Bank and sovereign risk feedback loops

This paper studies the link between sovereign risks and the fragility of the banking sector pointing to the challenges of bank rescue operations for the state.

Aitor Erce

European Stability Mechanism

Bank and sovereign risk feedback loops

Aitor Erce[1]

Abstract

Measures of sovereign and bank risk show occasional bouts of increased correlation, setting the stage for vicious and virtuous feedback loops. This paper models the macroeconomic phenomena underlying such bouts using CDS data for 10 euro area countries. The results show that sovereign risk feeds back into bank risk more strongly than vice versa. Countries with sovereigns that are more indebted or where banks have a larger exposure to their own sovereign, suffer larger feedback loop effects from sovereign risk into bank risk. In the opposite direction, in countries where banks fund their activities with more foreign credit and support larger levels of non-performing loans, the feedback from bank risk into sovereign risk is stronger. According to model estimates, financial rescue operations can increase feedback effects from bank risk into sovereign risk. These results can be useful for the official sector when deciding on the form of financial rescues.

Key words
Sovereign Risk, Bank Risk, Feedback Loops, Balance Sheet Exposure, Leverage

JEL codes
E58, G21, G28, H63

I thank Antonello D'Agostino, Gong Cheng, Jon Frost, Patricia Gomez, Carlos Martins, Tomasz Orpiszewski, Cheng PG-Yan, Chander Ramaswamy, Juan Rojas, Karol Siskind and seminar participants at the European Stability Mechanism and the 2014 Symposium of Economic Analysis for their suggestions, and Sarai Criado, Gabi Perez-Quiros and Adrian Van Rixtel for sharing their CDS data. Assunta Di Chiara provided outstanding research assistance.

[1] European Stability Mechanism. The author can be contacted at: a.erce@esm.europa.eu.

ISSN	443-5503	**DOI**	10.2852/501718
ISBN	978-92-95085-06-0	**EU catalogue number**	DW-AB-15-001-EN-N

Introduction

As the global crisis engulfed a number of economies into a perverse spiral of fiscal and financial distress, the interconnectedness between banks and sovereigns has attracted increasing attention. On the one hand, a number of countries faced severe banking crises, whose management contributed to the subsequent fiscal crisis. Arguably, this is what happened to Iceland, where the materialization of contingent claims brought havoc onto the sovereign's balance sheet.[1] On the other hand, pro-cyclical fiscal policy and a lack of competitiveness led to a sovereign debt crisis in Greece. As foreign investors withdrew, banks became major holders of public debt (Broner et al., 2014). Successive sovereign downgrades, ending in a sovereign debt restructuring, contributed to the collapse of the Greek banking sector. Against this background, this paper uses euro area data to extract lessons about the processes through which sovereigns and banks interlink. In order to do so, this paper provides a framework that relates the joint dynamics of fiscal credit risk (Sovereign Risk) and banking credit risk (Bank Risk) to different underlying vulnerabilities and shocks. The analysis delivers an understanding of what conditions facilitate the emergence of feedback loops between sovereign and bank risk.

A number of recent contributions study this two-way relationship by modelling the common dynamics of bank and sovereign Credit Default Swaps (CDS) spreads using vector-auto regression models as in Diebold and Yilmaz (2009). According to Moody's (2014), which studies the dynamic relation between sovereign and bank CDS spreads by means of a Markov switching VAR methodology, the euro area did not suffer one financial crisis, but a variety of crises, each of them with its own specificities. According to their results, only Ireland witnessed a spillover of financial stress into sovereign stress. Instead, for Greece and Italy their results point to the opposite feedback effect. For the rest of the countries analyzed, stress feeds back in both directions. These time series techniques deliver interesting indices of contagion but fall short of describing the actual channels through which such bouts of contagion take place. To bridge this gap, this paper provides a framework conditioning the intensity of the feedback loops on different economic factors. In doing so, similar to Acharya et al. (2013) or Mody and Sandri (2011), this paper delivers an understanding of the vulnerabilities and shocks that are fertile ground for the emergence of vicious spirals of increasing sovereign and bank risk.[2]

To provide estimates of how credit risk interconnectedness varies with the economic environment, the analysis uses detailed information on the state of public finances, the banking system and the macro economy. The paper presents a simple econometric strategy to assess whether the sensibility of the feedback between bank and sovereign risk varies with these indicators. Given the low frequency of macroeconomic variables and the short time series available for CDS

[1] In Iceland, bank failures directly increased net public debt by 13% of GDP (Carey, 2009).

[2] Heinz and Sun (2014) or Delatte et al. (2014) show the presence of non-linearities on sovereign risk pricing.

data, the paper relies on panel data econometrics. In addition to a generalised-least-squares estimator, motivated by the high persistence of the CDS series, dynamic models are also used. The framework provides a quantitative benchmark to measure the impact on sovereign risk of bank rescue measures, as those enacted by euro area governments between 2007 and 2013. Understanding the sensitivity of sovereign risk to such policies is, given the Euro Area policy setting, fundamental.[3]

The main findings are the following. There is a strong pass-through of sovereign risk on bank risk. Moreover, the sovereign feedback effect is quantitatively stronger when increases in sovereign risk occur in countries with a larger stock of public debt, when the banking system exposure to the sovereign is large or when the sovereign has lost its investment grade rating. There is also evidence of positive spillovers from bank risk into sovereign risk. In this case, however, significant pass-through appears only under specific macroeconomic environments and is significantly smaller. Bank risk spillovers are significantly stronger in countries where banks have bigger balance sheets and where the volume of non-performing loans and foreign liabilities is larger. As regards the role of bank rescues, the results show that such policy operations can facilitate the appearance of strong feedback effects.

The next section summarizes the main channels through which distress spreads, as documented in the literature. The following one describes the data and presents some preliminary evidence. The next describes the econometric strategy and details the main results from the analysis. The section also presents a detailed analysis of the effect on the feedback between risks of the bank bailouts designed in Europe during the crisis. The final section concludes.

1 Literature review: what are the channels of transmission?

In order to guide the analysis and help clarifying the choice of variables for carrying out the empirical exercise, this section discusses the most relevant channels through which financial and fiscal stress intertwine, as identified in literature.[4] These channels include the direct balance sheet interconnection, as well as other indirect ways through which underlying vulnerabilities in either the banking or public sector may materialize into twin crises.

[3] The European Banking Union aims to delink sovereigns and banks by allowing for bank recapitalisation funded at the European level whenever a bank rescue risks overburdening the national fiscal position.

[4] Reinhart and Rogoff (2012) show that (i) private and public debt booms ahead of banking crises, (ii) banking crises, both home-grown and imported, often accompany sovereign debt crises and, (iii) public borrowing increases sharply ahead of debt crises and (iv) it turns out that the government has "hidden debts" (domestic public debt and contingent private debt). Closely related, Balteanu and Erce (2014) show that twin sovereign debt and banking crises in emerging countries always combine with boom-bust patterns on the banking system.

A number of recent contributions study the two-way feedback between Sovereign and Bank stress by studying the common dynamics of bank and sovereign CDS spreads using vector-auto regression models (following the methodology proposed by Diebold and Yilmaz (2009). While these models are extremely useful to understand the joint dynamics of the series, as they rely fully on the time series dimension, they provide no economic guidance on the drivers of the feedback effects. In order to gauge an idea on the specific mechanisms through which stress transmits, the literature has relied, instead, on pooling country data together. Heinz and Sun (2014) use a generalized least squares panel data approach to analyze sovereign CDS drivers. They show that global factors account for a relevant portion of the observed variation. Acharya et al. (2013) present cross-country evidence about the potential for bank bailouts to trigger a fiscal crisis. Their narrative of the crisis presents three differentiated periods. They portray a first period, extending until 2007, in which sovereign risk was never an issue within the euro area. Then, starting with the first bank bailouts in 2008, sovereign risk starts to surface in some parts of the Monetary Union as economic prospects deteriorate and public debt raises on the back of the support provided to a seriously deteriorated financial system. Since 2010, sovereign risk has become the major concern and, for some countries, implied a resurfacing of concerns regarding financial risk, due to the fact that a number of banks were either heavily exposed to the sovereign (Bruegel, 2012) or suffered from the lowering of the public guarantees provided to them (BIS, 2010). The empirical analysis in Acharya et al. (2013) relies on the use of CDS spreads and relates their co-movement to resolution policies and macro factors. Their results show that the bailout led to an increase in sovereign risk. Moreover, they show that, even after controlling for bank-specific and macroeconomic variables, the contemporaneous relation between sovereign and bank CDS spreads remain, confirming the existence of a sovereign bank loop. Closely related, Thukral (2013) uses a panel data framework with lagged regressors to study the role of financial sector variables on the determination of sovereign CDS spreads. He constructs a bank risk index using bank CDS spreads and finds that the index is the primarily statistically significant determinant of sovereign risk premia even when fiscal variable are included, which he characterizes as bank dominance of sovereign financing conditions. Mody and Sandri (2011) recognize the existence of broadly similar sub-periods as Acharya et al. (2013), in which the feedback between sovereign and bank risk changed. Instead of comparing CDS spreads, Mody and Sandri (2011) focus on sovereign spreads as a measure of the fiscal risk, and banks' stock market capitalization as a measure of risk within the banking system. Their results, using spreads and market valuations, show that the euro crisis traces back to the demise of Bear Stearns. They argue that under the weight of increasing support for banks, sovereign spreads started to rise, especially in countries with weak growth prospects and high debt levels.

Another literature strand has delved into the role of monetary policy in strengthening the vicious relation between sovereign and bank risk. According to Darraq-Pires et al. (2013), the ECB's full-allotment liquidity policy is an

efficient tool to stabilize spiralling feedback loops between banks and the fiscal authorities. Drechsler et al. (2013) study the reasons behind the heterogeneous take up of long-term refinancing operations (LTROs) among European banks. They document that banks where this take up was larger also featured larger increases in their sovereign debt exposure.[5] Drechsler et al. (2013) define a haircut subsidy associated with using government bonds as collateral with the ECB, as opposed to government bonds in private repo markets. Using this subsidy, they provide support for the hypothesis that ECB collateral policies action help explain the increased balance sheet interconnection between banks and sovereigns in the euro area.

As regards the main transmission channels from bank stress to the sovereign, Candelon and Palm (2010) highlight four. First, rescue plans may impair the sustainability of public finances.[6] They can include bailout money, government deposits, liquidity provisioning by the central bank, public recapitalization and the materialization of public guarantees.[7] Second, if contingent liabilities materialize, fiscal costs are likely to be substantial. Next, the risk premium increases even if guarantees remain unused, raising borrowing costs for both the sovereign and the private sector (sovereign ceiling).[8] Last, the downturn originated by the credit crunch accompanying the financial crisis can deepen the recession, leading to further falls in public revenues, deepening the deficit and driving up debt. King (2009) provides an event analysis on the impact of government guarantees on the banking system using the battery of bank rescues that took place in late 2008. According to his results, the bailouts benefited the banks' creditors, as reflected in falling bank CDS spreads, at the expense of equity holders, given that banks' stock underperformed vis-a-vis the market.

If financial turmoil negatively influences asset prices, unemployment and output, the direct costs increase by the impact of the crisis on tax collection and public expenditure. Baldacci and Gupta (2009a, 2009b) argue that sovereign debt distress (deterioration of the fiscal position) after a banking crisis is likely to occur due to a combination of lower revenues and higher expenditures (bank rescues and outlays associated with the downturn).[9] According to Honohan (2008), banking crises last 2.5 years on average, public debt increases by around 30% of GDP and their estimated median fiscal cost stands at 15.5% of GDP. Distress can also spread through the credit crunch created by the financial

[5] Acharya and Tuckman (2013), using data for broker-dealers in the US, show that Lender of Last Resort activities can have the perverse side effect of slowing down deleveraging, increasing illiquid leverage and the risk of default.

[6] Rosas (2006) studies the drivers of government intervention after banking crises. He finds that authorities are more likely to bailout failing institutions in open and rich economies or if financial turmoil was caused by regulatory issues. On the other hand, electoral constraints and central bank independence seem to favor bank closure.

[7] See Feenstra and Taylor (2008) or Reinhart and Rogoff (2011).

[8] Laeven and Valencia (2011) show that blanket guarantees increase the fiscal costs of banking crises, but this can also be because they are set in place during severe crises.

[9] Baldacci and Gupta (2009) argue that fiscal expansions do not improve the growth outlook by themselves and lead to higher interest rates on long-term government debt. They identify a trade-off between boosting aggregate demand (short-run) and productivity growth (long run).

crisis. As credit falls or becomes more expensive, the economy is likely to suffer a drop in GDP growth. This might put additional pressure on the fiscal position through its impact on tax revenues, likely to be lower as activity falls.[10] Relatedly, Laeven and Valencia (2011) focus on the impact of financial sector interventions on the capacity of the financial system to provide credit. Their results show that firms dependent on external financing benefited significantly from bank recapitalization operations. However, as documented in Acharya, if the sovereign becomes overburdened, the value of the public guarantees falls, deepening the interconnection of stress. Kollmann et al. (2012) also focus on the impact of bank rescues. Their message is positive and highlights the ability of bank rescue operations to improve macroeconomic performance. Still, while they show that bank rescues raise investment, in line with the evidence in Broner et al. (2014) or Popov and Van Horen (2013), they find that sovereign debt purchases by domestic banks lead to a crowding out of private investment. Gray and Jobst (2011) and Gray et al. (2013) present a less benign exercise showing the potentially high impact on fiscal risk associated to the existence of contingent liabilities.

Finally, if uncertainty augments the crisis could lead to a sudden stop of capital inflows. In this line, Reinhart and Rogoff (2008) argue that banking crises often follow credit booms and high capital inflows. Moreover, they find that periods of high international capital mobility gave rise to banking crises in the past. Cavallo and Izquierdo (2009) provide further evidence showing that, after financial crises in emerging markets, capital flows may collapse for months or years potentially triggering a solvency crisis. Indeed, as argued by Obstfeld (2011) when discussing the role of international liquidity in the recent debt crisis, "...gross liabilities, especially those short-term, are what matter". Van Rixtel and Gasperini (2013) show that sovereign risk, as measured by the sovereign swap spreads, has shown in some periods a strong correlation with the three-month USD Libor-OIS, a sign that borrowing strains in foreign currency for banks affect the creditworthiness of the sovereigns.

In turn, a number of transmission channels of a fiscal crisis on the broader economy can be traced through the domestic financial system.[11] Whenever assets need to be written off or rescheduled, domestic banks are usually the first in line to take a hit. Along these lines, Noyer (2010), argues that banks' holdings of defaulted government bonds might lead to large capital losses and threaten the solvency of elements of the banking sector. IMF (2002) provides a comprehensive overview of the effects of four sovereign restructurings (Ecuador, Pakistan, Russia and Ukraine) on the domestic banking sector. The paper documents the extent of direct losses from banks' holdings of government securities, an increase in the interest rates on liabilities not matched by increased returns on assets (on the contrary, in this context government securities usually offer non-market rates), and an increase in the rate of non-performing loans increases, as higher financing costs lead to corporate bankruptcies. Similarly, Erce (2012)

[10] See De Paoli et al. (2009) or Feenstra and Taylor (2008).
[11] See IMF (2002) or Reinhart and Rogoff (2012).

suggests that the degree of bank intermediation and the banking system exposure to the sovereign strongly influence a debt crisis ripple effect on the real economy. In addition, authorities often react to debt problems by coercing domestic creditors to hold government bonds in non-market terms (Diaz-Cassou et al., 2008).[12] While this keeps borrowing costs low, a government default may trigger a banking crisis.[13] In Darraq-Pires et al. (2013) the positive connection between sovereign and bank risk is due to banks investing in government securities to hedge future liquidity shocks. Along these lines, Angeloni and Wolff (2012) assess the impact of sovereign bond holdings on the performance of banks during the euro area crisis using individual bank data and sovereign bond holdings. They find that peripheral sovereign bonds affect banks' stock market valuations heterogeneously. While Italian, Irish and Greek debt appear to have negatively affected the market valuation of the banks holding them, such an effect is not significant for other peripheral sovereign debt, most notably, Spanish.[14] Acharya et al. (2013), document the high exposure of their sample banks to their own sovereign, which according to their theory should be a main channel through which stress feeds back.[15]

Beyond this direct balance sheet effect, the ensuing fiscal contraction may lead to reduced activity, affecting banks' profits and further damaging the financial system. Moreover, a credit crunch may worsen the economic downturn, as banks reduce lending due to capital losses and to the increase in uncertainty that comes with a sovereign debt default (Panizza and Borenzstein, 2008). Popov and Van Horen (2013) focus on the feedback from sovereign risk into banking risk by assessing the extent to which increasing holdings of distressed sovereign bonds limit the banks' ability to extend loans to the private sector, furthering the vicious feedback loop by limiting the growth potential of the economy. They document a stronger reallocation away from domestic lending in the periphery. A similar crowding out effect is present in Broner et al. (2014), who present a battery of stylized facts for the euro area, including both an increase in sovereign bond holdings by banks and a simultaneous drop in financing to the private sector.[16] Corporate borrowers and banks may face a sudden stop after a sovereign default even if their exposure to government bonds is limited. Gennaioli et al. (2010) and Erce (2012) argue that sovereign defaults trigger capital outflows and credit crunches. An additional pressure to curtail lending might come from

[12] Das et al. (2012) argue that regulatory factors could lead to further balance sheet intertwining. In Livshits and Schoors (2009), as public debt becomes risky, governments have incentives to not adjust prudential regulation.

[13] In past crises, prudential regulation treated government bonds as risk-free despite default expectations were not zero (IMF, 2002). According to Castro and Mencia (2015), a similar phenomenon has been at play in the Eurozone

[14] A caveat of this analysis is that data stops in mid-2012, before the height of stress in Italy and Spain.

[15] Among other things, the paper assesses the extent to which reduced sovereign ratings affected the banks CDS through their effect on the public guarantees.

[16] These papers present a nuanced view of domestic purchases of public debt. Others have found positive effects. According to Asonuma et al. (2015) and Andritzky (2012), domestic bank purchases of sovereign bonds help stabilize sovereign funding costs.

the fact that the economic uncertainty may lead to deposit runs or a collapse of the inter-bank market (Panizza and Borenzstein, 2008). Finally, sovereign rating downgrades further limit banks' access to foreign financing, leading to sudden stops or higher borrowing costs (Reinhart and Rogoff, 2012).

2 Data

On the sovereign front, some authors have measured credit risk using credit ratings (Correa et al., 2012) or bond spreads (Mody and Sandry, 2011). In turn, bank risk proxies previously used include credit ratings (Correa et al., 2012) and the stock market behavior (Angeloni and Wolff, 2012). The analysis here follows a recent strand of the literature that has opted for using credit default swaps (CDS). By design, CDS contracts shield the holders from events of default, so are the financial instruments most related to credit risk. Importantly, although the data spans back a little less than a decade, CDS markets are relatively liquid.[17] Monthly data for 5-year CDS contracts for both individual banks and sovereigns comes from Bloomberg and DataStream. For sovereign CDS data, in most countries the information spans back to late 2005. In order to be able to assess the various twists observed during the crisis, countries for which sovereign CDS data was missing prior to 2008 (Cyprus and Luxembourg) were excluded from the sample. In turn, the above-cited sources returned active CDS contracts for 48 banks in the euro area. Unfortunately, prior to 2007, the coverage was less homogeneous. When considering together the coverage of both banks and sovereign entities, sufficiently large series were available for 10 euro area countries: Germany, Italy, France, Spain, Ireland, Greece, Portugal, Belgium, Netherlands and Austria.[18]

As in Acharya et al. (2013), to have a system-wide measure of bank stress, individual bank CDS data is aggregated in a country-specific bank risk index. Defining the CDS of bank $j \in J$ from country i at time t by $Bank\ CDS_{jit}$ and the corresponding weight as w_{jit},country's i Bank Risk Index is

$$BankRisk_{it} = \sum_{\forall j \in J} w_{jit} BankCDS_{jit}$$

From the various weighting schemes available, for simplicity, this paper uses $w_{jit} = \frac{1}{J}$.[19]

The econometric exercise controls for various macroeconomic, financial and global factors. Data on sovereign ratings comes from Fitch. Data on the banks' balance sheets come from Haver Analytics, the European Central Bank, the

[17] An important limitation of CDS data relates to the existence of counterparty risk. The lack of detailed data on CDS counterparties prevents from controlling for this potential bias.

[18] There is no CDS data for Finnish banks, preventing its inclusion in the analysis.

[19] Banks weights could be set according to their market capitalization or total assets. While the first option above focuses on private capital, depending on the extent of bank nationalisation, the second can be more adequate.

Bank for International Settlements and the IMF's Financial Stability Indicators.[20] The series included are: total assets, exposure to the general government, funding from the central bank, foreign assets and liabilities, non-performing loans, return on assets and equity ratio. Macroeconomic data (unemployment, inflation, nominal GDP growth, fiscal deficit, current account and public debt) was obtained from Haver Analytics.[21] The Itraxx financial Junior and VIX index come from Bloomberg.

3 Preliminary Evidence

Figures 1 and 2 (in the Appendix) provide a bird's eye view on the behavior of the risk series. Figure 1 portrays the behavior of sovereign and bank risk from an aggregate perspective. Euro area wide sovereign stress is proxied using a simple average of sample countries' sovereign CDS. The Itraxx Junior represents bank risk. In turn, Figure 2, shows the behavior of sovereign and bank on a country-by country basis.

As a reminder of the importance of policy action, the shadowed areas in Figure 1 represents two periods of marked policy activism. The first depicts the two months of 2008 in which most sample countries enacted programs of support for their financial systems. Remarkably, even at the low frequency employed here, the very specific dynamics ongoing during the third quarter of 2008 are still apparent. On the back of the public guarantees, the bank credit risk decreased markedly. However, simultaneously, the sovereign CDS started to pick up. According to Acharya et al. (2013), the increasing sovereign CDS reflected market fears regarding the just absorbed liabilities. The second period shadowed in Figure 1 corresponds to that following the ECB announcement of the Outright Monetary Transactions (OMT) instrument (August 2012). While it is not apparent that such policy action changed the correlation, Figure 1 shows a change in risk dynamics. Since then, both risk indicators have trended down. Another way to look at time patterns for the correlation between the risk variables comes from comparing sub-periods. This is done in Table 1 below.

[20] IMF's FSI indicators (non-performing loans, return on assets and equity ratio) are available only since 2008.

[21] Converse to the literature on sovereign spreads that focuses on real GDP, nominal GDP is used given its relevance in markets' assessment of debt sustainability. The debt and fiscal data refers to the General Government. These variables, as GDP, are available only on a quarterly basis. They have been linearly interpolated into monthly frequency.

Table 1. Correlation over periods

	Period 1	Period 2	Period 3	Period 4	Period 5
Corr (Sovereign Risk, Bank Risk)	0.507	-0.095	0.024	0.316	0.501
Observations	313	20	140	274	171

Period 1 refers to the period September 2005-August 2008 (Pre-crisis). Period 2 covers September 2008-August 2008 (Bail-out period). Period 3 extends until January 2010 (from the G-20's coordinated fiscal impulse to the inception of the Euro Area crisis). Period 4 lasts until August 2012 (OMT announcement) and Period 5 extends until January 2014 .

In periods 2 and 3 (bail-out and fiscal activism), the correlation observed previously broke down. Remarkably, since the inception of the OMT, the correlation is back to its pre-crisis value.[22] Following, Broner et al. (2014) narrative of the crisis, further insights into the dynamic relation of the risk indicators can be gained by breaking the euro area into a core and a periphery. This is done by running the following regressions

$$Risk\_A_{it} = \alpha_i + \sum_{p\in(1,5)} \beta_p \cdot Period\ p\ dummy \cdot Risk\_Z_{it-1} + \varepsilon_{it}, \quad (1)$$

$$Risk\_A_{it} = \alpha_i + \sum_{r\in(core,periph.)} \beta_r \cdot region\ r\ dummy \cdot Risk\_Z_{it-1} + \nu_{it} \quad (2)$$

where $Risk\_A_{it}$ and $Risk\_Z_{it}$ stand, interchangeably, for country's i sovereign and bank risk. Within regression (1) the feedback effect from one risk to the other is allowed to depend on the specific periods described in Table 1. In turn, within regression (2) the coefficients are allowed to differ differ between core and peripheral countries. The results are presented in Table 2 in the Appendix. The European crisis period (January 2010-August 2012) featured a particularly large degree of pass-through from bank risk into sovereign risk. Notably, feedback loops are not too different in peripheral and core countries. If anything, bank risk has a stronger pass-through effect on sovereign risk in peripheral economies. Overall, there is some evidence of the correlation between risk indicators having diverged across time and regions. The rest of the paper attempts to connect this time and spatial variation in risk to the dynamics of the underlying macroeconomic conditions.

4 Econometric Analysis

This section presents a panel data model of the feedback loop for each risk variable.[23] As in Thukral (2013) or Heinz and Sun (2014), the starting point is

[22] To complement the data description, Table A1 in the Appendix presents summary statistics for the full sample and for the core and periphery subsamples.

[23] The low number of observations calls for pooling country data to take advantage of both time series and cross-country variation and for keeping the model as parsimonious as possible.

a Generalized Least Squares (GLS) estimator, using the CDS variables in levels. Following the literature, in addition to the risk indicators, the model controls for financial, global, macroeconomic, and contagion effects:

$$Risk\_A_{it} = \alpha_{Ai} + \beta^{ZA} Risk\_Z_{it-1} + \Gamma_{AA} X^A_{it-1} + \Gamma_{ZA} X^Z_{it-1} + \Gamma_{GA} X^G_{it-1} + \varepsilon^A_{it}$$

Within this framework, the coefficient β^{ZA} measures the extent to which *Risk Z* feeds into *Risk A*. In addition, the model controls for the primary determinants of *Risk A* (X^A_{it}) and *Risk Z* (X^Z_{it}). When dealing with the sovereign risk model, X^A_{it} collects the macro variables and X^Z_{it} collects the banking sector variables. When dealing with the bank risk model, this reverses. The variable α_{Ai}collects country-specific characteristics. Euro area sovereign debt markets have been subject to recurrent bouts of dramatic co-movement during the crisis, which a number of commentators have associated with contagion.[24] This cross-sectional correlation can bias the standard errors, making the estimations less reliable. To address this issue the model controls for global and contagion factors (X^G_{it}). To gauge the relative importance role of the different sets of covariates, they are included and discussed in steps.

Additionally, the high degree of persistence of the CDS series raises concerns about the robustness of the results. To address this concern the model incorporates dynamic effects by including a lag of the dependent variable,

$$(1 - \gamma^A L) Risk\_A_{it} = \alpha_{Ai} + \beta^{ZA} Risk\_Z_{it-1} + \Gamma X_{it-1} + \varepsilon^A_{it}$$

where L is the lag operator, γ^A is the autoregressive coefficient of *Risk A*, $\Gamma = [\Gamma_{AA}, \Gamma_{ZA}, \Gamma_{GA}]$ and $X_{it-1} = [X^A_{it-1}, X^Z_{it-1}, X^G_{it-1}]$. The bias (Nickel bias) introduced by the dynamic element is tackled by using system-GMM (Arellano and Bover, 1995), which relies on the use of internal instruments (lagged levels and differences of the endogenous and predetermined variables).

4.1 Sovereign Risk Model

In a first step, similar to D'Agostino and Ehrmann (2014), the model only uses the macro factors. The variables included are: debt to GDP, fiscal balance, financial account, GDP growth, unemployment and inflation.[25] The results (Column 1, Table 3) are broadly in line with previous literature. Remarkably, the fiscal balance shows no significant relation with sovereign risk. Next, to assess the importance of banking factors for the pricing of sovereign risk, the model also includes the bank risk determinants. Following the literature, the regressors include: loan quality (non-performing loans to total loans), profitability

Significant gaps in Greek data preclude its use on the econometric part.

[24] According to Alter and Beyer (2013) or Broto and Perez-Quiros (2013) contagion played a non-negligible role in peripheral countries. Heinz and Sun (2014) find that shocks to Spanish and Italian CDS delivered the largest spillovers.

[25] The Breusch-Pagan Lagrange Multiplier test strongly supported the inclusion of random effects.

(return on assets), bank capital (tangible common equity ratio), the home bias in the banks' portfolio (domestic assets as a % of total assets), the exposure to public entities (private assets over total assets) and a measure of funding stability (assets to deposits). The results, in column 2, serve as test for the financial dominance hypothesis (Thuckar, 2013). While banking variables heavily influence the behavior of sovereign risk, converse to Thuckar (2013), macroeconomic factors play a dominant role.[26]

The next step adds $BankRisk_{it}$ to the framework. The coefficient associated with the bank risk indicator measures the feedback from bank into sovereign risk. Column 3 presents the results for this model. There is a positive and significant relation between bank and sovereign risk. For every 10 basis points (bps) increase in bank risk, sovereign risk increases by 4.2 bps in the following month. This is a large degree of pass-through. To lower the degree of commonality in the error terms, the model also controls for global shocks and potential contagion effects.[27] To proxy contagion, the model includes the average of the sovereign CDS for other euro area countries. In turn, the model includes the VIX index to proxy for global shocks. Column 4 from Table 3 presents the results. While the VIX Index does not appear to have a significant relation to sovereign risk, the contagion indicator presents a highly significant positive relation with sovereign risk. Controlling for global and contagion effects does not alter the significance of pass-through, although the size of the coefficient becomes smaller (3.1 bps increase in sovereign risk for every 10 bps increase on bank risk).[28]

Finally, column 5 presents a dynamic version of the sovereign risk model. As detailed above, the model is estimated using system GMM.[29] The dynamic element is large (close to unity) and highly significant. Remarkably, while the pass-through from bank to sovereign risk remains significant, the sign reverses. According to the results, for every 10 bps increase in bank risk, sovereign risk decreases by 0.9 bps.

4.2 Bank Risk Model

Following similar steps, the bank-related variables are included first. Next, the macroeconomic controls are introduced. Global shocks are again proxied with the VIX. Instead, contagion effects are now accounted for using the Itraxx Junior index. Finally, the dynamic version of the model, including the lagged value of bank risk, is estimated. Table 4 presents the results for these models.

As shown in Columns 1 and 2 of Table 4, banks with a larger home bias and larger private sector credit face larger bank risk. Non-performing loans are associated, as expected, with higher bank risk. Interestingly, a lower ratio of

[26] The regression's R-squared increases by more than 50% after adding the bank variables, but still gives macro factors a larger weight in explaining the sovereign risk variance.

[27] A Pesaran test on the model´s residuals shows a significant degree of spatial correlation.

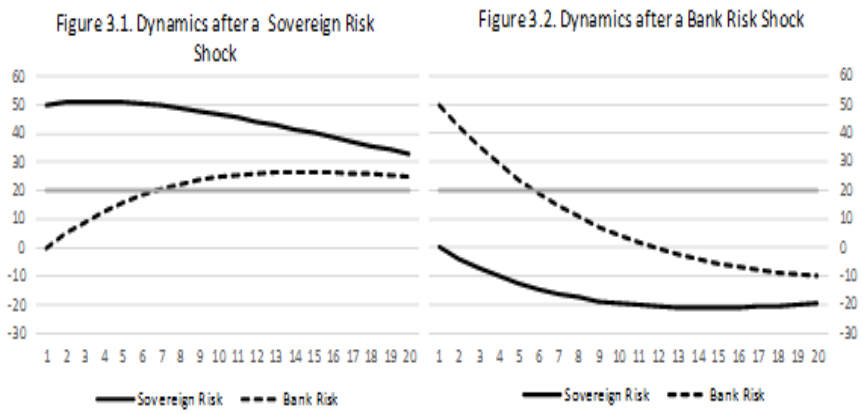
[28] The results (available under request) using a two-step Driscoll-Kraay correction for cross-sectional correlation are almost undistinguishable.

[29] Both the Sargan endogeneity tests and the Difference-in-Hansen tests of exogeneity tests validate the instruments.

assets to deposits and higher bank capital are associated with larger levels of stress. This result could be reflecting the fact that banks located in countries with stronger sovereigns have less need to build their own capital cushions (as in De Grauwe and Ji, 2013).[30] Column 3 shows the results for the model including the lagged value of sovereign risk. The feedback coefficient is, again, highly significant (0.53). In turn, as expected, larger values for the Itraxx and VIX Indices associate with more bank risk (column 4). Contagion across banks is a significant phenomenon. Finally, column 5 of Table 4 presents the estimates for the dynamic model of bank risk. The coefficient of main interest, the one associated with the sovereign risk indicator, is positive and significant. According to the results, a 10 bps increase in sovereign risk leads to a 0.8 bps increase in bank risk.

4.3 A cheat impulse-response

Combining the pass-through coefficients obtained from the sovereign and bank risk models, one can recoup the dynamic response of sovereign and bank risk to shocks to one another. The figures below present a graphical representation of shocking such system of equations with a 50 bps shock to sovereign risk (left chart) and to bank risk (right chart).



The charts present the effect of a 50 bps shock to a system of equations where sovereign and bank risk depend on both risks lagged values. The lag structure corresponds to the coefficients on Table 3 (column 5) for sovereign risk and Table 4 (column 6) for Bank Risk.

Figures 3.1 and 3.2 illustrate the different form that average feedback effects take. On the one hand, there is a strong positive feedback arising from sovereign shocks (Figure 3.1). On the other, there is no evidence of a feedback loop from bank risk into sovereign risk. Quite the opposite, bank risk shocks induce a milder and negative reaction of sovereign risk (Figure 3.2).

[30] In unreported estimates using the Driscoll-Kraay correction, the results are qualitatively identical

5 Digging into the Sources of Feedback Loops

The relation between both risks might depend on the underlying economic and financial environment. For instance, according to Acharya et al. (2013) or Martin et al. (2014), explicit and implicit balance sheet interrelations can powerfully amplify feedback loops. This section tests what conditions affect the intensity of the pass through by incorporating interactions between the risk measure and other variables,

$$(1-\gamma^A L)Risk\_A_{it} = \alpha_{Ai}+\beta^{ZA}Risk\_Z_{it-1}+\delta^{FZA}F_{it-1}Risk\_Z_{it-1}+\Gamma X_{it-1}+\varepsilon^A_{it}$$

where F_{it-1} is the factor interacting with the *Risk Z*. Within this framework, the feedback between risks becomes:

$$\frac{\partial Risk\_A_{it}}{\partial Risk\_Z_{it-1}} = \beta^{ZA} + \delta^{FZA}F_{it-1}$$

The sovereign risk model with interactions is estimated for the following variables: size of the banking system (Gennaioli al., 2014), banks' foreign liabilities (Cavallo and Izquierdo, 2009) and banks' non-performing loans (Acharya et al., 2013).[31] In turn, the candidate variables for affecting the feedback from the sovereign to the banks are public debt to GDP (Mody and Sandry, 2011), banks' balance sheet exposure to the sovereign (Angeloni and Wolff, 2012), and the investment grade status of sovereign debt (Correa et al., 2012). Table 5 (sovereign risk) and Table 6 (bank risk) contain the result.

Table 5 vindicates the validity of most of the above-mentioned channels of transmission. It shows that the three interactions present significant positive spillovers from bank to sovereign risk. The pass-through of risk becomes stronger where the volume of non-performing loans and banks' foreign liabilities are larger. Conversely, there is no evidence that, where banks have bigger balance sheets, the feedback effect is stronger.

In turn, Table 6 shows that the feedback from sovereign into bank risk is stronger the larger the stock of public debt and larger banking system exposure to the sovereign. The results also show a significantly stronger pass-through of sovereign risk when the sovereign rating is below investment grade.[32] When a sovereign rating falls outside the investment grade category, it loses a large pool of potential investors, affecting negatively sovereign risk.

5.1 Economic significance

To grasp the economic relevance of these results, Figures 4.1 and 4.2 depict various effects in basis points (bps). Figure 4.1 shows how the pass-through onto

[31] All the variables are measured as percentage of GDP to make them relative to the authorities' potential.

[32] This is despite the fact that the adjustments to the ECB's collateral policy during the crisis (Eberl and Webber, 2014) ameliorated the impact of not having an investment grade.

sovereign risk of a 100 bps increase in bank risk depends on different values of F_{it}. Figure 4.2 does the same for the effect on bank risk of a 100 bps increase in sovereign risk. The figures compare the effects at the minimum and maximum values within sample of the corresponding indicators.

Figure 4.1. Transmission of Bank Risk to Sovereign Risk

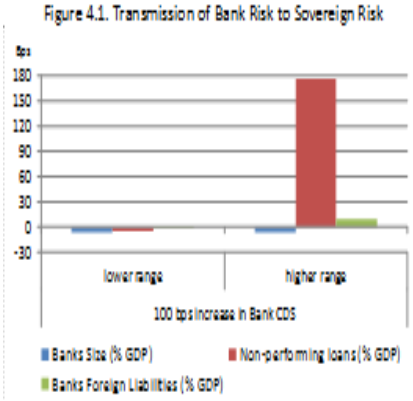
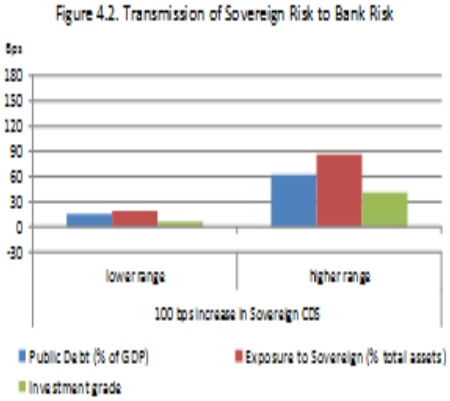


Figure 4.2. Transmission of Sovereign Risk to Bank Risk



Some of the conditional risk dynamics are economically very sizeable. For instance, Figure 4.1 shows that a 100 bps increase in bank risk does not lead to a positive feedback on sovereign risk even if the banking system size is at its maximum within the sample. The feedback is, instead, very large when the asset quality of the banks, as measured by the share of non-performing loans (NPLs), is high. While for the lowest level of NPLs there is no positive feedback effect, at the maximum value within sample, the effect is well above 150 bps.

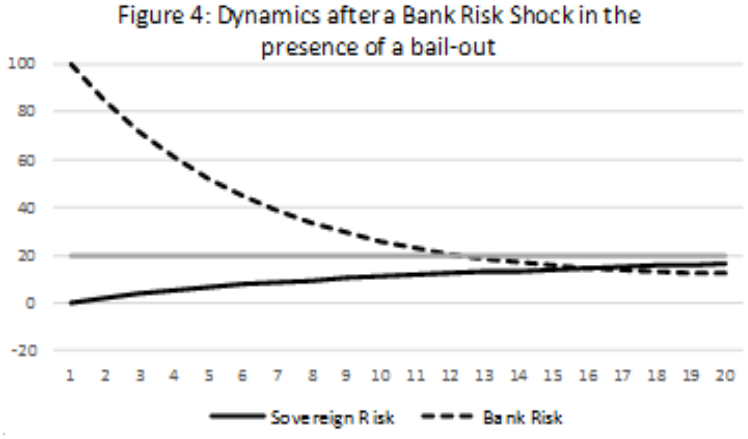
Similarly, when banks' foreign liabilities are large, there is a sizeable positive feedback effect of bank risk to sovereign risk. In turn, Figure 4.2 shows the relevance of the balance sheet exposure to the sovereign in the transmission of stress. Faced with an increase in sovereign risk of 100 bps, banking systems holding the lowest level of exposure face an 18 bps increase in their risk. Instead, banks with larger exposures face an increase of 80 bps. The feedback effect can also grow considerably in the presence of large public debt stock (up to 62 bps), and when the sovereign has lost its investment grade (40 bps).

6 Bank Rescues and the Feedback Loop

This section uses the sovereign risk model to assess quantitatively the effect that bank rescue operations can have on the feedback from bank into sovereign risk. According to Acharya et al. (2013), the rescue packages enacted by euro area governments to fight off the financial crisis generated a risk transfer. As sovereigns began to support their banks, investors became more confident about banks. This led to a lowering of banks' CDS spreads. Unfortunately, in some cases, the weight governments had to lift pushed up sovereign risk, facilitating

the emergence of a perverse feedback loop.[33] To limit extreme forms of this risk transfer, the euro area authorities devised a tool to assist banks directly using the European Stability Mechanism (ESM, 2014).[34] Implementing this policy requires determining when a sovereign might not be able to do it on its own. The analysis focuses on direct exposures and contingent liabilities.[35]

Figure 5 provides a dynamic representation of the effects of a shock to bank risk when the sovereign has bailed out the banks using an amount equal to the average fiscal cost of bank crises (15% of GDP) in Laeven and Valencia (2011).



The chart presents the dynamic effect of a 100 bps shock to bank risk using a system of equations where both risks depend on lagged risk values and the size of the bail-out. The lag structure corresponds to the coefficients on Table 3 (column 5) for sovereign risk and Table 7 (column 2) for Bank Risk. The bail out size is set at 15% of GDP.

In line with Acharya et al. (2013) risk-transfer hypothesis, the results, presented in Table 7, point to a significantly larger pass-through of bank risk into the sovereign for those economies where the authorities more heavily supported their banking system. According to the results, given a size of the bailout equal to 15% of GDP, for every 100 bps increase in bank risk, sovereign risk increases by 11 bps within a year. As shown in columns 3 and 4, this effect becomes more sizeable for countries where the banks have a larger amount of foreign liabilities or a larger balance sheet exposure to the sovereign.

7 Conclusions and Policy implications

This paper has analyzed the factors associated with the emergence of perverse spirals of sovereign and bank stress. Using a dynamic panel data model, it uncovers underlying vulnerabilities that reinforce the process where shocks to

[33] Alter and Beyer (2013) find that, in Spain, the nationalization of Bankia led to an increase on spillovers.

[34] Direct recapitalisation is provided if a sovereign cannot provide support without triggering a fiscal crisis.

[35] The data, in an annual format, comes from the European Commission.

a country´s fiscal health contaminate the financial sector. Countries where public debt is larger, and where domestic banks have a larger exposure to their own sovereign, face stronger feedback loops from sovereign into bank risk. The same goes for countries losing their investment grade status. On the other, the analysis also identified factors associated with an elevated transmission of bank distress to the sovereign. In countries where banks are larger, funded with more foreign credit and face more non-performing loans, the feedback from bank risk into sovereign risk is stronger.

From an economic policy perspective, these results can help in monitoring the build-up of fiscal weaknesses and the robustness of the financial system to fiscal shocks. Additionally, the new framework to handle banking crises in the euro area implies that, if the foreseen bail-in of the bank's private creditors is not enough, individual banks could be rescued directly by the official sector. For such direct recapitalization to happen, it has to be the case that the country could endanger its sustainability if supporting the bank alone. This paper informs this process by studying the circumstances in which financial rescues might overburden the sovereign.

References

[1] Acharya, V., I. Dreschlet, and P. Schnabl (2013), A Pyrrhic Victory: Bank Bailouts and Sovereign Credit Risk, Mimeo.

[2] Acharya, V., and B. Tuckman (2013), Unintended Consequences of LOLR Facilities: The Case of Illiquid Leverage, NBER Working Paper 19773.

[3] D'Agostino, A., and M. Ehrmann (2013), The pricing of G7 Sovereign bond spreads: The times, they are a-changing, Journal of Banking and Finance, forthcoming.

[4] Alessandri, P. and A. Haldane (2009), Banking on the State, Bank of England, mimeo.

[5] Alter, A. and A. Beyer (2013), The Dynamics of Spillover Effects during the European Sovereign Debt Turmoil, Mimeo.

[6] Andritzky, J. (2012), Government Bonds and Their Investors: What are the Facts and Do They Matter?, IMF Working Paper 12/158.

[7] Angeloni, C., and G. Wolff, 2012, Are Banks Affected by Their Holdings of Government Debt?, Bruegel Working Paper 2012/07.

[8] Arce, O., Mayordomo, S., and J. Pena (2012), Credit-risk valuation in the sovereign CDS and bond markets: Evidence from the euro area crisis, CNMV Working Paper Series, No. 53.

[9] Arellano, C. and N. Kocherlakota (2008), Internal Debt Crises and Sovereign Defaults, NBER Working Paper 13794.

[10] Asonuma, T., Bakhache, S., and H. Hesse (2015), Is Banks' Home Bias Good or Bad for Public Debt Sustainability?, IMF Working Paper 15/44.

[11] Baldacci, E. and S. Gupta (2009a), Fiscal Expansions: What Works, Finance & Development, Volume 46, Number 4.

[12] Baldacci, E., C. Mulas-Granados and S. Gupta (2009b), How Effective is Fiscal Policy Response in Systemic Banking Crises?, IMF Working Papers 09/160.

[13] Balteanu, I., and A. Erce, 2014, Bank Crises and Sovereign Defaults in Emerging Markets: Exploring the Links. Bank of Spain, Working Paper 1414.

[14] Broner, F., Erce, A., Martin, A., and J. Ventura (2014), Sovereign Debt Markets in Turbulent Times: Creditor Discrimination and Crowding Out, Journal of Monetary Economics, Volume 61.

[15] Broto, C. and G. Perez Quiros (2013), Disentangling contagion among Sovereign CDS spreads during the European debt crisis, Bank of Spain Working Paper Series No. 1314.

[16] Candelon, B. and F.C. Palm (2010), Banking and Debt Crises in Europe, The Dangerous Liaisons?, CESifo Working Paper No. 3001.

[17] Caprio, G. Jr. and P. Honohan (2008), Banking Crises, Institute for International Integration Studies Discussion Paper Series no. 242.

[18] Castro, C., and J. Mencia (2014), Sovereign Risk and Financial Stability, Revista de Estabilidad Financiera No. 26, Bank of Spain.

[19] Cavallo, E. and A. Izquierdo (2009), Dealing with an International Credit Crunch: Policy Responses to Sudden Stops in Latin America, Inter-American Development Bank, mimeo.

[20] Carey, D. (2009), Iceland: The Financial and Economic Crisis, OECD Economics Department Working Papers, No. 725, OECD Publishing.

[21] Correa, R., Kuan-Hui, L., Sapriza, H., and G. Suarez (2012), Sovereign Credit Risk, Banks' Government Support, and Bank Stock Returns Around the World, Federal Reserve Board, International Finance Discussion papers No. 2012-1069

[22] Das, U.S., Oliva, A.O., and T. Tsuda (2012), Sovereign Risk: A Macro-Financial Perspective, Public Policy Review Vo. 8, No. 3 (Ministry of Finance, Japan).

[23] Delatte, A. L., Fouquau, J. and R. Portes (2014), Nonlinearities in Sovereign Risk Pricing: The Role of CDS Index Contracts. OFCE Working Paper 2014-08.

[24] De Grauwe, P., and Y. Ji (2013), Strong Governments, Weak Banks, CEPS Policy Brief No. 305.

[25] De Paoli, B., Hoggarth, G. and V. Saporta (2009), Output costs of sovereign crises: some empirical estimates, Bank of England working papers no. 362.

[26] Diaz-Cassou, J., A. Erce and J. Vazquez (2008), Recent episodes of sovereign debt restructuring: A case-study approach, Bank of Spain, Occasional Document 0804.

[27] Diebold, F., and K. Yilmaz (2009), Measuring financial asset return and volatility spill overs, with an application to global equity markets, Economic Journal, Issue 119.

[28] Dreschler, I., Drechsel, T., Marques-Ibanez, D., and P. Schnabl (2013), Who Borrow from the Lender of Last Resort?, Mimeo.

[29] Eberl, J., and C. Webber (2014) ECB Collateral Criteria: A Narrative Database 2001-2013, Ifo Working Paper No. 174

[30] Erce, A. (2012), Selective Sovereign Defaults, Federal Reserve Bank of Dallas, Globalization and Monetary Policy Institute, Working Paper No. 127.

[31] European Commission (2009), Public Finance Report in EMU-2009, European Economy No. 5.

[32] European Stability Mechanism (2014), ESM direct bank recapitalisation instrument adopted, Press release no 18/2014

[33] Feenstra, R.C and A. Taylor (2008), International Economics, Worth Publishers.

[34] Gennaioli, N., Martin, A. and S. Rossi (2014), Sovereign Default, Domestic Banks and Financial Institution, Journal of Finance, forthcoming.

[35] Gray, D. and A. Jobst (2011), Modelling systemic financial sector and sovereign risk, Sveriges Riskbank Economic Review, 2011:2.

[36] Gray, D., Gross, M., Paredes, J., and M. Sydow (2013), Modelling Banking, Sovereign and Macro Risk in a CCA Global VAR, IMF Working Paper 13/218.

[37] Heinz, F. and Y. Sun (2014), Sovereign CDS Spreads in Europe: The Role of Global Risk Aversion, Economic Fundamentals, Liquidity, and Spill overs, IMF Working Paper 14/17.

[38] Honohan, P. (2008), Risk Management and the Costs of the Banking Crisis, The Institute for International Integration Studies Discussion Paper Series no. 262.

[39] IMF (2002), Sovereign Debt Restructurings and the Domestic Economy Experience in Four Recent Cases, Policy Development and Review Department.

[40] King, M. (2009), Time to buy or just buying time? The market reaction to bank rescue packages, BIS Working Paper No. 288.

[41] Kollmann, R., Roeger, W., and J. in't Veld (2012), Fiscal Policy in a Financial Crisis: Standard Policy vs. Bank Rescue Measures, Ecares Working Paper 2012-006.

[42] Laeven, L. and F. Valencia (2011), The Real Effects of Financial Sector Interventions During Crises, IMF Working Paper 11/45.

[43] Livshits, I. and K. Schoors (2009), Sovereign Default and Banking, mimeo.

[44] Mody, A., and D. Sandri, 2011, The Eurozone Crisis: How Banks Came to be Joined at the Hip, IMF Working Paper 11/269.

[45] Moody's (2014), European Sovereign Debt and Banking Crises: Contagion, Spill overs and Causality, Moody's Investors Service, Credit policy.

[46] Noyer, C (2010), Sovereign crisis, risk contagion and the response of the central bank, mimeo.

[47] Panizza, U and E. Borensztein (2008), The Costs of Sovereign Default, IMF Working Paper 08/238.

[48] Reinhart, C.M. and K.S. Rogoff (2008), Banking Crises: An Equal Opportunity Menace, NBER Working Papers 14587.

[49] Reinhart, C.M. and K.S. Rogoff (2012), From Financial Crash to Debt Crisis, American Economic Review, 101(5).

[50] Rosas, G. (2006), Bagehot or Bailout? An Analysis of Government Responses to Banking Crises, American Journal of Political Science Vol. 50 No.1, pages 175-191.

[51] Popov, A., and N. Van Horen (2013), The impact of sovereign debt exposure on bank lending: Evidence from the European debt crisis, DNB Working Paper No. 382.

[52] Thukral, M. (2013), Bank dominance: Financial sector determinants of sovereign risk premia, Mimeo.

[53] Van Rixtel, A., and G. Gasperini (2013), Financial Crises and bank funding: recent experience in the euro area, BIS Working Papers No. 406.

Appendix

Variables included in the analysis: Main features

Data Series	Source	Frequency
Local currency rating	Fitch	Monthly
Harmonized CPI Index	Haver Analytics	Monthly
Nominal GDP	Haver Analytics	Quarterly
Financial Account Balance	Haver Analytics	Quarterly
Harmonized Unemployment Rate	Haver Analytics	Monthly
General Government Nonconsolidated Debt	Haver Analytics	Quaterly
General Government: Net Lending/Borrowing	Haver analytics	Quarterly
Banking System Balance Sheet	Haver Analytics	Monthly
VIX index	CBOE	Monthly
Itraxx Junior Financial Indices	Bloomberg	Monthly
Central Bank Lending	Individual Central Banks	Monthly
Bank rescue operations (liabilities and contingent liabilities)	European Comission	Annual
Sovereign 5-year CDS spreads	Bloomberg and Datastream	Monthly
Bank 5-year CDS spreads	Bloomberg and Datastream	Monthly

Figure 1: Sovereign and Bank Risk in the Euro Area

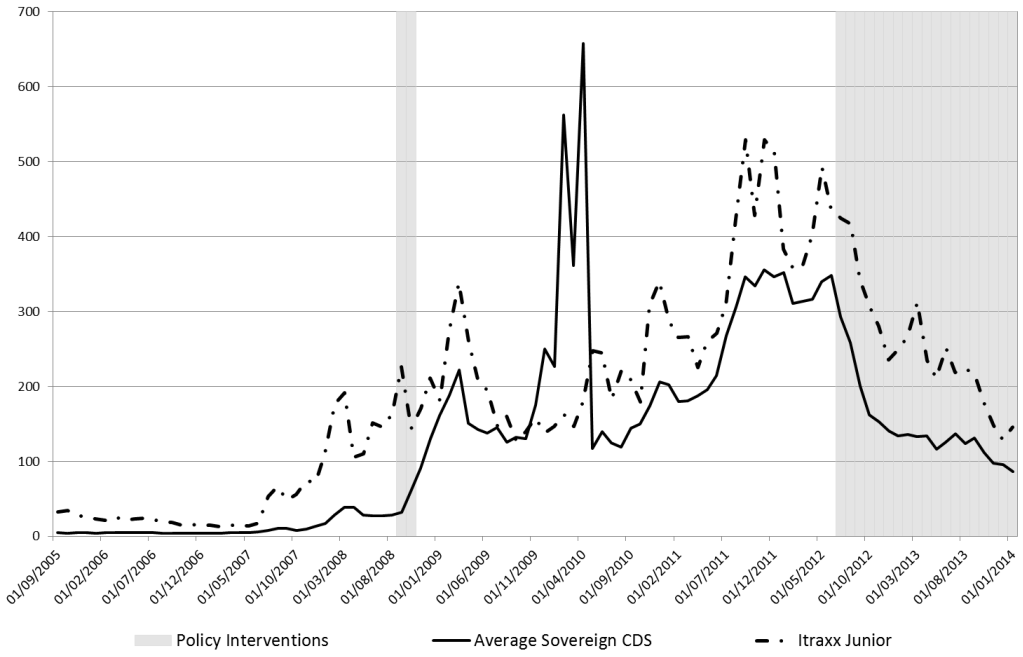
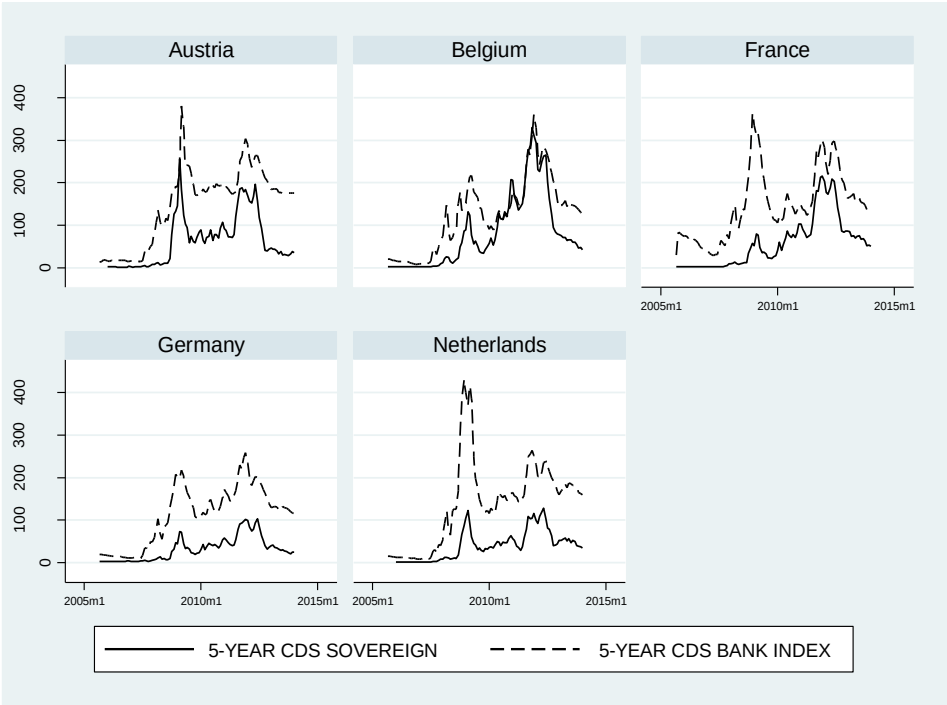


Figure 2: A bird's eye view of Sovereign and Bank risk



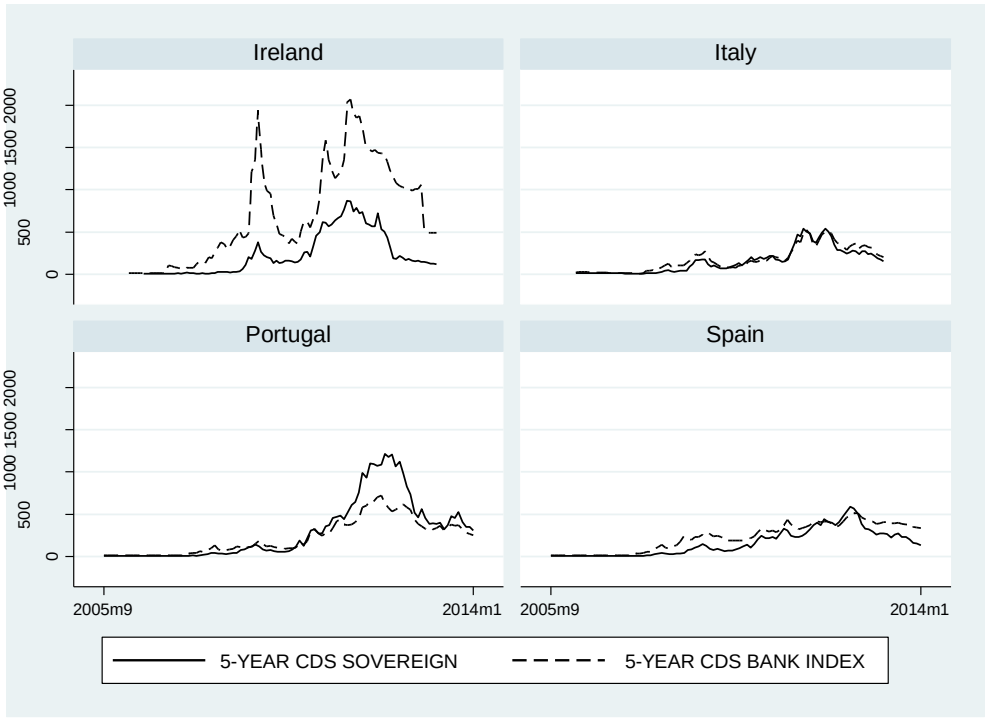


Table A1. Summary statistics by geographical area: Core versus periphery

	Core					Periphery					Full Sample				
Variable	Observations	Mean	Std. Dev.	Min	Max	Observations	Mean	Std. Dev.	Min	Max	Observations	Mean	Std. Dev.	Min	Max
Sovereign CDS	497	55.18	59.88	1.30	329.28	450	263.28	525.55	1.76	6882.40	947	154.07	379.19	1.30	6882.40
Bank CDS Index	505	134.83	87.57	7.93	431.49	471	399.27	436.90	8.10	2067.82	976	262.45	336.83	7.93	2067.82
Public Debt (% GDP)	485	86.23	17.64	50.21	118.93	485	94.61	35.58	25.62	183.29	970	90.42	28.38	25.62	183.29
GDP Growth	470	0.65	0.68	-1.52	1.56	470	0.17	1.19	-2.87	2.86	940	0.41	1.00	-2.87	2.86
Fiscal Balance (% GDP)	467	-2.70	3.88	-13.85	7.52	485	-6.90	7.12	-40.31	8.69	952	-4.84	6.13	-40.31	8.69
Inflation	500	1.99	1.05	-1.64	5.77	500	2.07	1.64	-2.92	5.68	1000	2.03	1.38	-2.92	5.77
Unemployment	500	6.71	2.21	3.00	11.30	498	12.28	5.91	4.20	27.80	998	9.49	5.25	3.00	27.80
Financial account (% GDP)	485	-2.96	3.97	-10.24	5.28	485	5.31	4.64	-6.75	13.80	970	1.17	5.98	-10.24	13.80
Central Bank Liquidity (% GDP)	485	0.07	0.04	0.01	0.37	485	0.20	0.21	0.00	0.86	970	0.13	0.16	0.00	0.86
Bank Size (% GDP)	485	4.09	0.48	3.20	5.05	485	5.04	2.96	2.03	12.95	970	4.56	2.17	2.03	12.95
Bank access to Central Bank (% of total assets)	495	0.02	0.01	0.00	0.08	495	0.04	0.05	0.00	0.24	990	0.03	0.04	0.00	0.24
Bank exposure to General Government (% total assets)	495	0.07	0.02	0.04	0.14	495	0.06	0.03	0.02	0.12	990	0.06	0.02	0.02	0.14
Bank foreign liabilities (% total assets)	495	0.14	0.10	0.04	0.42	495	0.12	0.13	0.02	0.44	990	0.13	0.12	0.02	0.44
Bank Home Bias	495	0.76	0.12	0.44	0.87	495	0.83	0.19	0.42	0.96	990	0.79	0.16	0.42	0.96
Non-performing loans	315	2.95	0.93	0.51	4.37	321	8.91	6.08	0.75	29.37	636	5.96	5.29	0.51	29.37
Return On Assets	291	0.27	0.30	-1.31	0.74	312	0.16	1.51	-9.52	8.11	603	0.21	1.10	-9.52	8.11
Capital ratio	291	14.43	2.40	10.47	19.64	321	11.73	3.09	-2.89	20.29	612	13.01	3.09	-2.89	20.29
VIX Index	505	21.47	10.13	10.31	68.51	505	21.47	10.13	10.31	68.51	1010	21.47	10.13	10.31	68.51
Itraxx Junior	505	189.70	134.92	12.70	529.63	505	189.70	134.92	12.70	529.63	1010	189.70	134.85	12.70	529.63

Data runs from September 2007 until January 2014. Core countries are Germany, France, Belgium, Austria and Netherlands. Periphery countries include Ireland, Italy, Portugal, Greece and Spain.

Table 2. Bank and Sovereign risk loops by periods and regions

Dep. Var: Sovereign Risk	Full Sample	Core vs Periphery
Bank Risk Index (during Period 1)	8.74E-02	
	[0.09]	
Bank Risk Index (during Period 2)	2.54e-01**	
	[0.11]	
Bank Risk Index (during Period 3)	2.52e-01***	
	[0.03]	
Bank Risk Index (during Period 4)	6.04e-01***	
	[0.02]	
Bank Risk Index (during Period 5)	3.66e-01***	
	[0.02]	
Bank Risk Index (if core country)		4.80e-01***
		[0.06]
Bank Risk Index (if peripheral country)		5.49e-01***
		[0.02]
Constant	2.77e+01**	6.64
	[11.48]	[18.48]
Observations	890	890
R-squared	0.57	0.47
	Full Sample	Core vs Periphery
Dep. Var: Bank Risk		
Sovereign Risk (during Period 1)	2.25e+00***	
	[0.85]	
Sovereign Risk (during Period 2)	2.72e+00***	
	[0.74]	
Sovereign Risk (during Period 3)	2.26e+00***	
	[0.14]	
Sovereign Risk (during Period 4)	1.04e+00***	
	[0.03]	
Sovereign Risk (during Period 5)	1.19e+00***	
	[0.06]	
Sovereign Risk (if core country)		1.16e+00***
		[0.11]
Sovereign Risk (if peripheral country)		1.01e+00***
		[0.03]
Constant	7.46e+01***	9.93e+01
	[13.09]	[61.77]
Observations	887	887
R-squared	0.53	0.49

Standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1. Period 1 refers to the period September 2005-August 2008. Period 2 covers September 2008-August 2008. Period 3 extends until January 2010. Period 4 last then until August 2012. Period 5 extends until January 2014. Peripheral economies included are Portugal, Ireland, Spain and Italy. Core countries in the sample include Germany, France, Austria, Beligum and The Netherlands.

Table 3: Sovereign Risk Determinants

	Macro factors	Financial Dominance?	Including Bank Risk	Contagion & Global	Dynamic Panel - GMM
Public Debt (% GDP)	2.85074***	3.03412***	4.36466**	2.41267	-0.16140
	[0.89192]	[0.56061]	[2.09820]	[2.07418]	[0.20781]
Inflation	41.88270**	42.31815***	29.64377**	22.61933	0.44141
	[20.46094]	[5.00052]	[14.16609]	[14.55856]	[1.41064]
Fiscal Balance (% GDP)	-0.89429	-0.55020			
	[2.11210]	[1.26736]			
Unemployment	24.68218**	-12.20295***	-10.53978	-7.01676	-0.31433
	[12.53592]	[2.09126]	[8.34691]	[8.04618]	[0.26713]
Financial account (% GDP)	8.77482**	7.80787***	7.17697***	8.14635***	1.09265*
	[4.14930]	[1.20988]	[1.80998]	[1.64103]	[0.58133]
GDP Growth	-17.52449	-18.99286***	-14.83255	-18.74828	6.17804**
	[23.69710]	[7.22454]	[20.55788]	[21.74692]	[2.41609]
VIX Index				-0.91588	0.39047**
				[0.82917]	[0.19799]
Other EA Sovereigns shock				0.39342***	0.00061
				[0.11429]	[0.00676]
Sovereign Risk					1.01593***
					[0.00858]
Bank Risk			0.39870***	0.31215***	-0.07841***
			[0.12477]	[0.11033]	[0.00990]
Bank Home Bias		11.00246	236.51432**	78.24319	-50.41017***
		[59.50422]	[92.86427]	[107.01573]	[15.36646]
Banks Private Assets		160.95964***	107.23422*	58.04025	15.34203***
		[18.25573]	[57.96847]	[54.51904]	[4.45689]
Banks Assets to Deposits		-236.85313***	-163.62463	-32.00543	-14.99333
		[65.08768]	[146.28101]	[114.79124]	[19.15749]
Banks funding from CB		5,198.06913***	4,112.84212***	4,519.80440***	-223.87460
		[470.39164]	[1,407.27665]	[1,441.52373]	[149.90186]
Non-performing loans		12.12065***	-7.57912	-3.34707	2.47547*
		[2.26705]	[7.11940]	[7.22369]	[1.27734]
Banks ROA		47.70184**	31.68372	31.27290	-14.87771**
		[18.74357]	[51.60539]	[45.46797]	[7.28199]
Banks' capital		-3.18224	-12.52783	-15.01924	
		[3.26946]	[13.04944]	[13.30132]	
Constant	-412.95925***	-393.23746***	-474.62623***	-251.14994	33.93331
	[97.57750]	[104.77950]	[147.34333]	[169.74052]	[30.87990]
Observations	819	543	543	543	534
R-squared	0.38	0.69	0.57	0.64	
Sargan Test					163.8

Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1. Banks Home bias refers to asset that are of a domestic nature. Banks private assets refers to assets not related to the Public sector.All bank balance sheet variables are measured as a % of banks' total assets but Bank Assets to deposits that presents the ratio of total assets to deposit liabilities. All explanatory variables enter in the regression in lagged form.

TABLE 4: Bank Risk Determinants

	Bank factors- ECB data	Bank factors - ECB & IMF data	Bank & macro factors	Including Sovereign Risk	Contagion& Global	Dynamic Panel - GMM
Bank Home Bias	645.29571***	-716.28140***	-593.35841***	-603.49704***	-632.80719***	-98.82991***
	[145.31905]	[72.68564]	[59.86096]	[51.56742]	[50.16786]	[17.39234]
Banks Private Assets	152.65238***	159.25283***	145.29523***	61.91358***	69.18806***	16.86370*
	[18.11861]	[14.43979]	[18.07193]	[16.72809]	[16.77667]	[9.94408]
Banks Assets to Deposits	-543.65014***	-68.74126	-204.20386***	-83.56846	-44.39201	-28.38901
	[104.23514]	[79.97998]	[66.36337]	[57.84573]	[56.27863]	[23.93555]
Banks funding from CB	6,595.00077***	2,684.92650***	2,528.43335***	-458.79641	324.59844	-194.33941**
	[446.91417]	[494.04588]	[476.17691]	[465.16681]	[448.88955]	[98.64389]
Non-performing loans		35.35430***	48.81510***	41.70719***	43.35807***	5.90579***
		[2.61304]	[2.31106]	[2.05799]	[1.94035]	[0.54551]
Return on Assets		56.36885***	19.19785	-16.29750	21.99971	-11.52246**
		[19.51918]	[18.90258]	[16.48943]	[16.14227]	[5.11996]
Banks Capital		19.45874***	20.19696***	20.11718***	21.42841***	1.38871
		[3.58217]	[3.33560]	[2.87317]	[2.79773]	[1.71676]
VIX Index					3.33184***	0.74053***
					[0.53468]	[0.25618]
Itraxx Junior Index					0.22615***	-0.01302
					[0.05723]	[0.01891]
Bank Risk						0.84649***
						[0.02360]
Sovereign Risk				0.53566***	0.43689***	0.09855*
				[0.03935]	[0.04121]	[0.05741]
Public Debt (% GDP)			-3.37438***	-4.94036***	-4.46404***	-0.68918*
			[0.56867]	[0.50316]	[0.51088]	[0.41107]
Inflation			29.39950***	6.72022	2.28081	-0.64970
			[4.94414]	[4.57294]	[4.39152]	[3.40228]
Unemployment			-4.23686**	2.03623	2.90225	0.23715
			[2.12738]	[1.88949]	[1.79895]	[0.83246]
Financial account (% GDP)			2.40681**	-1.23244	-1.74867*	-0.07521
			[1.20956]	[1.07562]	[1.03529]	[0.30885]
GDP Growth			-3.79514	9.13444	22.17504***	10.21375***
			[7.36727]	[6.41658]	[6.21383]	[2.93831]
Constant	-74.18393	-76.50793	295.24515***	538.73613***	256.14497***	97.26295***
	[181.85684]	[121.33788]	[106.88495]	[93.78800]	[98.68833]	[34.31770]
Number of Observations	873	543	543	543	543	543
R-squared	0.31	0.79		0.84	0.87	.
Sargan Test						176.04

Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1. Banks Home bias refers to asset that are of a domestic nature. Banks private assets refers to assets not related to the Public sector.All bank balance sheet variables are measured as a % of banks' total assets but Bank Assets to deposits that presents the ratio of total assets to deposit liabilities. All explanatory variables enter in the regression in lagged form.

Table 5. Channels of transmission of Bank Risk

Dep. variable: Sovereign Risk	Bank Size	Non-performing loans	Bank foreign Liabilities
Bank Risk	-0.06955***	-0.06905***	-0.06800***
	[0.01003]	[0.01025]	[0.01041]
Bank Risk* Banks' Size	0.00071***		
	[0.00012]		
Bank Risk* Non-performing loans		0.00890***	
		[0.00197]	
Bank Risk*Banks' Foreign Liabilities			0.01927***
			[0.00287]
Constant	81.07124***	79.63427**	80.33793**
	[31.02581]	[31.08578]	[31.29246]
Other controls	Yes	Yes	Yes
Observations	534	534	534
Number of countries	9	9	9

Robust standard errors in brackets. *** p<0.01, ** p<0.05. Other controls include all the regressors presented in the last column of Table 3. All the variables interacted with the SovereignRrisk index are measured as % of GDP.

Table 6. Channels of transmission of Sovereign Risk

Dep. Variable: Bank Risk	Public debt	Exposure to the sovereign	Investment grade effect
Sovereign Risk	0.05698	0.05916	0.07102*
	[0.03960]	[0.04105]	[0.04270]
Sovereign Risk* Bank's exposure to the Sovereign	6.66832***		
	[2.03944]		
Sovereign Risk* Public Debt		0.00380***	
		[0.00112]	
Sovereign Risk* Non-Investment Grade Dummy			0.33462*
			[0.17285]
Constant	49.58306	47.43372	48.26995
	[41.72077]	[43.26140]	[46.91890]
Other controls	Yes	Yes	Yes
Observations	534	534	534
Number of countries	9	9	9

Robust standard errors in brackets. *** p<0.01, ** p<0.05. Other controls include all the regressors presented in Table 4. Public debt is measured as % of GDP. Banks' exposure to the sovereign is measured as % of total assets.

Table 7. Bank bailouts and feedback loops

Dep. variable: Sovereign Risk				
Bank Risk	-0.01432***	-0.01259***	-0.01180***	-0.01273***
	[0.00319]	[0.00258]	[0.00275]	[0.00247]
Bank Risk* Bailout Size (including contingent claims)	0.03402***			
	[0.00101]			
Bank Risk* Bailout Size		0.22592***		
		[0.02244]		
Bank Risk*Bailout Sizes*Banks' Foreign Liabilities			0.06211***	
			[0.00365]	
Bank Risk*Bailout Size*Banks' sovereign exposure				4.46927***
				[0.43230]
Constant	-1.04590	-1.68672	12.64554***	-1.83684
	[3.80581]	[3.47236]	[3.56339]	[3.41779]
Other controls	Yes	Yes	Yes	Yes
Observations	534	534	534	534
Number of countries	9	9	9	9

Robust standard errors in brackets. *** p<0.01, ** p<0.05. Other controls include all the regressors presented in the last column of Table 3. The bail out variables are in % of GDP. Banks' foreign liabilities is measured as % of GDP. Banks' sovereign exposure is measured in % of total assets.

European Stability Mechanism

6a Circuit de la Foire Internationale
L-1347 Luxembourg

Tel: +352 260 292 0

www.esm.europa.eu

info@esm.europa.eu