Bank Lending and the Sovereign Debt Crisis

Filippo De Marco *

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Abstract

I investigate the relationship between the sovereign debt crisis and the credit crunch in Europe. Using data from the European Banking Authority (EBA) on banks' exposure to government debt, I construct a bank–specific shock which measures the impact of the sovereign debt crisis on each bank's balance sheet. I show that banks more exposed to the sovereign shock tightened credit supply by more than banks that were less exposed. Controlling for aggregate credit demand conditions at the country level, a 1% increase in the sovereign losses-over-total assets ratio leads to a decline in the growth rate of both domestic and foreign loans around 4%. Moreover, using syndicated loans data, I show that, for a one standard deviation increase in the sovereign shock (20 bps.), interest rate spreads are 40 to 65 bps. higher, even after controlling for sector–specific credit demand and borrower controls. Preliminary evidence suggests that banks' sovereign exposures mattered for the credit crunch because they increased banks' cost of funding rather than affecting banks' capital requirements.

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Introduction

" The financial and sovereign debt crisis have underpinned the importance of breaking the disastrous sovereign-banking nexus [...] Rises in sovereign risk are transmitted into reduced bank lending. Banks that were highly exposed to strained European sovereign debt have reduced their lending to the private sector. "
- Jens Weidmann, Bundesbank Governor, Financial Times 30th Sept. 2013

This paper examines the effect of the sovereign debt crisis on the European credit crunch through its effect on banks' balance sheets. Banks' holdings of risky sovereign debt are substantial: Figure 1 shows that, at the beginning of 2010, the 90 European banks that participated in the European Banking Authority (EBA) Stress Test had a total exposure of €750 bn. to the sovereign debt of the periphery, the so–called GIIPS countries (Greece, Ireland, Italy, Portugal and Spain). These exposures are, on average, 7% of total banking assets of GIIPS banks [1] and 2–3% of the assets of banks in the core countries (France and Germany) [2], as Figure 2 shows. In 2010–2012, rising yields in the sovereign bond markets for these countries caused a devaluation of the stock of sovereign bonds held in banks' balance sheets. At the same time, the growth rate of bank credit to European customers rapidly declined. Figure 3 plots the evolution of bank loans to domestic non–financial firms aggregated by country. The slowdown following the the 2007–2009 global recession is common to all countries, but the heterogeneity in growth rates of credit since 2010 is clear. Most GIIPS countries have lower growth rates than in the core, especially

[1] Most of GIIPS debt held by GIIPS banks is *domestic*. European banks, especially in the GIIPS but also in Germany, have a large *home bias*, as documented, among others, in Acharya and Steffen (2013), Battistini, Pagano and Simonelli (2013) and De Marco and Macchiavelli (2014).

[2] It should be noted, however, that French and German banks are very large compared to the size of their own economy. The top 5 French banks, for example, have total assets that are more than twice the size of the French economy. GIIPS exposures of French and German represent roughly 5% of their respective countries' GDP.

in the final part of the sample [3]. Moreover, the average interest rate spreads for corporate borrowers in the periphery has been significantly higher than in the core since 2009–2010 (Figure 4). The fact that loan volumes decreased while loan prices (interest rates) increased suggest that, at least at an aggregate level, the sovereign debt crisis had a negative effect on the supply of credit. In this work, I will argue that losses in banks' sovereign portfolios have caused the credit crunch, *i.e.* the sovereign debt crisis was a negative shock to the supply of credit.

My results suggest that European banks that were more exposed to the sovereign shock significantly reduced credit supply during the crisis. In particular, a 1% increase in losses-over-total assets ratio decreases the growth rate of domestic loans around 4%. The result is not driven by country specific credit demand, even accounting for different categories of borrowers between large and small banks, or by the own domestic sovereign exposure for GIIPS banks that experienced very large shocks to their balance sheets. In this respect, I acknowledge that sovereign exposures are endogenous and I can instrument the domestic sovereign exposure with the *political ownership* in each bank. In De Marco and Macchiavelli (2014) we find that banks' home bias in sovereign bonds can in part be explained by the amount of shares owned by the respective government in each bank. We believe that political ownership is fairly exogenous, as it is determined by historical and political factors rather than banks' unobserved quality [4]. Moreover, to provide further evidence for a credit supply shock, I show that the European cross–border groups cut foreign loans, i.e. loans issued by their international subsidiaries, by the same amount as domestic loans. I find evidence that credit supply tightening also occurred through loan prices: loan interest rate spreads on syndicated loans are 40 to 65 basis points (bps.) higher for a one standard deviation increase in the sovereign shock (20 bps.

[3] Unexpectedly, this is not true for Italy, at least until the end of 2011. German credit growth actually fell behind Italy's in 2010–2011, underlying the difficulties of the banking sectors in the core too.

[4] "Political" institutions are not worse than other banks, at least in terms of observable bank's perfomance. In particular, they do not have more non–performing loans or lower profits–over–assets. See Table 14 for details.

shock), even after controlling for sector specific credit demand and borrower characteristics.

Why do sovereign losses matter for credit? There are two main channels: the *capital channel* and the *funding channel*. According to the first, banks with large sovereign losses may fall below the minimum regulatory capital ratio. Given that equity is a relatively costly source of finance and banks may be reluctant to issue new shares at a time of low stock prices, banks would find optimal to cut off loans. The funding channel indicates instead that sovereign losses mean that the bank cannot refinance on the interbank market, where government bonds are the preferred source of collateral for repos [5] . I find some preliminary evidence that the second channel is more important than the first. In fact, I show that banks relying heavily on short term funding cut lending by more the higher the sovereign losses, whereas banks with low Tier1 capital or low leverage ratio [6] were not more significantly affected than other banks. I interpret the absence of a capital channel in terms of *forbearance* by the EBA in enforcing capital requirements in a time of crisis (capital requirements were effectively not binding). The funding channel is instead the result of *market discipline*, where banks with below average collateral are either shut out of the market or face higher repo rates or haircuts. In this respect, I find that the ECB 3 year LTRO intervention in 2012 alleviated the effect of the sovereign shock for all banks, but it had no differential impact for banks dependent on short term funding.

The dataset is the result of a merger of different data sources. I construct the bank specific shock, *i.e.* potential losses on sovereign debt holdings, using data on exposure to sovereign debt for the European banks participating in the European

[5] The findings are also consistent with a broader view of the funding channel: banks with higher exposure to risky sovereign debt are perceived as more risky by all types of lenders, not only other banks.

[6] Tier1 capital is defined as Equity over Risk–Weighted Assets (RWA), calculated under Basel II rules. Note that government equity injections count as equity for the determination of Tier1 capital. The leverage ratio is actual leverage, calculated as Common Equity over Total Assets, as under Basel III rules.

Banking Authority (EBA) Stress Tests and Recapitalization Exercises. The granularity of the EBA data, containing individual bank–level exposure to each European country and its maturity structure, allows me to exactly calculate the capital loss (profit) caused by the deterioration (appreciation) of existing bond holdings on each bank's balance sheet during the sovereign crisis. I then match the EBA exposure data with balance sheet information and explore the significance of the bank–specific sovereign shock in explaining loan growth, controlling for aggregate credit demand conditions at the country level with a set of country–time fixed effects. The key identifying assumption is that there are no systematic differences in unobserved borrowers' characteristics between the most exposed banks and the least exposed ones once time–varying, country–level unobservables are accounted for [7]. Note that I can somewhat relax this assumption in the analysis of loan interest rate spreads. Syndicated loans from LPC DealScan, in fact, contain the identity, industry and location of corporations borrowing in the syndicated loan market. This allows me to control for credit demand by introducing country–industry–quarter fixed–effects, so that I am comparing loans made to borrowers in the same country, industry and quarter by banks with different sovereign exposures. Moreover, for those borrowers that can be linked to Compustat, I introduce firm–level controls to further control for credit demand.

This paper contributes to a recent, but active area of research, both theoretical and empirical, that studies the relationship between sovereign and banking crises. Whereas most applied papers look at cross–financial linkages between the two (Acharya and Steffen (2013) on bank stock returns and sovereign bonds, De Bruyckere et al. (2012) on sovereign contagion, Kallestrup et al. (2012) on bank and sovereign CDS) or at the relationship between sovereign risk and bank bailouts (Acharya et al. (2011), Greenwood et al. (2012)), very few have focused on the real effects of the sovereign debt crisis. To my knowledge only Bofondi et al. (2013)

[7] This point is made more rigorously in a simple model of bank lending in Section 3.

and Popov and Van Horen (2013) look at the real effects of the sovereign debt crisis on credit supply. The main contributions of this paper compared to the latter are the following. First, I investigate the effect on both credit quantity and prices. As far as I am aware, this is the first paper that examines both these outcomes for European banks during the sovereign debt crisis. Second, I attempt to shed light on the mechanisms as to why sovereign losses matter for bank credit. I claim that risky sovereign bonds exposure matter because they increase bank cost of funding, rather than by decreasing equity.

The rest of the paper is organized as follows. Section 1 contains a brief review on the empirical literature on credit supply shocks and the sovereign debt crisis. Section 2 describes the data and the construction of the bank specific sovereign loss, while Section 3 outlines a simple model of bank lending that illustrates the main assumptions for the empirical methodology used in Section 4. Section 5 presents the regression results and Section 6 discusses the possible channels at work. Finally Section 7 concludes.

1 Literature Review

The academic literature on credit supply shocks faces significant empirical challenges for the identification of a causal effect. In fact, data on loans from banks' balance sheets are the outcome of credit supply and demand and thus it is hard to disentangle between the sources of the shock. Traditionally, the literature has either exploited clever identification schemes (Kashyap et al. (1993), Kashyap and Stein (2000)) or examined specific institutional/quasi–experimental settings that allowed a clear separation from the two (Jayaratne and Strahan (1996) on the finance–growth nexus, Peek and Rosengren (1997, 2000) on the international transmission of bank shocks, Rocholl et al. (2011) on retail credit in Germany during the financial crisis, Ramcharan et al. (2012) on US consumer credit) or, finally, having access to detailed firm–bank relationship data, included firm–period fixed effects to fully control for credit demand (Khwaja and Mian (2008) seminal work, Jimenez et al. (2011) and Jimenez et al. (2012) for Spain, Bofondi et al. (2013) for Italy).

Bofondi et al. (2013) provide evidence that foreign banks operating in Italy, mainly German and French groups, tightened credit volumes less and charged lower interest rate than Italian banks during the sovereign debt crisis. However, they do not find any differential impact for banks that are more exposed to GIIPS debt. I emphasize instead that banks with higher sovereign exposure and thus higher losses, were both cutting lending volumes by more and charging higher interest rates.

Popov and Van Horen (2013), on the other hand, is more closely related to my work. They show that non-GIIPS European banks with higher exposure to GIIPS debt decreased the volume of syndicated loans at the country–borrower level by more than less exposed banks. In a robustness check, I also confirm their result on syndicated loans volume using my measure of the sovereign shock. Compared to their work, I analyze loan data from banks' balance sheets, that includes loans to small and medium enterprises and households. I also investigate a "price channel" of the sovereign debt crisis through which higher sovereign losses translate into higher syndicated loan interest rates.

2 Data

The final dataset is the result of the merger of different data sources.

The master dataset consists of the EBA sovereign exposure data collected during the "EU–wide Stress Test" and "Recapitalization Exercises". Specifically, the EBA, in an effort to enhance transparency and restore confidence in the financial system, decided to disclose on its website bank–by–bank result for both the 2010 and 2011 Stress Test Results[8] and the so–called 2011 and 2012 Recapitalization Exercises.

[8] Data for the 2010 Stress Test, with data as of March 2010, were published on the former banking

These exercises contain information on the capital composition (including government's support measures), credit risk exposure and, most importantly, sovereign debt exposure to each of the 30 members of the European Economic Area (EEA 30) at different maturities for all the participating banks. The 2010 and 2011 Stress Tests sample consists of 90 European banks, covering more than 60% of banking assets in Europe and at least 50% in each Member State. In the 2011-2012 Recapitalization Exercises, the sample is restricted to around 60 banks, because smaller, non–cross border institutions were excluded [9]. In conclusion, the EBA exposure data offer an unbalanced, bank–level panel of sovereign exposure data, at irregular frequency (2010Q1, 2010Q4, 2011Q3, 2011Q4 and 2012Q2). For all the dates except in 2010Q1, a detailed breakdown by residual maturity, from 3 months to 15 years, is also provided [10].

A possible concern with this type of supervisory data is that banks may have been "window dressing" their balance sheets around the stress tests' reporting dates. There is some evidence (Acharya and Steffen (2013), Acharya, Engle and Pierret (2013)) that some banks effectively "gamed" the second stress test by reducing their GIIPS exposure right before the reporting date and increasing it following the disclosure of the results. However, even if this behavior has indeed been common practice among banks, it means that the EBA data understate the true amount of sovereign debt on banks' balance sheets, so that any negative effect of the sovereign shock on bank loans would be underestimated.

Banks' exposures are then matched with balance sheet information either from Bankscope or hand–collected (and cross–checked) from banks' annual reports. Since balance sheet data have a yearly frequency, I end up eliminating the mid–year

authority website, CEBS. A link to the sovereign exposure for this date can be found at the Peterson Institute for International Economics http://www.piie.com/blogs/realtime/?p=1711

[9] Most of the excluded banks are from Greece or Spain. The six Greek banks, present in the Stress Tests, were under restructuring and IMF monitoring by the time of Recapitalization Exercises. Most of the regional savings bank in Spain were excluded too.

[10] I will extrapolate the maturity structure for 2010Q1 exposure from the 2010Q4 data, by using the same proportions.

EBA exposures on 2011Q3 and 2012Q2. On the other hand, I impute the 2010Q1 sovereign exposure to the beginning of the year and I match it with the end–of–year 2009 balance sheet data. The EBA sovereign exposure data are provided at the group level for the reporting banks; thus, the matching with the balance sheet data has to be done carefully. Balance sheet controls in the regressions are kept at the same "highest" level of consolidation, but the outcome variables, either domestic or foreign loans, need to be adjusted depending on the size of the bank. For smaller, local banks, domestic loans come from the unconsolidated statements, whenever possible, or the consolidated group statement otherwise. For the larger, global bank groups, domestic loans either consist of the unconsolidated figures of the parent bank or, when no unconsolidated statements were available, they are computed as the consolidated total minus the loans of the foreign subsidiaries belonging to the group. For the cross–border groups only, I am able to construct a series for foreign loans using the unconsolidated loans of the international subsidiaries. In this case, I end up with 36 cross–border banks out of the original 90 banks of the EBA sample, yielding a total of 140 subsidiaries (see Appendix for a list of banks).

I also merge the EBA sample with LPC DealScan that contains loan–level information on interest rate spreads. The largest EBA banks are especially active in the syndicated loan market, with at least one of the top 10 European banks being present in more than 75% of the syndicated loans granted by the EBA sample banks over 2009-2012. Interest rate spreads are available at the tranche (facility) level, so that the relevant panel–id variable is the bank–facility pair at a quarterly frequency. Moreover, I could match some of the borrowing firms in DealScan to accounting data available from Compustat using the link file provided by Chava and Roberts (2008). I exclude corporate borrowers in the financial, insurance and real estate sectors [11] Table 1 below provides some summary statistics for these two dataset mergers. Syndicated loans are large, with a mean (median) of 430$

[11] SIC codes between 6000 and 6999

mil. (150), have an average maturity of 5 years, average all-in drawn spread over the reference rate (LIBOR or EURIBOR) of 300 basis–points and attract an average (median) of 4.2 (3) participant banks, including 3 (2) Lead Arrangers. The DealScan-Compustat sample is broadly consistent with the DealScan-EBA sample and, although loans are on average twice as large, the spreads, maturity and number of banks are similar. Borrowing firms are also very large, with average (median) assets of 25.9$ bil. (8), average profit margin (EBITDA/Sales) of 0.22 and average leverage ratio of 0.36.

Table 1: DealScan Summary Statistics

	DealScan-EBA Sample					
	N	Mean	Std.dev.	10^{th}	50^{th}	90^{th}
Loan characteristics						
Loan Amount ($M)	11,795	430	960	18	150	1,140
All–in drawn spread (bps.)	7,041	301.2	162.4	115	275	500
Maturity (months)	11,331	65.14	50.32	18	60	102
Number of participants	11,810	4.2	4.3	1	3	9
Number of arrangers	11,810	3	3	1	2	7
	DealScan-Compustat Sample					
	N	Mean	Std.dev.	10^{th}	50^{th}	90^{th}
Loan characteristics						
Loan Amount ($M)	1,386	984	1,440	100	513	2,120
All–in drawn spread (bps.)	1,208	248.8	133.7	100	225	425
Maturity (months)	1,360	55.84	23.6	30	60	78
Number of participants	1,386	4	4.5	1	2	13
Number of arrangers	1,386	2.6	3	1	1	6
Borrower characteristics						
Tot.Ass.($B)	833	25.9	51.9	0.96	8	56
EBITDA/Sales	792	0.22	0.72	0.05	0.2	0.49
Leverage	805	0.36	0.24	0.13	0.35	0.63
Investment/Assets	667	0.015	0.017	0.003	0.01	0.029

Finally, bond yields are taken from Bloomberg. For the construction of the sovereign shock, I keep only maturities longer than or equal to 2 years because shorter maturities, 3–months (3M) and 1–year (1Y), contain a lot of noise, have missing values and do not matter as much for the computation of sovereign losses (short duration). Also, due to data availability, I can match bond yields to the sovereign exposures of 17 countries only out of the original EEA 30: Austria (AT), Belgium (BE), Germany (DE), Denmark (DK), Spain (ES), Finland (FI), France (FR), Greece (GR), Hungary (HU), Ireland (IE), Italy (IT), Netherlands (NL), Norway (NO), Poland (PO), Portugal (PT), Sweden (SE) and the United Kingdom (UK).

In conclusion, the final dataset contains a bank–level panel with around 90 European banks in 20 countries, matched with both balance sheet variables over 4 years (2009-2012), individual bank–by–bank sovereign exposure to 17 countries, at five different maturities (2Y, 3Y, 5Y, 10Y, 15Y) and syndicated interest rate spreads made by 74 EBA banks over the 2010–2012 period.

2.1 The Bank–specific Sovereign Shock

The advantage of the EBA data is that it provides a detailed picture of bank exposure to central governments of all 30 countries of the EEA with a breakdown by maturity, from 3M to 15Y. The coupon rate for the bonds in the sovereign portfolio is not known. Thus, in order to calculate the losses I have to make some assumptions on the duration of these bonds. The maturity detail is also important for the calculation of losses. For example, suppose that a bank is exposed to GIIPS debt with a residual maturity of 3M only at the beginning of 2010. This bank can hold the debt to maturity and, unless a sovereign default happens before the principal is paid back, it will not have to report losses on its balance sheet.

I construct a bank–specific sovereign shock for bank b at time t, $SovShock_{b,t}$ as:

$$SovShock_{b,t} = \sum_{s=1}^{S} \sum_{m=2Y}^{15Y} Duration_{s,m,t} * \Delta yield_{s,m,t} * \frac{Exposure_{b,s,m,t-1}}{Total\ Assets_{b,t-1}} \quad (1)$$

where s is the sovereign country whom bank b is exposed to; m is the residual debt maturity, in years, and t is the end of year t, from 2010 to 2012. Essentially, this shock represents the *potential* capital loss (gain) incurred by bank b during year t

because of the depreciation (appreciation) of sovereign bonds. In other words, it is the marked–to–market value of the total exposure to sovereign bonds on banks' balance sheets. Although banks do not necessarily need to mark–to–market these exposures, especially if they are held in the Hold–to–Maturity (HTM) banking book, this measure is meant to capture expected losses on sovereign bonds and identify the banks most vulnerable to the sovereign shock. In any case, in September 2011 the EBA basically required banks to mark–to–market their sovereign exposures in order to build up an exceptional capital buffer [12], thus the mark–to–market assumption is not very far from reality. $SovShock_{b,t}$ is composed of several terms that I define below. Notice that, as described in the data section, I eliminate maturities shorter than 2Y and keep the exposures to 17 countries ($S = 17$). Also, since the March 2010 exposure data are disaggregated by country of exposure but not by maturity, I have assumed that the maturity structure of the sovereign portfolio has remained constant over the year and I have imputed the December 2010 maturity proportions to the March 2010 figures.

$Duration_{s,m,t}$ is the *modified duration* and it measures the percentage change in the price of a bond (P) for a unit change in the yield–to–maturity ($yield$). If the duration is, say, 4.5% then the price falls by 4.5% for any 1% increase in the yield. Sovereign bonds are coupon bonds and to compute the exact duration one would need to know the actual coupon value. However, since this information is not available in the EBA data, I have to assume that sovereigns are either *zero–coupon* bonds or *par* bonds (where the coupon equals the yield). Since the duration is a decreasing function of the coupon, using the par bond assumption will underestimate banks' losses, whereas the zero–coupon bond will overestimate them. Therefore, my preferred measure to calculate the duration is the par bond, but the results are not qualitatively affected by this assumption. According to the par bond assumption,

[12] Sovereign exposures in the Available–For–Sale (AFS) book are measured at fair–value and exposures in the HTM are valued "in a conservative fashion, reflecting market prices as of 30 September 2011" (EBA, Methodology for Recap Exercise 2011)

the duration is:

$$Duration_{s,m,t} = \frac{1}{yield_{s,m,t}}\left(1 - \frac{1}{(1 + yield_{s,m,t})^{2m}}\right)$$

where, given the assumption of semi–annual payments, $yield_{s,m,t}$ is the semi–annual yield and thus the maturity (in years) is multiplied by 2. For the zero–coupon bond, the duration becomes:

$$Duration_{s,m,t} = \frac{2m}{1 + yield_{s,m,t}}$$

It is important to keep in mind that both measures will contain a measurement error because in reality a sovereign bond is "in between" a zero–coupon and a par bond, with the latter being a closer approximation. Thus, in either case and as long as the measurement error is white noise, the OLS estimate will be biased towards zero as in the case of classical measurement error (Greene(2012)). An average of the par and zero coupon bond should contain less measurement error: I do find that this is the case in a robustness test (Table 5).

The second term in (1), $\Delta yield_{s,m,t}$, is simply the change in the average (semi–annual) yield for the month of December (or in the last quarter) for the sovereign debt of country s at maturity m. Thus the first part of the expression, $Duration_{s,m,t} * \Delta yield_{s,m,t}$, represents the total price change over the period observed, in this case from December of year $t-1$ to year t. This is the aggregate sovereign shock which is identical for all banks. Once this is interacted with bank b exposure to each sovereign c and maturity m at the beginning of the period, $Exposure_{b,s,m,t-1}$, and it is normalized by total assets, $Total\ Assets_{b,t-1}$, the loss (or gain) for bank j on that specific bond is obtained.

Finally, by summing over each country of exposure s and each maturity m, $SovShock_{b,t}$ calculates the losses (gains) from the devaluation (revaluation) of all sovereign bonds as a percentage of total assets. Table 2 reports the empirical distribution of the shock in the data using both the par bond and zero–coupon assumption to compute the duration. Not only the mean and standard deviation differ substantially, but the entire distribution using the zero–coupon assumption, especially in the upper tail, is wider. This is consistent with the fact that the zero–coupon bond overestimates the losses. In both cases, banks at the bottom of the distribution actually recorded some small gains on their holdings of sovereign debt, around 0.5% of total assets[13]. In fact, some Northern European countries, to which German, Danish, Dutch and Swedish banks have considerable exposures, actually experienced a decrease in bond yields during the sovereign debt crisis (flight–to–quality).

Table 2: Distribution of $SovShock_{b,t}$

Percentile	Loss (if positive)/ Gain (if negative)	
	Par bond	*Zero–coupon*
10^{th}	-0.563%	-0.681%
25^{th}	-0.16%	-0.167%
50^{th}	0.018 %	0.039%
75^{th}	0.350%	0.51%
90^{th}	0.964%	1.449%
95^{th}	2.75%	5.28%
Mean	0.375%	0.848%
std.dev.	1.89%	4.247%
Obs.	240	240

Banks in the 75^{th} and 90^{th} percentile had, respectively, losses accounting for 0.35% (0.51%) and 0.96% (1.45%) of total assets using the par (zero coupon) bond. These numbers are high: considering that the median capital–over–total asset ratio of around 5% over 2009-2011, losses in the top decile have the potential to wipe out almost a quarter (or third) of the book value of equity. Banks facing these heavy

[13] $SovShock_{j,t}$ is positive if there are losses and negative if there are gains. This is because *duration* is defined as $-dP/dyield$

losses are mostly headquartered in the GIIPS countries, but in the top quartile we also also find some banks domiciled in Belgium (Dexia), Germany (Commerzbank and Hypo Real Estate) and Luxembourg (BCEE).

3 A Simple Model of Bank Lending

This section describes a simple model of bank lending. The purpose of the model is to help understanding the identification assumptions underlying the empirical strategy. In particular, it spells out the assumptions on loan demand under which, as a result of sovereign losses, a credit supply shock can be identified using banks' balance sheet data. The baseline model is a modified version of Stein (1998)'s paper on banking with adverse selection and it is similar to Ehrmann et al. (2003).

Bank b needs to satisfy the following balance sheet constraint at time t: $L_{b,t} + S_{b,t} = E_{b,t} + B_{b,t} + D_t$. On the asset side, $L_{b,t}$ is loans and $S_{b,t}$ represents (risky) sovereign bonds. For simplicity, banks hold no other security. These assets are funded through equity, $E_{b,t}$, short–term, interbank funding $B_{b,t}$ and customer deposits D_t. Deposits are exogenous. They pay zero interest and are demanded by households as a mean of payment. Their demand is given by $D_t = c - \delta r_t^f$ with $c, \delta > 0$ and r_t^f the risk free rate. Bank capital, under the Basel II regulation, is determined as a fraction of risky assets (loans): $E_{b,t} = \kappa L_{b,t}$ with $\kappa < 1$. Thus the balance sheet can be conveniently rewritten as:

$$B_{b,t} = (1 - \kappa)L_{b,t} + S_{b,t} + c - \delta r_t^f \tag{2}$$

The interbank funding rate is:

$$r_{b,t}^B = r_t^f + \mu_1 \mathbb{X}(S_{b,t-1}) + \mu_2 f(X_{b,t-1}) \quad \text{with} \quad \partial x/\partial S > 0, \mu_1 > 0, \mu_2 >> 0 \tag{3}$$

where $\mathbb{X}$ is an increasing function of the level of *lagged* sovereign exposure and f is a function of other *predetermined* bank characteristics ($X_{b,t-1}$ is a $k \times 1$ vector). μ_1 is a positive constant and μ_2 is a $k \times 1$ vector of positive constants. Thus, if the bank is more heavily exposed to risky sovereign debt $S_{b,t}$, it will face a higher cost of funding for short–term sources of funds. The partial derivatives of the function $f(\cdot)$ with respect to the components of the vector $X_{b,t-1}$ are negative if the element of the vector is a "good" bank characteristic, positive otherwise [14]. These characteristics are not explicitly modeled here. One should think about these as endogenous, but predetermined variables that determined the bank's cost of funding. Likewise, sovereign bonds are an endogenous choice variable, but they are predetermined in determining the bank funding rate for short term funds. I acknowledge this fact in the empirical strategy by estimating the model through the dynamic panel GMM estimator (Arellano and Bond (1991)). Additionally, I can address the endogeneity of sovereign exposure via instrumental variable techniques. I use the percentage of political ownership in each bank as an instrument for its domestic sovereign exposure. Section 4 explains the IV strategy thoroughly.

Thus, in the model, the sovereign shock matters for banks because it increases the cost of funding, but it does not directly affect equity. Any negative equity shock is ruled out because the amount equity is simply tied to the level of risky assets (loans) through the Tier 1 capital ratio. The data seem to support this assumption, as there is evidence that banks with higher dependence on short term funding, and not undercapitalized banks, were more negatively affected by the sovereign shock. Section 7 analyzes this aspect in greater detail.

Banks are monopolistically competitive in the loan market and they all face a downward sloping loan demand when they lend in country c:

$$L^D_{b,c,t} = -\alpha_0 r^L_{b,t} + \alpha_{1,c,t}\lambda_{c,t} \quad \text{with} \quad \alpha_0, \alpha_{1,c,t} > 0 \tag{4}$$

[14] In the empirical part, the "good" characteristics are going to be capitalization, profitability and liquidity while the "bad" one is the average quality of the loan portfolio

where $\lambda_{c,t}$ is an aggregate demand shifter in country c at time t and $r^L_{b,t}$ is the loan interest rate charged to borrowers, α_0 is the loan interest rate elasticity and $\alpha_{1,c,t}$ is the impact of the country demand shifter which is allowed to vary over country and time. Notice that c is not necessarily the country where the bank is headquartered, as banks can lend internationally through their subsidiaries. However, in the empirical section, I assume that no bank directly lends to more than one country: the international subsidiaries are part of the group, but are independently managed.

There are several assumptions behind this loan demand schedule. First of all, since it contains only the loan rate, it implicitly assumes that substitution with other forms of finance is impossible. This may be extreme, but it is nonetheless a good approximation for many corporate borrowers in Europe for which bank funding is the predominant form of credit. Bank debt over total external financing for non financial firms is, on average, well above 80% in most European countries (see Altomonte et al. (2011)). Second, it assumes that loan demand is homogeneous across banks *within the same country.* In fact, the demand shifter is at the country–aggregate level and it is not back specific. Its impact ($\alpha_{1,c,t}$) is the same for all banks within a country. Also, notice that the interest rate elasticity (α_0) is the same for all banks. This rules out, for instance, that borrowers of large and small banks have different interest rate sensitivities. I can somewhat relax this set of assumptions in the empirical exercise. For example, I allow the elasticity $\alpha_{1,c,t}$ and α_0 to vary between large and small banks. When analyzing loan interest rates, the demand shifter is not only country specific, but country *and* sector specific.

Banks maximize the future discounted value of dividends (see Appendix for detail) by choosing sequences of loans $L_{b,t}$ and sovereign $S_{b,t}$:

$$\max_{S_{b,t},L_{b,t}} \mathbb{E}_t \sum_{i=0}^{\infty} \beta^i (r^L_{b,t-1+i} L_{b,t-1+i} + r^S_{t-1+i} S_{b,t-1+i} - r^B_{b,t-1+i} B_{b,t-1+i} - \kappa L_{b,t+i} - \phi(L_{b,t+i}))$$

s.to (3) and (4). Note that B_t is determined residually from (2) once $L_{b,t}$ and $S_{b,t}$

are chosen. r^S is the rate of return on risky sovereign (exogenous to the bank) and $\phi(L_{b,t})$ represent costs associated to banking activities, such as evaluation of credit rating of the customer, administering and monitoring the loan. I assume a quadratic cost of servicing the loans plus a bank–specific component: $\phi(L_{b,t}) = b_0/2L_{b,t}^2 + \eta_b L_{b,t}$.

Imposing loan market clearing and substituting in (2) and (3), the FOC for loans and sovereigns are:

$$
\begin{aligned}
(L): \quad & L_{b,t} = \frac{1}{2\beta + b_0\alpha_0}(-(1-\kappa)\alpha_0\mu_1\mathbb{X}(S_{b,t-1}) - (1-\kappa)\alpha_0\mu_2' f(X_{b,t-1}) + \alpha_{1,c,t}\lambda_{c,t} \\
& \qquad - (1-\kappa)\beta\alpha_0 r_t^f - \alpha_0(\eta_b - \kappa)) \\
(S): \quad & r_t^s - \frac{\partial x}{\partial S_{b,t}}((1-\kappa)L_{b,t} + S_{b,t})) - (r_t^f + \mu_1\mathbb{X}(S_{b,t}) + \mu_2' f(X_{b,t})) = 0
\end{aligned}
$$

The main empirical specification is a modified version of the first FOC [15]. The level of sovereign exposure and other balance sheet characteristics are endogenous but *predetermined* variables. I will take this into account in the estimation by using the GMM Difference estimator. This dynamic panel data estimator employs a set of lagged internal instruments for endogenous, predetermined variables.

The coefficient in front of the sovereign shock in the first FOC is negative: it implies that as losses on sovereign bonds increase, equilibrium loan quantity decreases. The interest rate elasticity, α_0, which is assumed to be homogenous for all banks, enters into the coefficient of the sovereign shock. In the empirical strategy, I will somewhat relax the homogeneity assumption by interacting the shock with bank characteristics, such as size category (large vs. small) Aggregate factors $\lambda_{c,t}$ and r_t^f have natural proxies in country–time fixed–effects and η_b is a bank fixed–effect.

Note that, by substituting the solution for loan quantity into the loan demand schedule (4), a similar equilibrium condition for the loan interest rate ($r_{b,t}^L$) can

[15] The only difference is that the regression will have $\Delta L_{b,t}$ rather than $L_{b,t}$ as dependent variable.

be found. In this case, the sign of the coefficient in front of the sovereign shock ($\mathbb{X}(S_{b,t-1})$) is positive: an increase cost of funding for banks translate into an increase cost of capital for firms. This motivates the regression of the interest rate spread on syndicated loans.

To summarize, in this section I showed that, in a simple model of bank lending, tensions on the sovereign bond market, by increasing banks' cost of funding, decrease the loan quantity of equilibrium. According to this model, in order to identify a credit supply channel of banks' exposure to sovereign debt, loan demand needs to be homogenous across banks within the same country and time. Specifically, the demand shifter is at the country–time level or country–sector level in the empirical specification with loan interest rates. The loan interest rate elasticity is assumed to be the same for all banks or, at best, the same by size category (large vs. small).

4 The Empirical Methodology

The baseline empirical specification is a slightly modified version of the FOC for loans. I end up estimating:

$$\Delta Loans_{b,c,t} = \beta_1 SovShock_{b,t} + \eta_b + \lambda_{c,t} + \gamma' X_{b,t-1} + \epsilon_{b,c,t} \tag{5}$$

with either OLS (with bank fixed-effects) or Difference GMM. $\Delta Loans_{b,c,t}$ is the annual growth rate of loans granted by bank b in country c (either domestic or foreign) at the end of year t; η_b is the bank fixed-effect; $\lambda_{c,t}$ is the country–year fixed–effect that accounts for country-specific credit demand; $X_{b,t-1}$ is a vector of bank balance sheet characteristics at the beginning of the period (Tier1Ratio, Pre–Tax Profits, Customer Deposits, Non–Performing Loans and Cash, all normalized by total assets [16]). The main coefficient of interest in (5) is β_1: I expect $\beta_1 < 0$, so

[16] Among these covariates, the Non–Performing Loans ratio controls for the average quality of the loan portfolio within each bank. This is important because we may worry that sovereign exposures towards

that losses from the holdings of sovereign debt, all else equal, should have a negative impact on credit growth.

When I look at the effect of the sovereign shock on *domestic* loans, the identification is particularly strong for banks headquartered in countries whose bond markets were not under pressure (non–GIIPS countries), but that nonetheless had high exposure to risky sovereign debt. In fact, the sovereign shock for these banks is plausibly exogenous with respect to domestic credit demand condition. For example, Greek sovereign problems should not affect aggregate demand conditions for German firms [17], but it would affect credit supply in Germany if its banks are highly exposed to Greek debt. On the other hand, in GIIPS countries aggregate demand conditions are probably negatively correlated with the rise in bond yields and one may worry that controlling for the country–period fixed-effects is not enough to take care of the endogeneity bias caused by the home–country exposure of GIIPS banks. I address these concerns on home–country and other endogeneity biases in several ways.

First I look at the effect of the sovereign shock on *foreign* (worldwide) loans of the largest, cross-border institutions, i.e. loans granted by the international subsidiaries of the largest banking groups. If, following a negative shock to the balance sheet of the mother bank, we observe that lending is reduced also abroad ($\beta_1 < 0$), then it must be a because of a credit supply shock.

Second, I can instrument the sovereign shock using the level of *government ownership* in each bank. In De Marco and Macchiavelli (2014), we show that the large degree of home bias can in part be explained by the degree of political connections of each bank with its domestic government, as measured by the the percentage of bank shares owned by the local or national government. We also show that these

GIIPS countries are correlated with the average loan quality held in banks' balance sheets, as exemplified by the Cypriot banks case (A&S (2013)).

[17] Germany's export to Greece are marginal, on average around 1% of total German exports over the last 10 years

political pressures are stronger during the crisis because, among the banks that receive government equity injections, only the "political" ones increase home bias. I can use this instrument to predict the domestic exposure in the construction of the sovereign shock. In particular, recalling that the sovereign shock is constructed as:

$$SovShock_{b,t} = \sum_{s=1}^{S} \sum_{m=2Y}^{15Y} Duration_{s,m,t} * \Delta yield_{s,m,t} * \frac{Exposure_{b,s,m,t-1}}{Total\ Assets_{b,t-1}}$$

I instrument only the sovereign exposure part, $Exposure_{b,s,m,t-1}/Assets_{b,t-1}$, when bank b is exposed to its *domestic* sovereign [18], while I let the yield follow its actual path. The implicit assumption in doing this is that the aggregate shock ($Duration_{s,m,t} * \Delta yield_{s,m,t}$) is exogenous with respect to banks' conditions, so that it does not need to be instrumented. Since political ownership is not time varying and it is measured at the *pre–crisis* level, I run three cross–sectional 1^{st} stage regressions for 2009, 2010, 2011:

$$(DomExp/TotSovExp)_b = \gamma_0 + \gamma_1 Political_b + \epsilon_b$$

where $(DomExp/TotSovExp)_b$ is the ratio of domestic sovereign bonds, at all maturities, over total sovereign bond holdings of bank b (home bias). I will then multiply the fitted values of this regression by $(TotSovExp/TotAssets)_b$ so to obtain the ratio of domestic exposure to total assets as in $SovShock_{b,t}$. Given that I have stacked together all maturities in $(DomExp/TotSovExp)_b$, I will use the 5 year bond yields for the predicted domestic exposure.

The instrument itself may be endogenous, *i.e.* correlated with the unobserved component in credit conditions, if we think that "political" banks are poorly managed and have low profitability. However, it does not appear that this is the case,

[18] Foreign exposures cannot be instrumented with domestic political ownership and I either treat them as exogenous or leave them out of the sovereign shock entirely. The results are not affected by either choice.

at least for observable bank characteristics: "political" banks do not have a higher share of non–performing loans or lower profits than non–political banks (see Table 14 in the Appendix). I believe that the political instrument is fairly exogenous, because it measures the historical, pre–determined presence of the government in many banks in Europe.

Third, I can eliminate the own–country exposure in the construction of the shock: doing this basically wipes out the shock for GIIPS banks that are almost exclusively exposed to their own country's debt. This specification is therefore meant to capture the effect of *foreign* exposure on *domestic* loans for non–GIIPS banks. If $\beta_1 < 0$, this means that, on average, the international transmission of the sovereign shock is present and it matters for credit supply. In a similar vein, I can also split the sample among GIIPS and non–GIIPS banks or between Core (France and Germany) and non–Core. The results lose some significance because the number of banks is not very large to start with, but they are qualitatively similar.

Finally, and most importantly, when I look at loan interest rate spreads, I can relax the assumption that there are no systematic difference in borrowers' unobservables once country–wide credit demand factors ($\lambda_{c,t}$) are taken into account. In fact, syndicated loan data from LPC Dealscan reveal the identity, location and industry of the corporate borrowers participating in this market. Therefore, I can introduce country–industry–quarter fixed–effects, so that I am comparing loans made to borrowers in the same country, industry and quarter by banks with different sovereign exposures. Specifically, in equation (6) I have:

$$Spread_{b,f,t} = \beta_1 SovShock_{b,t} + \eta_b + \lambda_{c,i,t} + \phi' F_{f,t} + \gamma' X_{b,t-1} + \epsilon_{b,f,t} \tag{6}$$

where $Spread_{b,f,t}$ is the all-in drawn spread over the Libor or Euribor of the loan extended by bank b (Lead Arranger) to firm f at quarter t [19]. $\lambda_{c,i,t}$ is a country×industry×quarter

[19] I use the all-in drawn spread because, according to DealScan, it also takes into account one–time and recurring fees associated to the loan, so it is a better measure of the overall cost of the loan. Since it is

fixed–effect where borrower f is located. The fixed–effect identification scheme is very solid here because I am comparing firms in the same industry (2 digit NAICS), in the same country at the same quarter. Moreover, for those firms that can be matched to Compustat, I can control for a set of the borrower's balance sheet variables, $F_{f,t}$. Thus in this case I am not only comparing firms within the same sector, country and quarter, but also those with similar observable characteristics [20]. Finally $SovShock_{b,t}$ is constructed at a quarterly frequency, holding the sovereign exposure fixed at the beginning of the year ad letting the (average) yield vary in each quarter. Here, I expect $\beta_1 > 0$: banks with higher losses from sovereign bonds are going to charge higher interest rates on their loans to make up for lost profitability.

Finally, note that all standard errors have been clustered at the bank–level. The key identifying assumption for consistency of cluster–robust standard errors is that there should be no inter–cluster correlation, although intra–cluster correlation is allowed (Liang and Zeger (1986)). To account for country–specific correlation among banks headquartered in the same country all models have been run through country–time clusters, rather than bank clusters, and the results still hold. However, I have decided to present the results for bank–clustered standard errors because for consistency one needs the number of clusters to go to infinity: I have a total of around 90 bank groups, but only 40 country–time pairs in equation (5).

Table 3: Domestic Lending and the Sovereign Shock
$\Delta Loans_{b,c,t} = \beta_1 SovShock_{b,t} + \eta_b + \lambda_{c,t} + \gamma' X_{b,t-1} + \epsilon_{b,c,t}$

	GMM (1)	OLS–FE (2)	OLS–FE (3)
SovShock	-3.808^{**}	-4.067^{**}	
	(1.625)	(1.573)	
SovShock/std.dev.			-7.721^{**}
			(2.987)
N	127	217	217
N of banks	78	89	89
bank fixed effects	no	yes	yes
country×year fixed effects	yes	yes	yes
Hansen–Sargan p–val	.73		
$AR(1)$ p–val	.836		
Bank controls: Tier1(+)***, Profits(+)*** , NPL(-)***, Dep(-), Cash(+)			

Cluster robust $s.e.$ in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: $Tier1$ is the Tier1–Capital–Ratio; $Deposits/Assets$, $Cash/Assets$, $PreTaxProfits/Assets$, $ImpairedLoans/Assets$ are, respectively: customer deposits, cash and other cash equivalents, EBT and non–performing loans all normalized by total assets. All variables are measured the beginning of the period $(t-1)$. $SovShock_{j,t}$ is the bank–specific sovereign loss normalized by total assets too. Column (1)–(2) use the Difference GMM estimator with instruments dated $t-1$ to $t-3$; column (3)–(4) use the standard OLS with bank fixed–effects. All std.err. have been clustered at the bank level.

5 Results

5.1 Loan Growth

Table 3 reports the results for the baseline regression in (5) for domestic loans using the par bond assumption. The coefficient of interest, β_1, is always negative and significant at 5%. It implies that banks that were more exposed to the sovereign shock and experienced higher sovereign losses had a lower growth rate of loans. Column (1) and (2) present the results with the GMM estimator and column (3) and (4) do the same with the OLS within estimator. The choice of instruments for GMM is the following: all balance sheet variables and the sovereign shock dated $t-1$ to $t-3$. In fact, the test for first order serial correlation in the error term in the difference equation ($\Delta\epsilon_{b,c,t}$) cannot reject the null of no serial correlation: the error term is a random walk. This allows me to use variables dated at $t-1$ as instruments for the equations in difference.

Column (1) estimates the baseline model with the Difference GMM. It implies that for a 1% increase in the sovereign losses–over–asset ratio, the growth rate of loans would decrease by slightly less than 4%. In column (2) I re–estimate the model with OLS, introducing a bank fixed effect: the coefficient is quantitatively almost the same, with a multiplier effect around 4.07. The number of observations is different from one estimator to the other because the panel has $T = 3$ (2010,2011 and 2012) and thus I "lose" one cross–section in the difference GMM equations. Finally, column (3) standardizes the shock by its standard deviation, so to ease comparisons with the robustness specifications that follow [21]. In this case the interpretation of

a spread over the benchmark interbank rates, it also nets out the effects of monetary policy. Finally, I am focusing on Lead Arrangers because I am assuming that these banks have the pricing power in each loan, but the results do not dependent on this assumption. See Section 4.2 for a detailed discussion

[20] The balance sheet variables are Leverage, Ebitda/Sales, Investment/Asset, Fixed Interest Rate Coverage, log(Assets)

[21] In some of the robustness tests I will change the construction of the sovereign shock, thus altering the whole distribution. I find the standardization with the standard deviation easy to compare across specifications

the coefficient is that for a one standard deviation shock to sovereign losses, the growth rate of loans is expected to decrease by 7.7%.

Among the balance sheet variables, the relevant ones are the Tier1 Capital Ratio, the profit–to–assets ratio and impaired loans–over–assets ratio. Not surprisingly, more capitalized, more profitable banks and banks with less non–performing loans at the beginning of the year had a higher loan growth rate during the following year.

Table 4: Foreign Lending and the Sovereign Shock
$\Delta Loans_{b,c,t} = \beta_1 SovShock_{b,t} + \eta_b + \lambda_{c,t} + \gamma' X_{b,t-1} + \epsilon_{b,c,t}$

	GMM Foreign (1)	OLS–FE Foreign (2)	GMM Both (3)	OLS–FE Both (4)
SovShock	-4.813^{***}	-5.738^{*}	-4.191^{***}	-3.706^{***}
	(1.444)	(3.182)	(1.084)	(1.319)
SovShock$\times foreign_b$			0.240	-1.653
			(0.993)	(1.798)
N	244	330	371	550
N of banks	140	137	218	227
bank fixed effects	no	yes	no	yes
country×year fixed effects	yes	yes	yes	yes
Hansen–Sargan p–val	.57	.04		
$AR(1)$ p–val	.935	.897		
Bank controls: Tier1(+), Profits(+)**, NPL(-), Dep(-)***, Cash(+)				

Cluster robust $s.e.$ in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: Column (1)–(2) focus on the subset of foreign loans issued by the international subsidiaries with the Difference GMM and the OLS–FE estimator respectively; column (3)–(4) do the same with the whole dataset, including both domestic and foreign. $foreign_b = 1$ if the bank is an international subsidiary, zero otherwise. All std.err. have been clustered at the bank level.

Effect on Foreign Loans The results of the baseline specification explore the effect of the sovereign shock on domestic loans, *i.e.* the loans issued by the parent bank in its own country. I now also examine the international transmission of the shock through the loans issued by the international subsidiaries of the cross–border institutions present in the EBA sample. Controlling for the country–year fixed–

effect of the country where the subsidiary is located, Table 4 shows that the effect of the shock is still negative and has a similar magnitude to the effect on domestic loans. In particular, column (1) implies that the GMM estimate of the effect of the sovereign shock is actually larger (*i.e.* more negative) for foreign loans than for domestic ones. The OLS–FE estimate is also larger, but less precisely estimated [22]. Column (3) and (4) merge the data on foreign loans with those on domestic loans and find that the effect is the same for domestic and foreign loans: there appears to be no "flight home" effect, whereby banks cut foreign lending by more than domestic one. In conclusion, the fact that the coefficient of interest, β_1, is still negative and significant even for foreign loans is another indication that $SovShock_{b,t}$ identifies a credit supply channel.

Robustness Tests I will now present a series of robustness test on the main result on the baseline regression on domestic loans. All the results are presented for the OLS–FE estimator only, but note that, in most cases, the results hold with the GMM Difference estimator too, both with and without the lagged dependent variable. I will be pointing out any significant departure in specific cases.

Robustness to outliers, credit demand controls and coupon assumption Table 5 tests the robustness of the first set of results. First, I want to make sure that the results are not driven by a few very large outliers. Accordingly, column (1) excludes Greek banks that had the highest losses on sovereign bonds: the results are unchanged and the coefficient is only slightly smaller, -3.6 compared to -4.0.

Columns (2)-(3) verify the robustness of the result to alternative measures of credit demand at the country level. A popular credit demand control in the bank lending channel literature (Altunbas et al. (2009), De Santis and Surico (2013)) is

[22] In unreported results, the estimate seems sensitive to the presence of lagged deposits over total assets of the parent bank. Although not significant in the OLS specification, adding deposits over total assets increases the p–val of the sovereign shock from 3.5% to 7.4%

Table 5: Robustness to Outliers, Credit Demand Controls and Coupon assumptions

	No Greek Banks (1)	$\Delta GDP_{c,t}$ $\times D_c$ (2)	$BLSDem_{c,t}$ $\times D_c$ (3)	Zero Coupon (4)	Par–Zero Average (5)
SovShock	-3.585^{**}	-4.631^{***}	-3.683^{***}		
	(1.796)	(0.956)	(1.364)		
SovShock/std.dev.				-7.581^{***}	-8.170^{***}
				(1.776)	(2.211)
N	206	217	162	217	217
N of banks	83	89	68	89	89
bank FE	yes	yes	yes	yes	yes
year FE	no	yes	yes	no	no
country×year FE	yes	no	no	yes	yes
Bank controls: Tier1(+)***, Profits(+)*** , NPL(-)***, Dep(+), Cash(+)					

Cluster robust *s.e.* in parentheses

* $p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Note: The dependent variable is the growth rate of domestic loans $\Delta Loans_{b,c,t}$. *SovShock* is the bank–specific sovereign loss. Column (1) excludes Greek banks; column (2)–(3) substitute the country*time fixed–effects with, respectively: GDP growth interacted with country dummies and BLS demand questions (diffusion index, country aggregate) interacted with country dummies. Column (4) uses the zero coupon bond duration for the calculation of the sovereing shock. All std.err. have been clustered at the bank level.

the growth rate of GDP in the country where the bank is lending. Alternatively, the Euro Area Bank Lending Survey (BLS) provides European banks' perceptions on credit demand conditions for the previous three months at a quarterly frequency. The BLS data is available, at the aggregate level [23], for most European countries [24]. I introduce these alternative credit demand controls by interacting either measure with the respective country dummy (columns (4) and (5)). The coefficient is negative and significant in all specifications. The magnitude is very similar to the baseline model with country–time fixed effects [25]. Finally, in column (4) and (5) I modify the coupon bond duration assumption used in the computation of the

[23] Unfortunately, bank–by–bank figures are confidential. Individual BLS demand questions would be a good candidate to control for *bank–specific* credit demand.

[24] The exceptions are non Euro countries such as the UK, Denmark, Norway and Hungary. For Greece and Finland no BLS data exist.

[25] In these robustness tests, the GMM Difference estimator works everywhere but for the BLS demand questions regressions. The coefficient on the sovereign shock in that case is not significant at 5% (p–val 8.9%).

sovereign shock. Column (4) uses the zero coupon bond duration while (5) averages par and zero coupon bond. Since this alters the entire distribution of the sovereign shock, I divide by the standard deviation to ease comparison with the baseline result in Table 3. The coefficient is remarkably similar to the one estimated with the par bond, implying that for a one standard deviation shock using the zero coupon assumption, loan growth decreases by 7.5% vis–a–vis 7.7% with the par bond. The average of the two, that should contain less measurement error than either of the two since it is a better approximation to real sovereign bonds, gives in fact an even larger effect (-8.5%), providing some evidence of an attenuation bias in the other estimates.

Table 6: Robustness to Loan Demand Homogeneity

	$\lambda_{c,t}\times$size	$SovShock\times$size
	(1)	(2)
SovShock	-4.496^{**}	-4.283^{***}
	(1.784)	(1.574)
SovShock$\times large$		0.883
		(0.796)
N	217	217
N of banks	89	89
bank FE	yes	yes
country$\times$year FE	yes	yes
Bank controls: Tier1(+)***, Profits(+)*** , NPL(-)***, Dep(+), Cash(+)		

Cluster robust $s.e.$ in parentheses

* $p < 0.10$, **$p < 0.05$, ***$p < 0.01$

Note: The dependent variable is the growth rate of domestic loans $\Delta Loans_{b,c,t}$. $SovShock$ is the bank–specific sovereign loss. Column (1) interacts the country–time fixed–effects ($\lambda_{c,t}$) with a dummy $large_b = 1$ if the bank is above the median asset size, 0 otherwise; column (2) interacts $SovShock$ with $large_b = 1$; All std.err. have been clustered at the bank level.

Robustness to loan demand homogeneity and other endogeneity concerns According to the model in Section 3, I can identify a credit supply effect of sovereign losses only if loan demand is homogenous across banks. Specifically, the loan interest rate elasticity (α_0), that enters into the reduced–form, partial effect of the sovereign shock on bank lending (β_1 in the regression), needs to be the same for

Table 7: Robustness to Endogeneity Concerns

	Political Ownership Instrument (1)	Foreign Exposure (2)	GIIPS vs. NonGIIPS (3)	Core vs. NonCore (4)	2010Q1 Exposure (5)
SovShock	-3.644^{**}				
	(1.391)				
SovShock/std.dev		-2.594^{**}			-3.174^{**}
		(1.243)			(1.315)
SovShock/std.dev $\times GIIPS$			-7.754^{***}		
			(2.633)		
SovShock/std.dev $\times NonGIIPS$			-5.220^{*}		
			(2.963)		
SovShock/std.dev $\times Core$				-7.471^{*}	
				(3.803)	
SovShock/std.dev $\times NonCore$				-5.698^{***}	
				(1.995)	
N	193	217	217	217	209
N of banks	80	89	89	89	84
bank FE	yes	yes	yes	yes	yes
country×year FE	yes	yes	yes	yes	yes
Bank controls: Tier1(+)***, Profits(+)*** , NPL(-)***, Dep(+), Cash(+)					

Cluster robust *s.e.* in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: The dependent variable is the growth rate of domestic loans $\Delta Loans_{b,c,t}$. *SovShock* is the bank–specific sovereign loss. Column (1) instruments the endogenous part of the sovereign shock, the domestic sovereign exposure, with the share of bank ownership held by the domestic government, see De Marco and Macchiavelli (2014) for details; column (2) constructs *SovShock* using only the foreign sovereign exposure for each bank; column (4) splits the sample into two groups by using a dummy GIIPS equal to 1 for Greece, Ireland, Italy, Portugal, Spain, zero otherwise and then divide the shock by its standard deviation in each group (GIIPS: 2.6% vs. non–GIIPS: 0.3%) ; column (5) splits the sample into two groups by using a dummy Core equal to 1 for France and Germany, zero otherwise and then divide the shock by its standard deviation in each group (Core: 0.46% vs. non–Core: 0.3%); finally column (6) uses the pre–crisis sovereign exposure only (2010Q1). All std.err. have been clustered at the bank level.

all banks. Also, the demand shifter elasticity (α_1) is the same across banks *within* the same country–time. In Table 6, columns (1) and (2), I relax these assumptions. I do so by interacting both the country–time fixed–effect and the sovereign shock with a dummy $large_b$ equal to one if the bank is above the median size by assets and zero otherwise. The results are largely unchanged [26].

Next, in Table 7, I discuss some possible endogeneity concerns on the sovereign shock and I propose some alternative measures. One concern is that the amount of sovereign bonds in banks' balance sheet is endogenous with respect to lending conditions, so that the sovereign shock would be correlated with unobserved credit conditions. Thus column (1) instruments the endogenous part of the sovereign shock, the domestic sovereign exposure over total assets, with the share of bank ownership held by the domestic government in each bank. In De Marco and Macchiavelli (2014) we observe that these "politically" owned banks, everything else equal, have a larger home bias in sovereign bonds than other banks, so that this instrument is well correlated with the bank's domestic exposure [27]. The result in column (1) shows that the effect of the sovereign shock is very similar to the baseline scenario, implying a decrease of 3.8% in credit growth for every percentage point loss in sovereign bonds over total assets [28]. In terms of the validity of the instrument, one may argue that political ownership is endogenous because "political" banks are more likely to be poorly managed and thus the instrument would be correlated with unobserved credit conditions. This is possible; however, as far as observable credit characteristics are concerned, "political" banks do not have a

[26] In unreported results, other thresholds for bank size, at the 75^{th} and 25^{th} worked as well.

[27] Note that the political ownership is not time–varying, being measured at the *pre–crisis* level, so I run three separate cross–sectional 1^{st} stage regressions for 2009, 2010 and 2011. The dependent variable in the first stage is the domestic exposure over total sovereign exposure $DomesticExposure/TotSovExp$, stacking together all maturities. In order to obtain $Exposure/TotalAssets$ used in the construction of the sovereign shock, I multiply the fitted values of the first stage regression by the $TotSovExp/TotalAssets$ ratio. The F–stats from the 1^{st} stage regressions are not less than 25, see Table 13 in the Appendix.

[28] In fact a Hausman–Wu test cannot reject the null hypothesis of the equality between the OLS–FE and the IV–FE estimator

larger share of non–performing loans or lower profits [29]. There is no indication of "poor management" according to measurable bank characteristics.

Column (2) looks at the effect of *foreign exposure* on domestic loans, by netting out the own domestic sovereign exposure for each bank. The aim here is to show that the home–country bias in sovereign holdings, especially strong for GIIPS banks, is not driving the results. In fact, one may worry that the contemporaneous part of sovereign shock ($\Delta yield_{c,m,t}$) is correlated with unobservable factors that affect bank credit and that are not accounted for by the $\lambda_{c,t}$ fixed–effects. This is especially true for GIIPS banks that are headquartered in countries that experienced severe tensions on their bond markets. Excluding the own country exposure is thus a way to eliminate the potential endogeneity issue for GIIPS banks. Since the distribution of the shock changes when using foreign exposures, I have divided the regressor by its standard deviation to ease comparisons with the baseline results. In column (3), β_1 indicates for a one standard deviation increase in losses on foreign sovereign debt over total assets, the growth rate of loans is predicted to be 2.59% lower. The effect is much smaller in magnitude than the -7.7 of the baseline regression, but still significant.

Further, column (4) and (5) address the same type of endogeneity bias as in column (3), but, instead of changing the definition of the sovereign shock, I split the sample between GIIPS and non–GIIPS banks or between Core (France and Germany) and non–Core banks. Once again, I divide the shock by its standard deviation in *each* group (2.6% for GIIPS banks, 0.03% for non–GIIPS banks) to ease comparison with the baseline result, because the distribution changes significantly in the two groups [30]. The results in column (4) indicate that the effect of the shock is stronger for GIIPS banks than for non–GIIPS banks: the coefficient on

[29] This is done in Table 14 in the Appendix by regressing political ownership on *Non Performing Loans* and *Return on Average Assets* (*ROAA*) and other bank characteristics for several years. The political variable is not significant at 5% in any of these regressions.

[30] Only a handful of banks in the non–GIIPS group have losses above 1% of total assets.

the interaction term for non–GIIPS banks is significant only at 10% (p-value of 0.082). One problem with this sample split is that among non–GIIPS banks there are many banks from other small countries with very little sovereign exposures to GIIPS countries (Malta, Hungary, Slovenia among others). Thus, column (5) splits the sample among banks belonging to the Core (France and Germany) and others. The coefficient on the sovereign shock for banks in the Core is now much larger: -7.4. It squares well with the baseline result, and although it's still significant at 10%, its p-value (0.053) is now much smaller than in the previous split between GIIPS and non–GIIPS banks. These results are a further indication that the sovereign shock caused a negative a credit supply shock in so far as credit demand conditions in the Core countries are not affected by deterioration of GIIPS sovereign debt: the negative effect on credit growth must be coming from French and German banks balance sheet exposure to GIIPS debt.

Finally column (6) uses an extra degree of caution in the construction of the sovereign shock, $SovShock_{b,t}$, by fixing the sovereign exposure at the *pre–crisis* level (March 2010) and letting only the duration and the yield vary over time. The choice of lending to firms and sovereigns are taken simultaneously, thus the one–year lag in the sovereign exposure as defined in (1) may not be sufficient to avoid the endogeneity bias. The results are robust to this specification: the coefficient is still negative and significant, although smaller in magnitude.

Effect on Syndicated Loans Volume As a further robustness check, I can run the same regression model on the volume of syndicated loans as in Popov and Van Horen (2013). The advantage of using syndicated loan data is that one knows the identity and the location of the borrower, so that the country–time fixed–effects is a better control for credit demand. The disadvantage however is that the exact loan breakdown for each lender in the syndicate is not available for the vast majority of loans, so that one needs to create some "artificial" variation. I follow Popov and

Table 8: Volume of syndicated loans by country
$\log(Loans_{b,c,t}) = \beta_1 SovShock_{b,t} + \eta_b + \lambda_{c,t} + \gamma' X_{b,t-1} + \epsilon_{b,c,t}$

	Country–Borrower FE (1)	Country–Quarter FE (2)	US & EU Borrowers (3)
SovShock/std.dev.	-8.735^{***}	-5.678^{*}	-7.628^{**}
	(2.354)	(3.105)	(3.835)
N	5617	5617	3559
N of banks	74	74	74
bank FE	yes	yes	yes
country–borrower FE	yes	no	no
country×quarter FE	no	yes	yes
Bank controls: Tier1(+), Profits(+), NPL(-), Dep(-), Cash(+)			

Cluster robust *s.e.* in parentheses
* $p < 0.10$, **$p < 0.05$, ***$p < 0.01$

Note: The dependent variable is the volume of syndicated loans of bank b to country c at quarter t. *SovShock* is the bank–specific sovereign loss; other balance sheet variables are defined as before. Column (1) controls for country–borrower FE; column (2) country×year FE; column (3) country×quarter FE. All std.err. have been clustered at the bank level.

Van Horen (2013) and divide the loan equally among syndicate members whenever the exact loan shares are not available. The loans are then aggregated at the bank–country–borrower pair at a quarterly frequency. There are a total of 95 country-borrowers, both advanced and emerging markets, for a total of 12,067 loans made by 74 EBA banks over the 2009-2012 period. The results are provided in Table 8: column (1) controls only for a country–borrower fixed–effects, column (2) adds an interaction with the quarter dummies: the results imply that, for a one standard deviation increase in the sovereign shock, lending contracts, on average, by 5% to 8%.

In conclusion, I find that sovereign losses negatively affect credit supply and the estimated effect is large: a one standard deviation increase in the sovereign losses–over–assets ratio, on average, decreases the growth rate of credit supply by more than 7%. The results are not driven by outliers, hold for domestic and foreign loans, are robust to differences in borrowers' unobservables across large and small banks and hold if one considers foreign sovereign exposure only, although the negative effect of the shock is halved in this case. Also, banks that experienced larger shocks to their sovereign portfolio had a lower volume of syndicated loans.

5.2 Loan Interest Rates

So far, I have shown that European banks with larger losses from sovereign debt tightened their credit supply by reducing aggregate and syndicated lending. However, there is another dimension to credit supply: loan prices or interest rates [31]. If, controlling for credit demand, we see equilibrium interest rates on loans rising, then it must be because of a negative credit supply shock. Since, in the model, banks are assumed to be monopolistically competitive, substituting the equilibrium condition for loans in the downward sloping demand function gives an equilibrium interest rate, r_t^L, as an increasing function of the sovereign shock.

I show that indeed interest rate spreads are on average 40 to 65 bps. higher, depending on the specification, in deals where lenders are hit with a one standard deviation shock to their sovereign portfolio. I am restricting the analysis to banks listed as Lead Arrangers (LA), assuming that these are the relevant lenders with the pricing power in each deal [32]. The sample includes deals with multiple LA, which make up for more than half of the total deals (the median is 2 arrangers per deal as shown in Table 1). Therefore, if I were to run the model using the multiple LA sample, significance values would be inflated because of repeated values in the dependent variable. In fact, the all–in drawn spread is the same in each deal even if there are multiple arrangers. To address this concern, I run the model by constructing an "artificial" *average* bank, averaging over balance sheet variables

[31] A loan has also other non price terms, such as maturity, collateral and debt covenants. However, I do not find any effect of the sovereign shock on these measures. In particular, I do not find evidence that banks with more losses increase maturity of syndicated loans or that debt covenants become tighter (using the covenants strictness measures defined in Murfin (2012)). I do not have good data on the collateral quality.

[32] Admittedly, this assumption may fail if most of the bargaining power in the syndicate is in the hands of the "marginal" participant that is needed to close a deal. To address this concern, in a robustness test I run the model on single–lender deal only.

and, especially, the sovereign shock across banks in each syndicated loan. Thus here the sovereign shock is the average shock across lenders (LA) in each deal.

Table 9: Interest Rate Loan Spreads. $Spread_{b,f,t} = \beta_1 SovShock_{b,t} + \eta_b + \lambda_{c,i,t} + \phi' F_{f,t} + \gamma' X_{b,t-1} + \epsilon_{b,f,t}$

	Country–quarter FE (1)	Country–industry–quarter FE (2)	Firm borrower controls (3)
SovShock/std.dev.	40.78***	40.40**	65.41**
	(10.87)	(0.011)	(29.21)
Leverage_ratio			77.40**
			(33.82)
Log(Assets)			−40.50***
			(11.41)
EBITDA/Sales			−12.29
			(16.51)
Investment/Assets			−4.160***
			(1.158)
N	5147	5147	949
bank FE	yes	yes	yes
country×quarter FE	yes	no	no
country×industry ×quarter FE	no	yes	yes

p-values in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: The dependent variable is the (log of) the all-in drawn spread on loans made by Lead Arranger b to firm f at quarter t. *SovShock* is the bank–specific sovereign loss at a quarterly frequency, divided by its standard deviaion; other balance sheet variables are defined as before. Column (1) controls for country–borrower FE; column (2) country×year FE; column (3) country×quarter FE. All std.err. have been clustered at the bank level.

Table 9 presents the results. In column (1) I control for country–quarter fixed–effects, whereas in column (2) I exploit the finer disaggregation of the loan–level data and control for country–industry–quarter fixed–effects [33]. Basically, in column (2) I am comparing the interest rate charged by an (*average*) bank hit with a one standard deviation shock and a bank not hit by the shock when they lend to the corporate borrowers in the same sector, country and quarter. In terms of the model

[33] I cannot control for firm– or firm–time fixed–effects because I do not observe many firms borrowing in more than one deal in my sample. In fact, the average maturity of syndicated loans is 5 years and I am focusing on a 3 year window, 2010-2012

in Section 3, I am allowing for the demand shifter to be not just country–time specific ($\lambda_{c,t}$), but country–industry–time specific ($\lambda_{c,i,t}$). The results suggest that the interest rate loans made by banks hit with a one–standard deviation shock [34] are 40 bps (one quarter of the standard deviation of interest rates) higher than banks with no shock. Furthermore, column (3) uses the DealScan–Compustat sample to control for firm–level characteristics. The effect of the shock is still positive and significant and it implies an even larger effect of 65 bps increase in spreads for a one standard deviation increase in the shock. Other firm characteristics have the expected sign: more levered and smaller firms pay higher interest rate spreads [35].

The regressions in Table 9 are robust to changing the various assumptions underlying the construction of the sample. In particular, to ease concerns that the results are driven by outliers that skew the shock distribution for the "artificial" *average* bank, in Table 10 column (1) I restrict the sample to the largest LA by total assets in each deal. These banks are mostly global banks with smaller shocks and they are more likely to be those with the most pricing power in each deal: the effect is just slightly smaller, 30 vs 40 bps higher. Furthermore, if one worries that the assumption of assigning the pricing power to LA is not accurate, column (2) analyzes single–lender deal only, nearly half of which are listed as non–LA in DealScan: the effect is larger than in the baseline specification (63 bps.), although significant at around 5% only. In the rest of the columns in Table 10 I run other robustness cheks. Column (3) and (4) distinguish between credit lines or term loans, keeping the average bank assumption. The effect of the shock appears not to be significant for credit lines, but it is significant and even stronger for term loans. Finally Column (5) adds two loan characteristics: the (log of) maturity and the (log

[34] The standard deviation of the sovereign shock in this sample is about 0.2% or 20 bps in terms of losses over total assets. No bank has *quarterly* losses of 1% of total assets, so I find it more realistic to provide the results normalizing by the standard deviation

[35] The result is not driven by the inclusion of firms' covariates. In an unreported robustness test, running the regression on the Dealscan–Compustat sample without including borrowers' balance sheet characteristics yields the same result.

of) loan amount. As expected, larger loans and those with shorter maturities have higher interest rate spreads, but the effect of the sovereign shock is still positive and significant.

Table 10: Interest Rate Spreads Robustness Tests

	Largest LA (1)	Single Lender (2)	Credit Lines (3)	Term Loans (4)	Loan controls (5)
SovShock/std.dev.	30.31**	63.70*	15.57	76.27***	30.89**
	(14.57)	(32.25)	(19.64)	(23.38)	(13.13)
Log(Loan Size)					−26.37***
					(4.021)
Log(Maturity)					40.40***
					(4.338)
N	5147	1372	2346	2377	5074
bank FE	yes	yes	yes	yes	yes
country×industry ×quarter FE	yes	yes	yes	yes	yes

Cluster robust *s.e.* in parentheses
* $p < 0.10$, **$p < 0.05$, ***$p < 0.01$

In conclusion, I have shown that sovereign losses matter for credit supply not only because they reduced the growth rate of credit, but also because they increase the interest rate spreads charged on syndicated loans. The effect is not driven by sector specific credit demand, it does not depend on assumptions on lenders pricing power, loan characteristics and, most importantly, holds also after I control for borrower specific characteristics.

6 The channels

I have established that the sovereign debt crisis has had a negative effect on the supply of loans through its effect on banks' balance sheets. In this section, I will explore two main hypotheses as to why sovereign exposures matter for credit supply:

the *capital channel* and the *funding channel*.

According to the first, banks that needed to recapitalize during the crisis period prefer to do so by shedding assets (loans) than by raising new equity. The regulatory capital target in Europe, the Core–Tier1 ratio (CT1), is defined as common equity, including government support measures, over Risk–Weighted Assets (RWA). Notably, government bonds receive a 0% risk weight in the calculation of RWA. When a negative equity shock (losses on the sovereign bond portfolio in this case) occurs, banks may go below the minimum level of regulatory capital. They can get back to the target ratio by either raising equity or by reducing risky assets, especially in the loan portfolio. However, we know that equity is a relatively costly source of finance (Myers and Majluf (1984)), so that a bank may be reluctant to issue new shares, especially at a time of low stock prices [36]. If this is the case, and capital constraints are *binding*, cutting off loan supply, thus reducing RWA, seems the only viable alternative to increase the capital ratio [37]. Admittedly, this channel may not be at work if capital constraints are not *binding* and the *potential* sovereign losses are not realized on bank books. It is difficult to ascertain whether capital constraints are binding in practice, because theoretical models (Repullo and Suarez (2009)) predict that banks would hold capital buffers well in excess of the minimum requirement, but could still find the constraint binding in their optimization problem. As I discuss at the end of this sections, there are reasons to believe that capital constraints were not binding over this period. Regarding sovereign losses, it is true that on average 50% of banks' sovereigns are in the Hold–to–Maturity (HTM) banking book, where they are not marked–to–market. However, according to the EBA September 2011 recommendation, capital had been assessed net of valuation losses on the sovereign

[36] Other ways to increase equity without issuing new shares include: increase retained earnings (difficult to do in the short term), debt–to–equity and hybrid shares conversion (widely used according to EBA and BIS (2012) reports).

[37] According to EBA and BIS Quarterly reports (2012), another way to reduce RWA without asset shedding is to change the risk weights used in internal models. Apparently, these changes were pre–agreed with regulators and they were used extensively during the sovereign debt crisis. I take this into account normalizing equity by total assets as well as RWA.

portfolio. Banks had to mark–to–market their whole sovereign portfolio, including the HTM banking book. Thus these losses had to appear on banks' books and banks had to put up capital against it.

The *funding channel*, on the other hand, suggests that losses on sovereign bonds matter for credit supply because they impair banks' ability to refinance on the wholesale, interbank market. Government bonds are the preferred source of collateral used for interbank repos, where the size of the haircut, the repo rate and the maturity depend on the perceived market risk of the collateral. When tensions on sovereign markets reached high levels in 2010–2012, banks lacked an important source of funding and this could have reduced the capacity to provide credit to the real economy (Gonzalez–Paramo (2011)). For example, there is evidence that as early as in March 2010, Greek sovereign bonds were no longer accepted in private interbank transactions, implying a market haircut of 100% (Drechsler et al. (2012)). My measure of the sovereign shock in this case would represent a proxy for the average quality of the collateral that banks can post on the interbank market. Admittedly, since the ECB eligibility criteria and haircuts for collateral have been less stringent than market ones throughout the debt crisis, the total effect on the funding channel may be ambiguous. In fact, if banks could not refinance on the open market, they could always resort to the ECB lending facility or, especially, participate in the 3–year longer–term refinancing operations (LTRO) in December 2011 and February 2012 that injected a total of €1.1 tn. in the banking system (Drechsler et al. (2012)).

Table 11 explores the capital and the funding channel in greater detail. The dependent variable in all regression is the growth rate of domestic loans, as in the baseline results. Column (1) tests for the presence of the capital channel by interacting the sovereign shock with a dummy variable, $lowTier1\_nogovhelp_{b,t}$, that takes value one if the bank, in each year, has a low Tier1 capitalization (below the 25^{th} pct.) and zero otherwise. I define capitalization as the *effective* own bank

Table 11: The Capital and the Funding Channel

	Capital Channel: Tier1 (1)	Capital Channel: Leverage (2)	Funding Channel (3)	Funding Channel: 2008Q4 (4)	Both Channels
lowTier1_nogovhelp	-0.0455				-0.0401
	(0.031)				(0.033)
lowLeverageRatio		0.00204			
		(0.051)			
highShortTermFund			-0.0246		-0.0194
			(0.042)		(0.042)
SovShock	-4.624^{***}	-3.494^{*}	-3.527^{**}	-3.521^{**}	-3.994^{**}
	(1.522)	(1.808)	(1.679)	(1.714)	(1.744)
SovShock× *lowTier1_nogovhelp*	0.930				1.182^{**}
	(0.599)				(0.579)
SovShock× *lowLeverageRatio*		-1.243			
		(1.597)			
SovShock× *highShortTermFund*			-1.707^{***}	-2.938^{**}	-1.763^{**}
			(0.788)	(1.276)	(0.746)
Shock+Shock× $lowTier1\_nogovhelp = 1$	-3.695^{***}				-2.811^{*}
	(1.391)				(1.627)
Shock+Shock× $lowLeverageRatio = 1$		-4.737^{***}			
		(1.719)			
Shock+Shock× $highShortTermFund = 1$			-5.235^{***}	-6.459^{***}	-5.756^{***}
			(1.387)	(1.648)	(1.387)
N	217	216	216	216	216
N of clusters	89	89	89	89	89
bank fixed effects	yes	yes	yes	yes	yes
country*time fixed effects	yes	yes	yes	yes	yes
Bank controls: Tier1(+)***, Profits(+)*** , NPL(-)***, Dep(-), Cash(+)					

Cluster robust *s.e.* in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: The dependent variable is the growth rate of domestic loans $\Delta Loans_{b,c,t}$. $lowTier1\_nogovhelp_{b,t}$ takes value 1 if the bank is below the 25^{th} pct. of the level of Tier1 ratio in year t, 0 otherwise; $lowLeverageRatio_{b,t}$ is equal to 1 if the bank is below the 25^{th} pct. of the level of the leverage ratio (CommonEquity/Total Assets) in year t, 0 otherwise; $highShortTermFund_{b,t}$ takes value 1 if the bank is above the 75^{th} pct. in short–term funding over total funding in year t, 0 otherwise; other balance sheet variables (Tier1, Deposits/Assets, PreTaxProfits/Assets, Cash/Assets) are defined as before. Standard errors are clustered at the bank–level.

capital, after subtracting equity injections from their respective governments [38]. The slope coefficient on the sovereign shock is significant and negative for all banks, regardless of the level of regulatory capital, but there appears to be no additional negative effect for poorly capitalized banks. If anything, in the subtable I show that the total impact of a 1% increase in the sovereign losses over assets ratio on loang growth seems to be smaller in absolute value for low capitalized banks (-3.7%) than for the other banks (-4.7%). Using other thresholds to define the dummy $lowTier1\_nogovhelp_{b,t}$ (either higher (50^{th}), lower (10^{th}) or fixed thresholds imposed by the EBA (5% in 2010 9% in 2011)) give similar results (not shown in the table).

Column (2) explores the capital channel using another definition of bank capital, the actual *leverage ratio*, defined as common equity (excluding government help) over total assets (not RWA), as it appears in Basel III rules. I do so to make sure that the results in column (1) are not capturing changes in RWA rather than in equity, which is the channel I am interested in. In fact, according to BIS (2012), a portion of banks recapitalizion plans (10%) would happen through changes in the internal models used to evaluate risk weights. Accordingly, the dummy used in the interaction in column (2), $lowLeverageRatio_{b,t}$, is equal to one if the bank is below the 25^{th} pct. of the distribution of the leverage ratio in each year and zero otherwise. The interaction term is not precisely estimated and the baseline effect for those with a higher leverage ratio is significant only at around 5%. If I compute the total effect of the sovereign shock on credit growth for banks that have a low leverage ratio, I find that it is larger (-4.73%) than the total effect for banks with low Tier1 ratio (-3.7%). This suggests that indeed the results in column (1) are somewhat contaminated by changes in the risk weights pre–agreed with regulators, rather than through changes in equity.

Column (3) turns to the funding channel. Here the interaction is with a dummy

[38] Government injection data are available as part of the Stress Test disclosure. Including them in the calculation of Tier1 capital does not qualitative alter any of the results that follow.

$highShort- \; TermFund_{b,t}$ that takes value 1 if the bank is above the 75^{th} pct. in short–term funding over total funding [39]. The interaction term is negative and significant, implying that banks with a higher dependence on short term funding have an additional negative effect of sovereign losses on bank lending. The total effect of the sovereign shock for these banks is a decrease in the growth rate of loans of 5.089% compared to 3.203% for other banks. It is also very precisely estimated. Note that this effect is present only for banks highly dependent on this source of funding: thresholds at 75^{th} or 90^{th} pct. work, but not at the 50^{th}.

A possible concern with the regression in column (3) is that the dependence on short term funding is endogenous: distressed banks could be forced to substitute long–term, stable source of funding (such as customer deposits) with short term debt. So it could be that the dummy $highShortTermFund_{b,t}$ is picking up solvency rather than funding liquidity concerns. One way to address the issue is using the dependence on short term funding at the beginning of the sample, at the end of 2008, to see if banks that "normally" fund themselves with short–term debt have been differentially impacted by the sovereign debt crisis. Therefore, column (4) defines $highShortTermFund_{b,t}$ to be the dependence on short term funding before the sovereign debt crisis, at the beginning of 2009 (2008Q4). The dummy itself, not being time varying, cannot be included in the fixed–effect regression. I still find an additional negative kick for banks highly dependent on short term funding, the total effect is even larger than before, implying a decrease in domestic loan growth of around 6.5%.

Finally, column (5) tests the joint hypothesis that both channels are working at the same time, using the version of the capital channel with Tier1 rather than actual leverage (similar results, not shown, apply with the leverage ratio as a measure for

[39] Bankscope provides a variable called *Other Deposits and Short–Term Funding* that captures all short term funding not classifiable as customer deposits. This includes interbank repos, but also short term certificates of deposits and all non depository sources of funding. So it is an imperfect measure of interbank funding, which is the source of funding that should suffer more given a risky sovereign debt exposure (worse quality of collateral).

the capital channel). It appears that the funding channel largely dominates the capital channel. In fact, the estimate of the sovereign shock for the low capitalized banks is much attenuated (-2.8%) and less precisely estimated. On the other hand, the effect for those highly dependent of short term funding is more negative (-5.7%) and significant.

In conclusion, the data seem to support the hypothesis that high sovereign debt exposure to risky sovereign debt affected banks' cost of funding rather than the cost of capital, consistent with the simple theoretical model provided in Section 3. I interpret the absence of the capital channel as a sign that capital constraints were not binding over this period. In fact, the *forbearance* by the EBA in enforcing the capital requirements may be responsible for this: according to EBA and BIS (2012) reports, almost a third (28%) of the aggregate shortfall in capital by EBA banks could be fulfilled with debt–to–equity and other hybrid shares conversion, rather than by issues of new equity. Notably, Banco Santander of Spain was allowed a €6.83 bil. debt–to–equity conversion vis–a–vis a capital shortfall of €15.3 bil. More in general, since risk based capital requirements tend to be pro–cyclical (they rise during recessions), regulators may be reluctant to impose additional capital buffers in a time of crisis. On the other hand, *market discipline* would make funding problems unavoidable for banks. If participants in the interbank market believe that the government bonds posted as collateral by a bank are not of sufficient quality or other lenders in general perceive the bank as risky, they may reduce the amount of money they lend to that bank (*i.e.* an increase in the haircut) or increase the repo rate. There would not be any forbearance on part of other market participants and the bank, unable to borrow on the market, has to cut loan supply [40].

[40] I want to emphasize that this result is only preliminary in so far as the measure on short–term funding dependence is very imprecise. In particular, it is not clear that it correctly measures the extent of interbank funding. This is the source of funding more likely to be affected by government bonds exposures because banks use these bonds as collateral in this market. In order to make more rigorous empirical statements on this phenomenon, one would need to look at better data on banks' actual cost of funding on the interbank market, which are not publicly available at the bank level

6.1 The ECB 3 year LTRO

In this section I investigate the effectiveness of the ECB 3 year LTRO operations in December 2011 (LTRO 1) and February 2012 (LTRO 2) in the context of the credit crunch. These operations were fixed–rate auctions, at 100 and 75 bps. respectively, with full allotment that injected gross funds of €1.1 tn. in the banking system [41]. The LTRO operations were intended to ease market funding concerns for European banks, especially in the peripheral countries [42]. Bank by bank figures on LTRO usage have not been released by the ECB, however it is still possible to investigate whether the LTRO operations has been successful in alleviating the credit crunch by using a simple time interaction with the sovereign shock. I do so in Table 12.

Given that the ECB funds were allotted at the end of 2011 and beginning of 2012, I create a dummy $LTRO_t$ equal to one in 2012 and zero otherwise and I interact it with the sovereign shock in column (1). The interaction coefficient on $SovShock \times LTRO_t$ is not significant, implying that the sovereign losses do not matter for bank lending during 2012: the total effect in the subtable under column (1) is negative, but not significant. This could be the result of LTRO, that eased funding concerns for distressed banks, or simply the fact that bond yields largely subsided by the end of 2012 [43]. In order to test whether the LTRO impact on lending happened through the alleviation of banks funding problems I can introduce a triple interaction term: $SovShock \times LTRO_t$, $SovShock \times HighSTFund_{b,t}$ and $SovShock \times HighSTFund_{b,t} \times LTRO_t$. In particular I want to see whether banks that rely more heavily on short term funding benefit the most after the advent of

[41] According to industry reports by Morgan Stanley Research (2012), only around half of gross funds were actually new *net funding*, as banks rolled over existing ECB facilities into the LTRO.

[42] See ECB press release: `https://www.ecb.europa.eu/press/pr/date/2011/html/pr111208_1.en.html`

[43] The latter explanation could be itself a by–product of the LTRO operations. There is evidence (Acharya and Steffen (2012), Morgan Stanley (2012)) that Italian and Spanish banks, the largest beneficiaries of the LTRO funds, invested heavily in their respective government bonds. These massive purchases contributed to decrease the yields. In general, by easing market concerns on banks' funding, the LTRO may have induced other investors to purchase government bonds of troubled countries.

Table 12: ECB 3 year LTRO and the credit crunch.

	LTRO (1)	Funding (2)	Funding 2008Q4 (3)
SovShock	-3.794^{**}	-2.729	-1.494
	(1.644)	(2.454)	(2.620)
SovShock$\times LTRO$	-0.792	-4.965	-4.951
	(5.781)	(7.080)	(7.494)
SovShock$\times HighSTFund_{b,t}$		-1.445	-3.845^{**}
		(1.417)	(1.638)
SovShock$\times HighSTFund_{b,t} \times LTRO_t$		6.617	-2.321
		(5.911)	(15.59)
Shock+Shock$\times(LTRO_t = 1)$	-4.586	-7.694	-6.445
	(4.916)	(5.74)	(5.624)
Shock+Shock$\times(HighSTFund_{b,t} = 1) \times (LTRO_t = 0)$		-4.174^{**}	-5.339^{***}
		(1.666)	(1.553)
Shock+Shock$\times(HighSTFund_{b,t} = 1) \times (LTRO_t = 1)$		-2.522	-12.61
		(4.511)	(17.78)
N	217	216	209
bank FE	yes	yes	yes
country$\times$quarter FE	yes	yes	yes

Cluster robust *s.e.* in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: The dependent variable is the growth rate of domestic loans. $LTRO_t$ is a dummy equal to one in 2012 and zero otherwise; $highSTFund_{b,t}$ takes value 1 if the bank is above the 75^{th} pct. in short–term funding over total funding in year t, zero otherwise.

the LTRO in 2012.

In column (2) I find that the sovereign shock decreases the growth rate of lending only for banks with high dependence on short term funding *before* the introduction of the 3 year LTRO in 2012. *After* the LTRO, all banks are not affected by the sovereign shock, but it does not appear that banks relying heavily on short term funding benefit more than others. A t–test for the equality of coefficients of $Shock + Shock \times (HighSTFund_{b,t} = 1) \times (LTRO_t = 1)$ and $Shock + Shock \times (HighSTFund_{b,t} = 0) \times (LTRO_t = 1)$ cannot reject the null hypothesis that the two coefficients are the same. Column (3) uses the dependence on short term funding before the sovereign debt crisis, in 2008, but the results do not qualitatively change.

In conclusion, I find evidence that, in 2012, the sovereign shock does not matter for lending. This could be the result of the ECB market intervention that culminated, at the end of 2011 and beginning of 2012, with the 3 year LTRO operation. Under this intervention the ECB injected considerable amount of liquidity into banks at low cost. However, I do not find a differential impact of the LTRO for banks that rely more heavily on short–term funding, casting doubts on the effectiveness of this operation in terms of easing funding liquidity problems. It is more likely that the sovereign shock loses potency in 2012 because the sovereign bond yields fell for most GIIPS countries at the end of the year. The decrease in the yields may still well be a by–product effect of the LTRO operation, whereby banks used LTRO funds to purchase massive amounts of GIIPS bonds that lowered the yields.

7 Conclusions

In this paper, I have shown that the sovereign debt crisis has had a negative real effect on credit supply through its impact on banks' balance sheets. Using bank–

by–bank exposure data to sovereign debt, I calculate the exact sovereign losses in banks' portfolio and I use them as an explanatory variable for the growth rate of loans and loan interest rate spreads. The results suggest that banks hit by a large sovereign shock (a one standard deviation increase) had a growth rate of domestic loans around 7.7% lower than a bank not hit by the shock. The results are robust to the elimination of outliers (Greek banks), to differences in unobservable borrowers' characteristics between large and small banks, to the exclusion of the home sovereign exposure and to the assumption used to compute the duration (zero–coupon or par bond). I also propose an instrument, the share of bank ownership from the domestic government, to account for the endogeneity of the home sovereign exposure and I find similar results. To provide conclusive evidence that the sovereign debt crisis represented a negative credit supply shock, I have also shown that global European banks reduced lending abroad, through their international subsidiaries, by the same amount as domestic loans. Moreover, I find that for a one standard deviation increase in sovereign losses-over-total assets (15–20bps.), banks charge interest rate spreads 40 to 65 bps. higher, even after controlling for industry unobserved heterogeneity and corporate borrower characteristics.

I also attempt to shed some light on the mechanisms as to why sovereign losses matter for bank lending. I find evidence for a *funding channel* over a *capital channel*: sovereign losses affect disproportionately more the growth rate of credit for those banks with a higher share of short term funding rather than those with low level of capitalization. I interpret the result as *forbeareance* from the European regulator (EBA) in enforcing capital requirements in a time of crisis

Appendix

Table 13: First stage regression

	(1)	(2)	(3)
	$HomeBias_{2009}$	$HomeBias_{2010}$	$HomeBias_{2011}$
Political Ownership	0.361***	0.328***	0.294***
	(0.071)	(0.065)	(0.053)
Constant	0.614***	0.669***	0.634***
	(0.039)	(0.035)	(0.038)
N	83	87	60
F–stat	25.6	24.76	30.65
R^2	0.154	0.141	0.173

White standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: The dependent variable is the ratio of domestic sovereign to total sovereign exposure (home bias). *PoliticalOwnership* is the % of ownership from domestic government in each bank, measured at the 2006 *pre–crisis* level. In order to obtain $Exposure/TotalAssets$ used in the construction of the sovereign shock, I multiply the fitted values of the first stage regression by the $TotalSovereignExposure/TotalAssets$ ratio.

Table 14: Political banks and Performance. Dependent variable: Political ownership (%)

	(1)	(2)	(3)	(4)
	2010	2010	2011	2011
Impaired Loans/	0.0171*	0.0233	0.00766	0.0180*
Gross Loans	(0.00945)	(0.0147)	(0.00743)	(0.0105)
Profits/	-3.237*	-2.758	2.904*	0.723
Assets	(1.791)	(3.488)	(1.512)	(2.626)
Log($Assets$)	-0.0485**	-0.0567*	-0.0694***	-0.0694
	(0.0185)	(0.0286)	(0.0237)	(0.0466)
Cash/Assets	-6.909***	-6.584***	-1.625	-0.231
	(1.640)	(2.458)	(1.204)	(1.634)
Tier	-0.122	-0.873	-0.694	-1.369
	(0.826)	(1.114)	(0.836)	(1.287)
Dep/Assets	-0.0515	-0.0691	-0.325	-0.345
	(0.322)	(0.468)	(0.327)	(0.418)
N	87	87	78	78
Country fixed–effects	no	yes	no	yes

White standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure 1: GIIPS Sovereign Exposures, March 2010. EBA Stress Test 2010

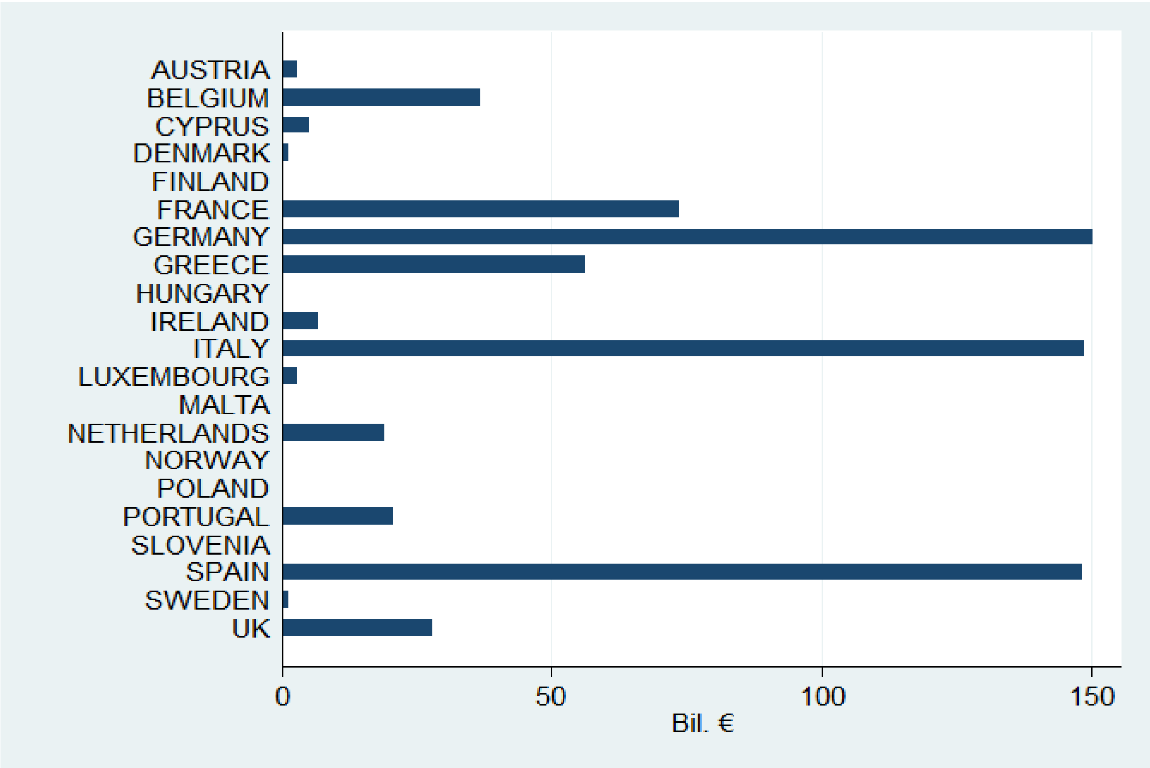

Figure 2: GIIPS Sovereign Exposures over Total Assets, March 2010. EBA Stress Test 2010

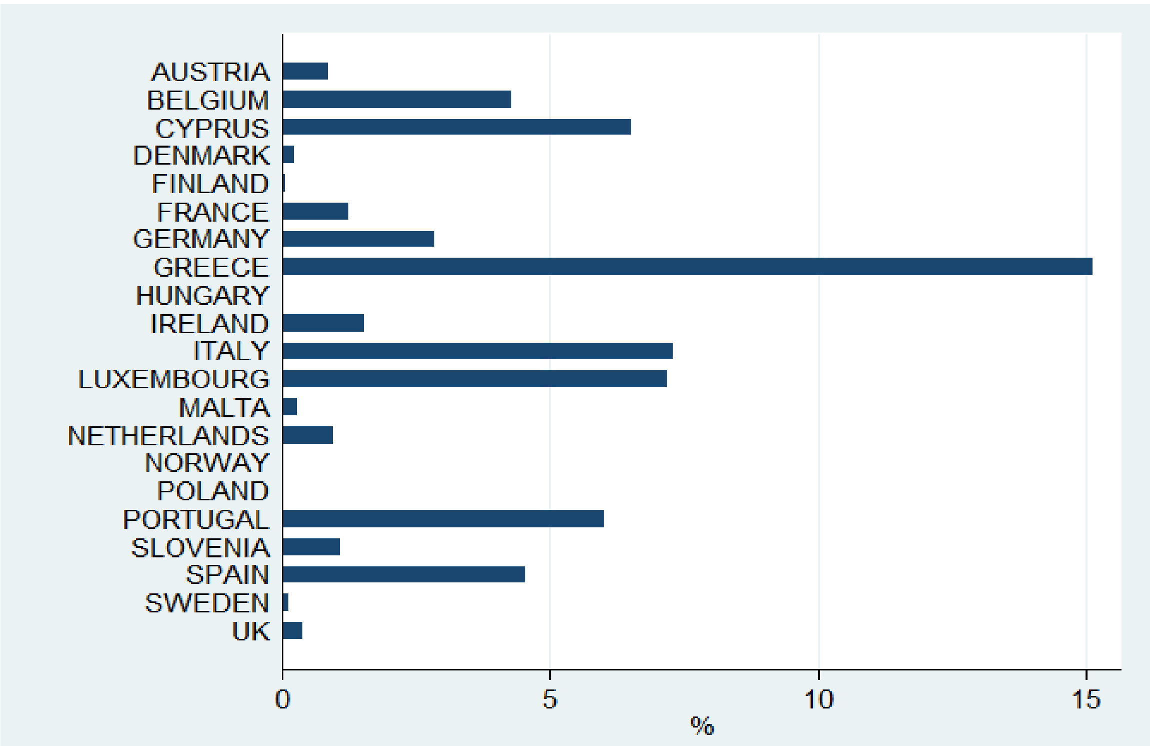

Figure 3: Domestic Loans Growth Rate to Non–Financial Corporations. ECB, MFI Aggregate Statistics

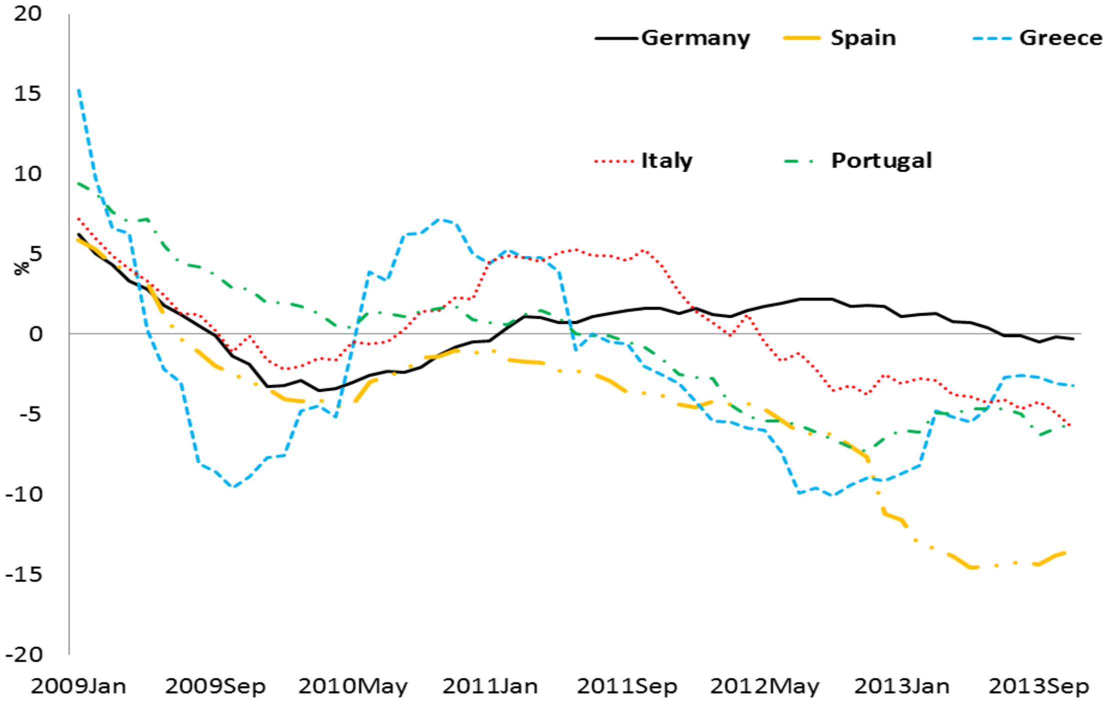

Figure 4: Average Interest Spread (on ECB Policy Rate) for New Loans to Non–Financial Corporations. ECB, MFI Aggregate Statistics (Narrowly Defined Effective Rates, all maturities and amounts).

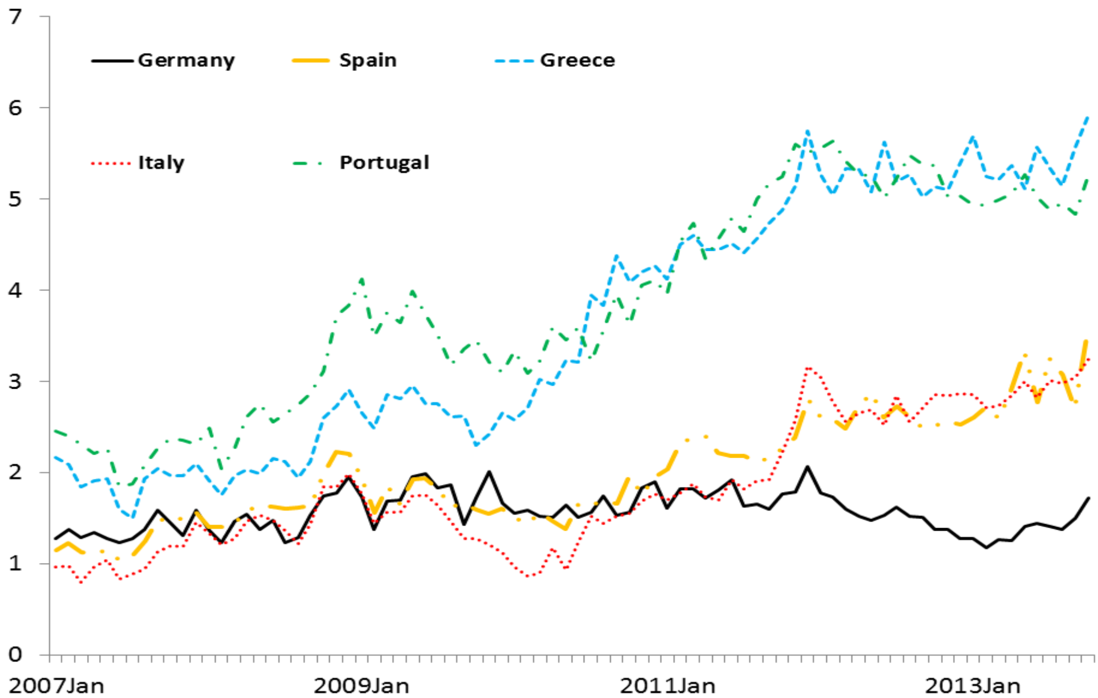

Table 15: List of EBA banks

EBA CODE	BANK NAME	CROSS BORDER	2009Q4 (2010Q1)	2010Q4	2011Q4
AT001	Erste Bank Group (EBG)	Y	Y	Y	Y
AT002	Raiffeisen Bank International (RBI)	N	Y	Y	Y
AT003	Oesterreichische Volksbank	Y	N	Y	N
BE004	Dexia	Y	Y	Y	N
BE005	KBC Bank	Y	Y	Y	Y
CY006	Cyprus Popular Bank (Laiki)	Y	Y	Y	Y
CY007	Bank of Cyprus	N	Y	Y	Y
DE017	Deutsche Bank	Y	Y	Y	Y
DE018	Commerzbank	Y	Y	Y	Y
DE019	Landesbank Baden-Wurttemberg	N	Y	Y	Y
DE020	DZ Bank	Y	Y	Y	Y
DE021	Bayerische Landesbank	N	Y	Y	Y
DE022	Norddeutsche Landesbank	N	Y	Y	Y
DE023	Hypo Real Estate Holding AG	N	Y	Y	Y
DE024	WestLB	N	Y	Y	N
DE025	HSH Nordbank	N	Y	Y	Y
DE026	Helaba	N	Y	N	Y
DE027	Landesbank Berlin	N	Y	Y	Y
DE028	DekaBank	N	Y	Y	Y
DE029	WGZ Bank	N	Y	Y	Y
DE N/A	Deutsche Postbank	N	Y	N	N
DK008	Danske Bank	Y	Y	Y	Y
DK009	Jyske Bank	N	Y	Y	Y
DK010	Sydbank	N	Y	Y	Y
DK011	Nykredit	N	N	Y	Y
ES059	Banco Santander	Y	Y	Y	Y
ES060	BBVA	Y	Y	Y	Y
ES061	BFA-Bankia	N	Y	Y	N
ES062	La Caixa	N	Y	Y	Y
ES N/A	BASE	N	Y	N	N
ES083	CAM	N	N	Y	N
ES063	Effibank	N	N	Y	N
ES064	Banco Popular Espanol	Y	Y	Y	Y
ES065	Banco De Sabadell	N	Y	Y	N
ES066	DIADA - CatalunyaCaixa	N	Y	Y	N
ES067	BREOGAN - NovaCaixaGalicia	N	Y	Y	N
ES068	Mare Nostrum	N	Y	Y	N
ES069	BankInter	N	Y	Y	N
ES070	Espiga	N	Y	Y	N
ES071	Banca Civica	N	Y	Y	N

ES072	Ibercaja	N	Y	Y	N
ES073	Unicaja	N	Y	Y	N
ES074	Banco Pastor	N	Y	Y	N
ES N/A	Caja Sol	N	Y	N	N
ES075	Grupo BBK	N	Y	Y	N
ES076	UNNIM	N	Y	Y	N
ES077	Kutxa	N	Y	Y	N
ES078	Grupo Caja3	N	Y	Y	N
ES N/A	Caja de Cordoba	N	Y	N	N
ES079	Banca March	N	Y	Y	N
ES N/A	Banco Guipuzcoano	N	Y	N	N
ES080	Caja Vital	N	Y	Y	N
ES081	Caja de Ontinyent	N	Y	Y	N
ES082	Colonya	N	Y	Y	N
FI012	OP-Pohjola Group	N	Y	Y	Y
FR013	BNP Paribas	Y	Y	Y	Y
FR014	Credit Agricole	Y	Y	Y	Y
FR015	BPCE	N	Y	Y	Y
FR016	SocGen	Y	Y	Y	Y
GB088	RBS	Y	Y	Y	Y
GB089	HSBC	Y	Y	Y	Y
GB090	Barclays	Y	Y	Y	Y
GB091	Lloyds	N	Y	Y	Y
GR030	EFG Eurobank Ergasias	Y	Y	Y	N
GR031	National Bank of Greece	Y	Y	Y	N
GR032	Alpha Bank	Y	Y	Y	N
GR033	Piraeus Bank Group	Y	Y	Y	N
GR034	ATE Bank	N	Y	Y	N
GR035	Hellenic Postbank	N	Y	Y	N
HU036	OTP Bank.	Y	Y	Y	Y
HU N/A	FBH	N	Y	N	N
IE037	Allied Irish Banks	Y	Y	Y	Y
IE038	Bank if Ireland	Y	Y	Y	Y
IE039	Irish Life and Permanent	N	N	Y	Y
IT040	IntesaSanPaolo	Y	Y	Y	Y
IT041	Unicredit	Y	Y	Y	Y
IT042	Monte dei Paschi	N	Y	Y	Y
IT043	Banco Popolare	N	Y	Y	Y
IT044	Ubi Banca	N	Y	Y	Y
LU045	BCEE	N	Y	Y	Y
LU N/A	Banque Raiffeisen	N	Y	N	N
MT046	Bank of Valletta	N	Y	Y	Y
NL047	ING Bank	Y	Y	Y	Y
NL048	Rabobank	Y	Y	Y	Y
NL049	ABN AMRO	N	Y	Y	Y
NL050	SNS Bank	N	Y	Y	Y

NO051	DnB NOR Bank ASA	Y	N	Y	Y
PL052	PKO Bank	N	Y	Y	Y
PT053	Caixa Geral de Depositos	Y	Y	Y	Y
PT054	Millennium Bcp	Y	Y	Y	Y
PT055	ESFG	Y	Y	Y	Y
PT056	Banco BPI	Y	Y	Y	Y
SE084	Nordea Bank	Y	Y	Y	Y
SE085	SEB	Y	Y	Y	Y
SE086	Svenska Handelsbanken	N	Y	Y	Y
SE087	Swedbank	Y	Y	Y	Y
SI057	NLB Bank	Y	Y	Y	Y
SI058	NKBM	N	N	Y	Y
	TOTAL	**36**	**91**	**90**	**61**

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