(T-T1-T2-T3:T-T1-T2-1,:);
log_Sov_BY=Post_BP_S(:);
Post_BP_B=log_B_CDS_BY(T-T1-T2-T3:T-T1-T2-1,:);
log_BankCDS=Post_BP_B(:);
VDAX_Post_BP=vdax(T-T1-T2-T3:T-T1-T2-1,:);
vdax_Post_BP=repmat(VDAX_Post_BP,[J2 1]);
Post_BP_eq=R_E(T-T1-T2-T3:T-T1-T2-1,:);
eq_r=Post_BP_eq(:);
alpha=zeros(N3,J2);
for i=1:J2
    alpha(T3*i-T3+1:T3*i,i)=ones(T3,1);
end
delta=zeros(N3,J2);
for i=1:T3
    delta_i=zeros(T3,1);
    delta_i(i,:)=1;
    D_i=repmat(delta_i,[J2 1]);
    delta(:,i)=D_i;
end
X_N=[log_Sov_BY vdax_Post_BP eq_r delta];
X_Y=[log_Sov_BY vdax_Post_BP eq_r alpha delta];
sbfl_5_BY= fitlm(X_N,log_BankCDS,'Intercept',false);%It excludes the Country
FE
sbfl_6_BY= fitlm(X_Y,log_BankCDS,'Intercept',false);%It includes the Country
FE
```

Summary

This work is related to the interconnectedness between the sovereign sector and banking sector credit risk, which, in the aftermath of the financial crisis, has raised concerns both among market operators and regulatory authorities. In particular, this study analyzes the sovereign-bank link assuming that it is structured as a loop in which the credit risk can circulate from a sector to the other and then back again. The introduction presents the situation pre- and post-crisis from a credit risk point of view. Indeed, the subprime crisis has first threatened the soundness of the financial sector, making its collapse a realistic outcome as never before, and then has attracted interests on the strength of the public sector.

Before to go in depth, the introduction gives two general ideas:

- the sovereign-bank feedback loop is a model that relates the sovereign credit risk to the banking sector credit risk and vice versa;
- such phenomenon has been spotted mainly in the aftermath of the 2007/2008 financial crisis as the governments' bailout measures have triggered the surge in sovereign credit risk.

Therefore, as later it will be clear, a fundamental role in such risk-transmitting mechanism has been played by the support measures employed by governments over the financial sectors.

Since this issue has been attracting interest mainly in recent times, very few work has been done to shed light on such phenomenon. From a broad conceptual point of view this study can be contained in the body of literature regarding the effects of the financial crisis. Anyway, the big portion of such studies focuses on the assessment of the impact on the government's fiscal position of the assistance measures undertaken to support the financial sector or on the ex-ante costs of banks bailout from a moral hazard point of view. However, the main contribution to the study of the effects of the sovereign-bank feedback loop has been provided by Acharya, Drechsler and Schnabl (2014). The authors have developed a model in which, in the short run, bailouts are funded through the issue of new debt, but, on the other hand a higher level of debt raises the sovereign credit risk, triggering a feedback

loop between sovereign and financial sector. The model is later confirmed using data on bank and sovereign CDS spreads. To prove that, Acharya and the co-authors have divided the sample period in three sub-periods in order to analyse the relationship between banking and sovereign sector credit risk before, during and after the bailout measures in Europe. This study will follow mainly the same approach.

After this initial part the paper specifies the approach used to measure the credit risk and the structure and composition of the dataset from which come all the results reported. Among the three main credit risk measures, credit rating, bond yield spreads and credit default swap, this wok considers mainly the last one. The CDS contract is a derivative instrument that provides insurance against the risk of a default by a particular company. The buyer of the insurance obtains the right to sell bonds issued by the company for their face value when a credit event (such as a failure to make a payment or a bankruptcy) occurs. Furthermore, the buyer of a CDS makes periodic payments to the seller until the end of the life of the CDS or until a credit event occurs. The total amount paid per year, as a percentage of the notional principal, to buy protection is known as *CDS Spread.* Therefore, by looking at the CDS spreads we can get a proxy of the market perceived credit risk of sovereigns and banks. Furthermore, there are several reasons to believe that the CDS market is a better source of credit risk measure with respect to the other two approaches:

- there are no daily observations on credit ratings since they are mainly a qualitative attribute to a specific entity's creditworthiness; furthermore, they tend to be smoothed since rating agencies want to avoid reversal;
- bond yield spreads suffer of several frictions such as the identification of an appropriate risk-free rate, category and a maturity.

Concerning the dataset, this work uses a panel data (observations collected over countries and banks as well as over time) containing 5-year CDS for 13 European countries and 23 European banks. Only systemically important institutions have been considered and, in any case, only those with publicly traded CDS. The period of analysis goes from February 2007 to December 2016 in order to include the pre-crisis (and pre bailout) period and the very recent times. This sample period is then divided in 4 sub-periods in order to make the analysis able to catch different trends over time. The first three sub-periods are determined

by identifying a “bailout” period. Such period, following the main literature, starts at the end of September 2008 and it lasts for practically one month, when almost every Western European country announced a bailout. The first country to deeply support the banking sector has been Ireland but many countries followed the example, in part to offset outflows from their own financial sectors to newly secured financial sectors. The last period is, instead, identified by looking at the unconventional monetary policies, such as the so called Quantitative Easing, employed by the ECB starting from the second half of 2012. Hence, following the 4 sub- periods:

1. The Pre-Bailout period goes from 1/02/2007 to 25/09/2008;
2. The Bailout period goes from 26/09/2008 to 21/10/2008;
3. The Post-bailout period goes from 10/22/2008 to 6/29/2012
4. The Quantitative Easing period goes from 7/1/2012 to 12/31/2016

Initially, this work focuses only on the first three sub-periods, while the quantitative easing period will be considered just later when assessing the effect of such non-standard monetary policies on the sovereign-bank credit risk relation.

The preliminary analysis, it is divided in two sections: the first related to the risk transfer mechanism associated with the bailout measure; the second related to the determinant of the sovereign sector credit risk. The transmission of risk from one sector to the other has been treated in two different ways. The paper, indeed, first consider the movements in the CDS market after a government announcement of a bailout and then it considers the changes in sovereign and banking sector CDS over the three sub-periods. The Irish and Dutch cases are, therefore, presented. In both circumstances, we can notice that just after the government announcements (the government of Ireland announced that it had guaranteed all deposits of six of its biggest banks while the Dutch government provided capital injection to the main national banks) the sovereign CDS have experienced a huge and sharply increase. Contextually, the banking sector CDS has decreased. After the government announcement can be notice that, within counties, the two series keep comoving, as correlation seems increased. However, by looking at the change of the sovereign and banking sector CDS during the three periods, can be detected important differences. In the pre-bailout period, in almost every country has been observed a

significant increase in the sovereign CDS while no particular movement can be noticed in the banking sector's credit risk. This confirms that in a first period investors weren't concerned that the distress in the financial sector might spread into the sovereign. During the bailout period, since significant public interventions were necessary in order to avoid chain effects across intermediaries and across countries, governments, in advanced economies, have stepped in providing support to banks and financial institutions. Investors realized that, through the bailout measures, portion of the credit risk was transferred toward the governments' balance sheets: with all the capital injections, the impaired asset purchase programs and the explicit guarantees to the financial sector the governments were bearing several risks. In a one-month period the average bank CDS for almost all the countries in the sample has experienced a huge decrease. In the meanwhile, we can notice that the sovereign credit risk has increased as we would have expected. In post-bailout period both sovereign and bank CDS increased in most countries and that the magnitude of the movements is quite similar within countries. The increase in correlation is then confirmed: if in the pre bailout period the average correlation between the daily changes in sovereign CDS and the daily changes in banking sector CDS is almost 0.08, in the post-bailout period appears to be up to 0.4.

In the second section the main results are the following:

- Correlation among sovereign credit risk and debt-to-GDP ratio has hugely increased after the banks bailout, mainly suggesting that investors have updated their risk pricing models and have augmented the weight that the public debt has in determining the sovereign credit risk.
- The pre-bailout financial sector distress is highly predictive of post-bailout sovereign credit risk level and of the change in debt-to-GDP ratio after the bailouts. Indeed, two regressions are presented. One regressing the natural logarithm of the sovereign CDS level after the bailouts on a measure of financial distress in the pre bailout period, the other regressing the change in the debt-to-GDP ratio between the pre and post bailout period over the same measure of financial distress. Coefficients are statistically significant.

After this preliminary analysis, the paper moves to deliver its main purpose: to analyse the loop in the relationship between the sovereign credit risk and the banking sector credit risk. The idea is that the financial crisis has caused a shock in the financial sector's CDS market. Through the bailout measure employed by governments in Europe the credit risk has been transferred from the banking sector to the sovereign sector. The increase in sovereign credit risk has caused, on its turn, an increase in the banking sector CDS which can be explained with several risk-transmitting channels. Before to move to the results of the empirical analysis, such channels are discussed. Two main categories of channels are identified: channels transmitting credit risk from banking sector to sovereign and channels transmitting credit risk from sovereign to the banking sector. Among the first category, the main channel is the one discussed before, that is, the bailout measures employed by governments in state aids. Indeed, such support packages, not only meant a significant increase in governments' expenses, but, given the unprecedented extent of the bailout measures, countries had to deal with the subsequent recession and with the increase in taxation typically implemented to deal with them. Concerning the second category, there are several factors transferring credit risk from sovereign to banks, some of these work via the asset side of the banks, other via the liability side. Relating the asset side, as literature suggests, the link between the credit risk of the banking sector and the one of the sovereign could be partially explained through the higher (relatively to other borrowers) exposure banks have with respect to their national government. Indeed, a deterioration or improvement in government's creditworthiness, as perceived by the markets, may cause losses or gains on banks' portfolios of sovereign securities. From this point of view, sovereign exposures are not conceptually different from claims on any other debtor. What makes this kind of exposures differing from the others is that they are often substantial, typically reflecting large holdings of domestic government debt. In such common phenomenon, regulatory frame plays a fundamental role. Indeed, current regulation gives at government securities a preferential treatment over those on private borrowers when assessing capital charges. Relating the liability side, a factor able to transfer credit risk from the sovereign sector to the banks could work through the government guarantees over the banking sector' s debt. Indeed, several governments introduced explicit guarantee schemes on banks' bonds after the collapse of Lehman Brothers in October 2008. There is

evidence that these guarantees helped reduce risk premium on banks' liabilities, and that their effect was proportional to the creditworthiness of the sovereign.

Once identified the possible channels through which the loop can work, the paper keeps considering the empirical analysis by introducing the model specification. In such sense, the main challenge is to determine a model linking the two sectors able to identify a direct effect of the sovereign CDS changes on the banking sector CDS changes. This work uses two main models differing each other in the set of control variables. Indeed, the presence of an unobserved factor that affects both variables could explain the comovements in the two variables even in absence of a direct relation. Hence, the basic model presented is the following:

$$\Delta \log Bank\ CDS_{it} = \alpha_i + \delta_t + \beta \Delta \log Sovereign\ CDS_{it} + \gamma \Delta X_{it} + \varepsilon_{it}$$

where $\Delta \log Bank\ CDS_{it}$ is the daily change in the natural logarithm of the CDS spread of banking sector of country i, $\log Sovereign\ CDS_{it}$ is the daily change in the natural logarithm of the sovereign CDS of country i, ΔX_{it} are daily changes in the control variables, γ is the set of coefficient relating changes in the banking sector credit risk to the daily changes in control variables, δ_t are day fixed effects, and α_i are banking sector specific effects. Daily fixed effect has been introduced capture market-wide changes in macroeconomic fundamentals that directly affect both bank and sovereign credit risk. These fixed effects capture all macro-fundamentals that have a common effect on the financial sector. By doing this, we assume that we are not aware of what the macro factor could be but, at least, it should have an effect at the same moment cross banks as well as cross countries. The model further control for country specific effects, in order to check whether there is or not a sort of heterogeneity among banking sector. In this way, it is possible to catch the effect of a country specific shock that may be affecting both sovereign CDS and banking sector CDS. The third set of control variables, the one differentiating one model from the other, is represented by determinants of banks fundamentals. Following the empirical literature, among these determinants this study has included a volatility index and equity returns. The first model includes only the volatility index. Here has been chosen a VIX-like index, the VDAX, which is the German counterpart to the VIX index for the S&P 500. Since in the sample there are only European banks, this choice

seems quite reasonable. The second model includes the volatility index as well as the equity returns.

Several OLS regressions are ran. First, both the models are applied in the pre-bailout, bailout, and post-bailout periods. Second, is considered also an estimation which uses government bond yield as a measure of sovereign credit risk. Finally, in the last section of the empirical analysis, the paper focuses on the effect of the unconventional monetary policies on the sovereign-bank credit risk connection. Here below are reported the main results:

1. In the pre-bailout period there is no economic significant sign of the effect of sovereign CDS changes on the banking sector CDS changes. In the following period, the one overlapping the bailouts announcement in Europe, estimations find large, negative and statistically significant coefficients, confirming the view that support measures employed by European governments may have triggered the transmission of risk from sovereign to the banking sector. In the post banks-bailout period there is sign of a positive economically and statistically significant effect of the sovereign credit risk movements over the banking sector credit risk. This last result may be reflecting the presence of risk transmitting channels that feedback the loop. Coefficients slightly change after controlling for equity returns. This is further evidence in support of a direct sovereign-to-bank risk dependence.
2. Using government bond yields leads to almost unchanged coefficients in all the periods of analysis with respect to the previous estimates, giving further robustness to the main results of this paper.
3. The paper considers the "Quantitative Easing" period separately from the post-bailout period in order to check whether the unconventional monetary policies, such as the Outright Monetary Transaction or the Asset Purchase Program (quantitative easing), have or not an effect on the sovereign-bank link. The analysis on such period shows still statistically significant coefficients but they are slightly smaller than the post bailout ones. Such findings suggest that the non-standard monetary policies of the ECB have, somehow, reduced the interconnectedness between the

sovereign credit risk and the banking sector credit risk as observed in a previous period.

Before to conclude, the paper assess the regulatory framework developed after the financial crisis in response to such issue. The main work has been done in relation to the bail-in mechanism. Such tool defines a sort of hierarchy among the liabilities of a distressed bank: the first to take the hit are the shareholders and the last ones are the covered depositors.
According to the model till now discussed, the new regulation could, in theory, intervene in the sovereign-bank loop by operating over the "bailout channel" and, therefore, reducing the effect of the banking sector credit risk on the sovereign credit risk.
Nevertheless, the BRR directive, which establishes the bail-in mechanism, does not exclude financial support measure of a State in favour of a bank. Indeed, the legislative body of the directive states that Member States may provide extraordinary public financial support for the purpose of participating in the resolution of an institution or an entity. So, as it happens, the bail-in mechanism can be often avoided as, from a political point of view, it is not a very comfortable alternative. This makes the effect of the legal framework on the sovereign feedback loop not very clear, even considering, as said before that very few cases of the new directive' s application have been observed.
The paper than concludes by stating that it is possible to identify a sovereign-bank feedback loop in the credit default swap market in Europe. The final remark states that, according to the above analysis, bailout measures are not just questionable from a moral hazard point of view but, instead, they are costly even in terms of credit risk.