Sovereign risk and deposit dynamics: evidence from Europe

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Abstract

The unprecedented expansion of sovereign balance sheets since the beginning of the global crisis has given a new meaning to the term *sovereign risk*. Developments in Europe since early 2010 revealed new challenges for the functioning of private banks in an environment of heightened sovereign risk and may have contributed to deleveraging. The paper uses an innovative way of measuring the perception of sovereign risk and its impact. Using an extension of a common market discipline framework, it shows that exposure to sovereign risk may have limited the ability of banks in Europe to collect deposits. Potential identification issues between deposits and bank efficiency are controlled by using Data Envelopment Analysis. The results are robust to inclusion of conventional measures of bank performance and the sector-wide holdings of foreign sovereign debt.

JEL Classification Numbers: E44, G21, and G28

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I. Introduction and Motivation

Ever since the beginning of the 2008 global crisis, banks in Europe have been under pressure from both regulators and markets to restructure and deleverage. While important cross-country differences in the way deleveraging took place were observed on the asset side (see IMF, 2013; p. 23),[1] on the liability side the response was rather uniform: the banks reduced their use of wholesale, short-term, and cross-border funding in favor of more stable domestic retail funding. As the banks subsequently learned, there were (objective and subjective) limits to what they could do in this respect.

Some countries in Europe have experienced massive deposit outflows (Figure 1). A total of $425 billion was drawn from banks in Spain, Portugal, Ireland and Greece in a 12–months period ending July 2012.[2] Only about a quarter of this decline in deposits was due to the core European banks' reduction of exposure to the Eurozone periphery, with the residual accounted for by a decline in domestic customer deposits. The erosion of deposits had forced banks in those countries to pay more to retain them.[3]

One of the factors that may have limited the banks' pursuit of stable funding was the extent of their (perceived) risk-taking on the asset side. The traditional market discipline hypothesis suggests that claim holders punish banks for holding excessive risk by reducing their exposure or charging higher costs for maintaining it. While risk taking has always been found to play a role in disciplining banks and limiting their ability to raise deposits (see Chapter II below), this time the source of that risk was likely to have been different. We conjecture that the reasons had to do with the unprecedented government support lent to the real economy and the financial sector during the crisis, stretching the government's balance sheets beyond what could be considered normal.

The combined effect of this support and the loss of tax revenues had resulted in deterioration of fiscal balances, increased public debt, and elevated levels of contingent liabilities. The maturity structure, composition, and holder profile of public debt too have been altered, reflecting increasing investor risk aversion. In some countries concerns of contagion among the sovereign, quasi-sovereign, and financial sectors remained at elevated levels for quite some time, while in other areas the protracted recovery caused problems with debt

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[1] This took the form of raising capital and shedding various categories of assets.

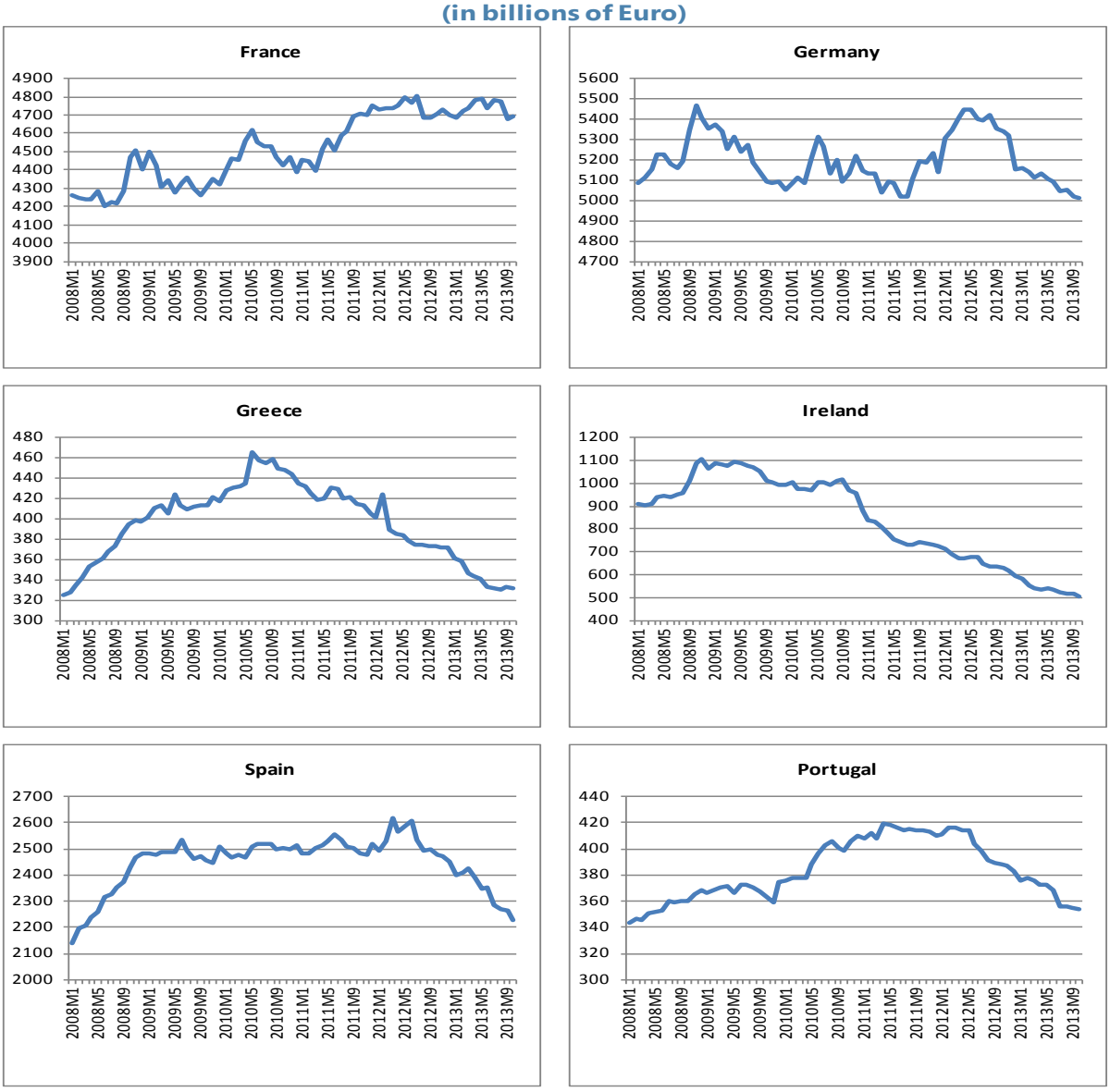
[2] "Deposit Flight From Europe Banks Eroding Common Currency," Bloomberg, September 18, 2012.

[3] For instance, while having arrested the decline in deposits in 2013, banks in Italy paid a high price to do so, with average deposit rates jumping 50 percent to 3.1 percent in July from a year earlier. For comparison, the average deposit cost at German banks in July was 1.5 percent and two years prior to that there was no difference between Italian and German deposit rates (both stood at 1.3 percent).

sustainability. These developments—dubbed as "sovereign risk"—have become a matter of concern for policy makers, capital market participants, and savers/depositors.[4]

[4] Sovereign risk can be split into two components, solvency and liquidity. *Solvency risk* can be defined as the risk that a country is not able to meet the present value of its obligations evaluated at interest rates that are commensurate with the debt stock and primary balance. *Liquidity risk* can be defined as the risk that the government is unable to discharge its obligations despite being solvent (at interest rates that are commensurate with the debt stock and primary balance) due to lack of liquidity. The conventional measures of sovereign risk are more narrowly focused on the probability of a sovereign government defaulting on its debt obligations. A wider construct, where core fiscal variables are complemented with elements reflecting (i) broader balance sheet developments, (ii) debt portfolio structure, (iii) investor base and cross-border linkages, and (iv) financial assets of a country would have been more meaningful given recent developments, but are yet to be integrated fully into the standard risk assessment tools.

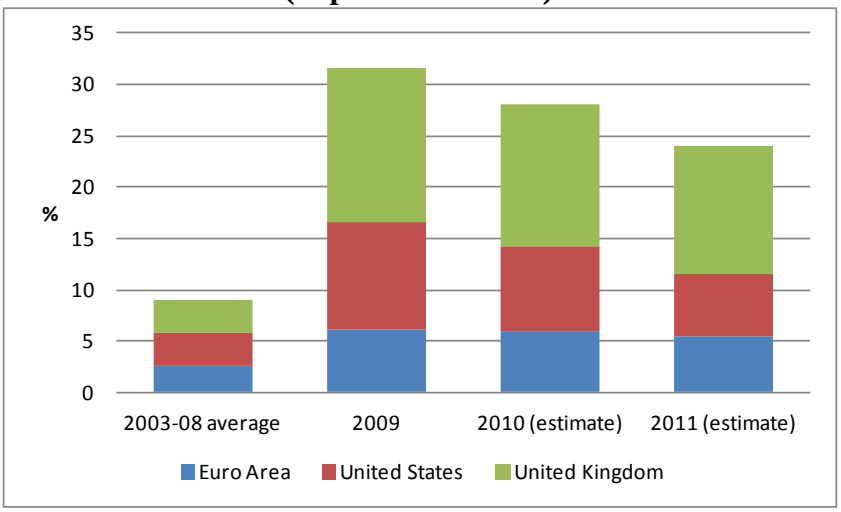
Figure 1. Evolution of Bank Deposits in Select Euro Area Countries, 2008-2013 (in billions of Euro)



Source: IMF, *International Financial Statistics*.

A noteworthy element of the overall picture was the elevated financial needs of the public sector. Total annual net sovereign borrowing in advanced countries has increased sharply in 2009 and 2010 (IMF, 2010). While for 2003-08, the average net borrowing in the US, Euro area, and the UK was around 2.5-3.3 percent of GDP, it had risen to 6-15 percent of GDP in 2009 and 2010, and was projected to decline only moderately in 2011 (Figure 2). In these countries, public debt was forecast to reach 110 percent of GDP on average by 2015—nearly 40 percentage points above the pre-crisis levels.

Figure 2: Total Net Borrowing Needs of the Public Sector as of 2010 (in percent of GDP)



Source: IMF, 2010.

The crisis also resulted in a sharp increase in public contingent liabilities. These have taken the form of explicit (e.g., on debt issued by financial institutions) as well as implicit (signals to support vulnerable segments of banking sectors) guarantees. Consequently, any weaknesses in the banking sectors were likely to have been viewed as contributing to this contingent liability. As of mid-2010, explicit contingent liabilities represented a significant proportion of GDP for the issuing European countries. Across the Eurozone, guarantees issued by Belgium, Germany, Ireland, Spain, and the Netherlands represented the largest proportions of outstanding guarantees: 10, 11, 17, 25, and 10 percent, respectively. (See Table 1 for a breakdown of government guaranteed debt).

Table 1: Outstanding stock of government guaranteed debt (in percent of GDP)

	Dec-08	Mar-09	Jun-09	Sep-09	Dec-09	Mar-10	Jun-10
Denmark	0.00	3.44	5.87	7.03	8.18	8.44	9.36
Eurozone average	0.34	1.61	2.68	3.88	4.15	5.03	4.56
Sweden	1.49	4.19	5.95	6.01	6.04	6.40	5.63
UK	2.12	4.74	5.89	6.28	7.03	6.89	7.31
US	0.64	1.34	1.54	1.66	1.73	1.71	1.60

Sources: Dealogic.

Given the (elevated levels of) sovereign risk and it is perhaps not surprising that savers may not view the deposit insurance available to them (an otherwise key factor of deposit mobilization) as fully credible and choose to reduce/alter their exposure by either moving their funds to safer/better-performing banks or cutting it down altogether.

Understanding how the sovereign risk influences banks' balance sheets is critical for understanding the full impact of a (large) fiscal shock on the economy and for designing an appropriate policy response. Sovereign risk could be transferred to the financial sector through two main channels: (i) on the asset side, via valuation losses on bank holdings of

sovereign securities (including inability to repo downgraded securities) (*direct* sovereign risk); and (ii) on the liability side, through an increase in bank funding costs caused by re-pricing of risk and credit rating downgrades (*indirect* sovereign risk). In turn, deteriorating bank balance sheets may require additional direct assistance, thus further increasing the debt burden of the sovereign.

These two-way effects may reinforce each other making matters worse, to a point that the implicit government guarantee to the banking sector (e.g., the "too big to fail"), may lose value for depositors if sovereign is in distress and therefore unable to honor its obligations when the guarantee is called (e.g., deposit insurance is no longer perceived as credible). In a number of periphery countries (e.g., Italy, Spain, and Portugal), sovereign CDS spreads exceeded the CDS spread for senior bank debt for extended periods of time since 2008, suggesting that markets perceived sovereigns to be more risky than the banks in their respective countries.

One of the key stylized facts of sovereign indebtedness is that countries with the highest debt-to-GDP ratios tend to have the highest proportion of government debt held by bank. This exacerbates the sovereign-bank nexus and can be viewed as a form of financial repression.[5] Whilst this has long been an emerging market phenomenon, it has recently become a feature of advance economies. These and other factors put a premium on assessing the banking sector's and sovereign vulnerabilities in a combined manner.

The Eurozone—which faced its own crisis in the first half of 2010—offers an excellent field to study this topic. With a common currency but idiosyncratic shocks to the real economies (and by extension also to sovereigns), events in Europe may shed new light on the link between banking and sovereign risk. In response to a questionnaire distributed by ECB in July 2012, 18 percent of European banks—compared with only 4 percent in the first quarter of 2012—attributed the deterioration in funding conditions to the sovereign debt crisis, through either direct exposures to sovereign debt, reduced collateral value of government bonds or other effects (ECB, 2012; Box 2).[6] The paper zooms in on the link between the sovereign risk and liability side of the banks' balance sheet.
As banks in Europe faced pressures on both sides of the balance sheet, having access to a stable deposit base to secure a smooth rollover of outstanding liabilities will be important going forward. As things stood then, the heightened levels of sovereign risk were causing a challenge for banks that may otherwise be both liquid and solvent. The main question asked in the paper is how sovereign risk affects the willingness of depositors to stay put (rather than withdraw) given heightened sovereign risk conditions in their respective jurisdictions. Using a bank-level indicator that controls for endogeneity between sovereigns and banks, we expect *ceteris paribus* consumer deposits to be negatively affected by a bank's perceived exposure to sovereign risk. The remainder of the paper is structured in the following way. Section II

[5] Gennaioli, Martin, and Rossi (2014) note that accumulation of high-risk public bonds by (predominantly large) banks during crises is also consistent with bailout guarantees or moral suasion.

[6] The same effect was reported to have abated slightly in some segments in the first quarter of 2013 (ECB, 2013), as the sovereign crisis was contained.

offers a brief survey of the relevant literature. Section III discusses the main features of the econometric model, data, and empirical estimates. Finally, Section IV concludes.

II. LITERATURE REVIEW

Market discipline can be seen as the ability of stakeholders of a bank—bank depositors, bond holders, and shareholders—to influence the behavior of the bank. In certain institutional frameworks, stakeholders will perform (costly) monitoring of bank activity to protect their interests and their reaction may provide useful signal to banking supervisors and the markets about riskiness of the bank.

A significant number of papers found support for the link between the riskiness of banks and depositors' actions. Confronted with higher risk, the depositors may—as the hypothesis goes—withdraw their deposits or demand higher interest rate on their holdings. Park and Peristiani (1998) used data on US thrifts between 1987 and 1991 and they found that riskier thrifts faced declining deposits and had to pay higher interest rates to retain them. Similar results were obtained by Goldberg and Hudgins (2002) using a larger time frame. In developing countries, Martinez Peria and Schmukler (2001) used data from Argentina, Chile, and Mexico to show that depositors punished high-risk banks by requiring higher interest rates or reducing their exposure to risky banks.

Other studies analyzed the behavior of bondholders (especially of subordinated debt holders) in response to banks' risk-taking. An early survey of empirical literature argues in favor of the existence of market discipline for large, traded US financial institutions (Flannery 1998). Using data from 1993-98, Morgan and Stiroh (2001) found that banks with higher risk levels face higher bond spreads. Similar results on the effectiveness of subordinated debt to inform on issuing bank financial conditions were presented by Jagtiani and Lemiex (2001) and DeYoung *et al.* (2001). Evanoff, Jagtiani, and Nakata (2011) survey the literature on the role of subordinated debt on market discipline and argue that a mandatory sub-debt program may significantly improve market discipline.

Market discipline can be a useful tool for bank supervision confronted with increasingly complex bank organizations and higher costs. Bernanke (2007) proposed a hybrid approach to keep banking system safe, by combining the regulatory oversight of the industry with market discipline. Kwan (2002) and Krainer and Lopez (2002) uses stock market data to measure the bank's level of risk. They argue in favor of using stock data to study market discipline and suggest that doing so may improve the quality of bank supervision.

Studies also looked at the role of deposit insurance on market discipline. Demirguc-Kunt and Huizinga (2004) used data for 30 developed and developing countries between 1990 and 1997 to show that deposit insurance affects make interest rates for deposits less sensitive to bank's risk. A cross-country study by Nier and Baumann (2006) on 729 banks from 32 countries found that implicit government guarantees weakens market discipline while the significant use of uninsured funds and more informational disclosure from banks strengthened market discipline.

While we are not aware of research that connects the risk associated with sovereign debt held by banks with market discipline, a number of recent papers analyze the impact of holding of sovereign debt on bank performance in the context of European sovereign debt crisis. Angeloni and Wolff (2012) find that banks' stock market performance was affected by exposure to Greek debt holdings (July to October 2011) or Italian and Irish sovereign debt (October to December 2011) while holding Spanish sovereign debt had less of an impact. Acharya *et al.* (2014) use the holdings of sovereign debt by banks to build a measure of banks dependence of GIIPS economies. They find that banks with high GIIPS dependence reduce the volume of loans to the firms, therefore negatively affecting their employment growth, level of investment and sale growth. Similarly, Popov and van Horen (2013) show that European bank's holdings of impaired foreign sovereign debt has impacted their lending.

III. EMPIRICAL ESTIMATION

A. Modeling and measurement

Consistent with the market discipline literature, we employ the following reduced-form equation to see whether the sovereign risk has any implications for the banks' ability to collect deposits:

$$\Delta Deposits_{i,j,t} = \beta_1 \cdot Performance_{i,j,t} + \beta_2 \cdot SovereignRisk_{i,j,t} + \beta_3 \cdot Controls_{i,j,t} + \varepsilon_{i,j,t} \quad (1)$$

where, $\Delta Deposits_{i,j,t}$ is change in deposit of the bank *i* operating in country *j* between two periods (*t* and *t-1*), $Performance_{i,j}$ a composite measure of bank performance (see below), $SovereignRisk_{i,j}$ is a measure of bank's exposure to sovereign risk, and $Controls_{i,j}$ is a matrix of bank- and country-specific control variables (market share, unemployment, and inflation).

Conventional measures of sovereign risk are imperfect and do not cover elements discussed earlier. The closest proxy used in the literature is the holdings of sovereign treasury securities. However, this measure has a drawback in that it measures the net as opposed to gross effect of sovereign holdings. The latter also offer liquidity services to banks (and its stakeholders) and should therefore in principle be viewed as positive. Practically, however, netting out this effect would be very difficult. Furthermore, most data services do not report country-by-country holdings of banks' sovereign portfolio. Lumping holdings of all (i.e., own and other countries') government securities together will mask the relative riskiness of the underlying sovereigns and may bias the results. However, the most important constraint in this case (i.e., when the behavior of depositors is being studied) is that most depositors are not very sophisticated and do not have access to data on banks' holdings of sovereign securities and, by extension, also of their sovereign risk exposure.

This paper proposes an innovative measure to proxy for sovereign risk. We use Factiva news service—which collects information from 32,000 news and information sources in 28 languages from nearly every country in the world—to construct a measure of (perception of) sovereign risk. The underlying assumption for doing so is that mainstream media reports

about banks and their conditions are more readily available to depositors than bank-specific financial data. We further assume that the frequency of media references about a particular subject is correlated with how deep/serious/widespread the subject matter is.

With this in mind, we used Factiva archive search engine to count the number of times that the terms "sovereign risk" or "government debt" were used in the same news article with the name of the bank in question in each country every year.[7] For example, the notation $Factiva_{2,5,2010} = 478$ would mean that there have been 478 articles in media outlets assembled by Factiva in 2010 from the 5th country that has terms of "sovereign risk" or "government debt" mentioned together with the name of the bank No. 2 in the same article. To eliminate the cross-country differences between Factiva reporting service, we constructed a measure of deviation from a country's average at a given period of time as follows:

$$SovereignRisk_{i,j,t} = Factiva_{i,j,t} - \overline{Factiva_{j,t}} \qquad (2)$$

where $\overline{Factiva_{j,t}}$ is the average of *Factiva* indicators for a country *j* at year *t*. The bank-level financial data used in the estimations cover 2006-11 and come from Bankscope. The statistical properties of variables used in the regression analysis are reported in Table 2.

Table 2. Summary Statistics

No. of observations = 957	Mean	Std. Dev.	Min	Max
Change in deposits, million euros	1.84	15.53	-62.58	87.39
Performance (DEA), a [0, 1] index	0.60	0.15	0.28	0.89
Inflation, percent	2.95	2.29	-1.09	12.35
Sovereign Risk (Factiva, demeaned) count	11.57	75.46	-71.00	483.31
Market Share, ratio	0.11	0.14	0.0001	0.65
Unemployment, percent	8.79	4.13	3.20	21.60

B. Baseline Regression Results

To reduce the potential endogeneity between deposits and bank performance in Equation 1 we measure the latter by using Data Envelopment Analysis (DEA) methodology. DEA scores are [0, 1] measures of composite bank efficiency/performance relative to sample peers, calculated based on a set of indicators—inputs and outputs to bank's operation, consistent with services provided by banks—which in this case excludes deposits (the dependent variable in the main equation). Appendix 1 contains detailed explanation behind the DEA methodology and input/output variables used in estimation. Using bank-specific DEA indices in such a way in Equation 1 thus works similar to a 2-stage approach aimed at reducing the endogeneity between performance and dependent variable.

[7] In addition to English, we used translations of these terms into the countries' national languages.

DEA methodology was used extensively in studies of banking industry in developed market economies but also in other industries where a comparison of decision-making units with their most efficient ones (those on the frontier) is required. The conventional DEA scores are subsequently corrected for efficiency bias following the methodology proposed in Simar and Wilson (1998, 2000) and reported across countries and time in Appendix II. The relative ranking of countries is largely consistent with one's prior about the level of efficiency of banks in those countries.

Table 3 (first and second columns) contains the results of the baseline fixed effects regression based on Equation 1.[8] The outcomes are as predicted. First of all, the perceived sovereign risk has a negative impact on growth of deposits. More news on a bank's exposure to sovereign risk prompts the depositors to reduce their deposits *ceteris paribus*.

Second, the results show that the growth of consumer deposits is positively affected by the efficiency of banks. Depositors reward more efficient banks by increasing their exposure to them. This outcome is consistent with most of the market discipline literature surveyed earlier.

Third, it appears that macroeconomic conditions (proxied by inflation and unemployment) have no direct impact on deposit growth. (They may, however, have indirect impact via sovereign risk and bank's efficiency indexes through impact on NPLs and profitability). The result on unemployment is particularly surprising, since one would expect that agents to respond to worsening economic fundamentals in a manner consistent with consumption-smoothing motives, that is, by reducing deposits. However, one reason behind this outcome could be due to consumers responding to expected future values of inflation and unemployment as opposed to contemporaneous ones.

Fourth, the banks' market share (in their own jurisdictions) has the right sign but is insignificant.[9] With efficiency considerations stemming from scale having already been captured by the DEA scores, this is likely to be a proxy for the "too big to fail" effect. If so—as conjectured above—it must be that depositors do not attach much value to the implicit guarantee of the government (to bail out the large banks) amid heightened sovereign vulnerabilities.[10] It could also be that some banks have already reached a size that makes them "too big to save", which will have the opposite effect on risk perception and pricing. Overall, this outcome is inconsistent with Völz and Wedow (2009), who found evidence of (a minor) "too big to fail" effect for bank CDS in Europe, and IMF (2014; Figure 3.8), which

[8] Using fixed effects specification helps control for any unobserved characteristics.

[9] We used the size of assets as a measure of scale, but it proved insignificant, perhaps emphasizing the need to control for banks' relative size in the economy and not its absolute size among its peers across countries.

[10] We also run the regressions using interaction between the market share variable and a crisis dummy (results not reported). While there was some indication that the "too big to fail" effect declined in 2010-11, the results were not significant.

reports a (slight) decline in implicit "too big to fail" subsidies to Euro area banks during 2006-11.[11]

To gauge the role of various indicators in the bank's ability to collect deposits *before* the crisis compared to *during* the crisis period, we run regressions for two time periods: 2006-09 and 2010-11 (Table 3, columns 3 and 4). The results point out to some interesting difference across the two periods. Specifically, the results show that *before* crisis: (1) bank performance is statistically a very strong predictor of deposit growth; (2) sovereign risk is not seen as an important factor by depositors (since debt sustainability is not a concern[12]); and (3) inflation leads to more deposit accumulation (perhaps consistent with increased cost of holding cash). On the contrary, *during* the crisis: (1) the impact of bank performance on deposits vanishes; (2) perception of sovereign exposure/risk becomes an important (negative) predictor of deposit behavior, and (3) inflation no longer matters (perhaps due to money balances becoming less sensitive to changes in prices, with implicit cash-in-advance-type constrains becoming more important).

Finally, we account for potential non-linearity in the impact of sovereign risk on depositor behavior by controlling for degree of exposure to sovereign-related news. To this end, we introduced a variable *Dummy75pc*, which takes value of 1 if *Sovereign Risk* is in the upper quartile of its distribution for a given country and year and 0 otherwise. The regressions, where *Dummy75pc* is interacted with *Sovereign Risk*, are presented in column 5 of Table 3. The results suggest that banks that are seen as strongly exposed to sovereign-related developments may be at a higher risk of losing deposits.

[11] Similarly, in the context of the US, Ötker-Robe *et al.* (2011; p. 6) showed that the cost advantange of large banks becomes visible only after the crisis.

[12] Prior to the global financial crisis, despite substantial differences in macroeconomic and specifically fiscal outcomes, all Eurozone countries were able to access financial markets at almost identical yields (Feld *et al* 2015).

Table 3. Fixed Effects Regressions, 2006-11

	2006 - 11	2006 - 11	2006 - 09	2010 - 11	2006 - 11	2006 - 09	2010 - 11
Performance (DEA)	13.699***	13.555***	22.038***	-0.545	13.283***	21.222***	-1.109
	[3.052]	[3.038]	[3.034]	[-0.133]	[3.026]	[3.012]	[-0.279]
Sovereign Risk (Factiva)	-0.031**	-0.031**	-0.006	-0.031***	0.109***	0.220*	0.093
	[-2.413]	[-2.409]	[-0.137]	[-2.934]	[3.090]	[1.774]	[1.597]
Sovereign Risk (Factiva) x Dummy75pc					-0.153***	-0.238	-0.137**
					[-3.355]	[-1.550]	[-2.041]
Inflation	0.104	-0.019	1.689***	0.478	0.27	1.673***	0.258
	[0.421]	[-0.0591]	[2.800]	[0.535]	[0.792]	[2.790]	[0.286]
Unemployment		-0.18	0.455	-0.311	0.031	0.541	-0.376
		[-0.617]	[0.973]	[-0.339]	[0.0982]	[1.140]	[-0.405]
Market Share	11.399	11.501	15.400	5.041	11.387	15.457	4.968
	[1.574]	[1.588]	[1.537]	[0.522]	[1.587]	[1.550]	[0.516]
Annual dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-8.021***	-7.084**	-22.718***	2.404	-8.370***	-21.791***	5.276
	[-2.830]	[-2.298]	[-4.892]	[0.343]	[-2.583]	[-4.785]	[0.758]
No. of observations	957	957	575	382	957	575	382
R-squared	0.117	0.117	0.162	0.149	0.127	0.166	0.164

Note: *** p<0.01, ** p<0.05, * p<0.1. Number of countries is 29.

Running the regressions *before* and *during* crisis (columns 6 and 7, respectively) reveals interesting differences. *Before* crisis, irrespective of the amount of sovereign-related news (i.e., whether in the first three quantiles or the fourth quantile), the latter is associated with deposit accumulation. This could be due to the fact that in tranquil time any news of a bank's association with sovereign might actually be interpreted as a positive sign rather than a negative one. This effect practically disappears *during* the crisis for those in the first three quantiles (coefficient is statistically zero) and becomes negative for the banks in the fourth quantile of sovereign news distribution (coefficient equals -0.137 and is statistically significant).

C. Robustness Tests

To test for the robustness of the baseline results, we used a number of alternative specifications. First of all, we replaced DEA indicator with a more conventional measure of bank performance, Return on Equity (ROE). The results (reported in columns 2-4 of Table 4) are largely consistent with the baseline specification.[13] In contract with the baseline regressions, however, the regression with ROE suggests presence of a "too large to fail" effect: the coefficient on market share on change in deposits is positive and statistically significant.

Second, we reintroduce the country component in the Factiva variable (instead of taking it out per Equation 2). Doing so does not materially change the results (reported in columns 5-7 of Table 4).

Finally, we used data from Bank for International Settlements to control for exposure of the countries' banking sector to various country groupings, such as, the US, core Eurozone, peripheral Eurozone, emerging Europe, and non-Eurozone Advanced Europe (see Appendix III for the country classifications). The results (reported in final column of Table 4) remain unchanged.[14] Interestingly, depositors distinguish between their banking sector's exposures to the country groupings.[15] While the coefficients on variables measuring exposure to sovereigns in the Periphery EZ, Emerging Europe, and the US are all negative, only the coefficient on Emerging Europe is significant, perhaps suggesting an ordering of sorts between the country groupings where the Emerging Europe would be seen as the riskiest and Core Eurozone as well as Non-Eurozone Advanced Europe groupings are seen by the depositors as the least risky.

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[13] Results with Return on Assets (instead of DEA) are very similar and available from the authors upon request.

[14] Adding country-specific interest rates (regressions not reported) did not change much, potentially because that information is likely to be contained in our measure of sovereign risk..

[15] Note that the additional variables (country groupings) in columns 3 and 4 measure the nominal dollar value of the home country banking sector to the sovereigns in those country groupings.

Table 4. Robustness Tests

	Baseline (2006-11)	2006 - 09	2010 - 11	2006 - 11	2006 - 09	2010 - 11	2006 - 11	2006 - 11
Performance (DEA)	13.555***				21.94***	-0.433	13.726***	21.083***
	[3.038]				[3.018]	[-0.105]	[3.077]	[2.976]
Performance (ROE)		0.102**	0.055**	0.085***				
		[2.326]	[2.392]	[3.473]				
Sovereign Risk (de-meaned **Factiva**)	-0.031**	0.004	-0.030***	-0.027**				-0.037***
	[-2.409]	[0.0977]	[-2.845]	[-2.150]				[-2.825]
Sovereign Risk (level of **Factiva**)					-0.003	-0.033***	-0.033***	
					[-0.080]	[-3.035]	[-2.593]	
Inflation	-0.019	1.568***	0.288	-0.017	1.688***	0.438	0.123	2.878**
	[-0.0591]	[2.694]	[0.338]	[-0.0565]	[2.802]	[0.496]	[0.383]	[2.048]
Market Share	-0.18	23.932**	3.589	16.129**	15.122	5.305	11.822	20.911
	[-0.617]	[2.381]	[0.372]	[2.214]	[1.502]	[0.549]	[1.626]	[1.614]
Unemployment	11.501	651.6	-26.57	-13.82	0.457	-0.251	-0.068	-0.130
	[1.588]	[1.309]	[-0.0284]	[-0.0456]	[0.967]	[-0.274]	[-0.229]	[-0.254]
US								-2.08E+05
								[-0.908]
Emerging Europe								-3.9e+05**
								[-2.320]
Non-EZ Advanced Europe								2.05E+05
								[0.765]
Core EZ								-8.24E+03
								[-0.0883]
Periphery EZ								1.71E+05
								[0.489]
	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-7.084**	-11.46***	1.850	-0.956	-22.70***	3.268	-7.809**	32.100
	[-2.298]	[-2.621]	[0.326]	[-0.345]	[-4.860]	[0.565]	[-2.521]	[1.260]
Observations	957	575	382	957	575	382	957	533
R-squared		0.154	0.156	0.119	0.162	0.153	0.121	0.167

Note: *** p<0.01, ** p<0.05, * p<0.1. With the exception of the last column (where number of countries is 14), the number of countries in all columns is 29.

IV. CONCLUSION

The main question posed in the paper was whether depositors punish the banks for carrying too much sovereign risk. Our estimates based on data from 29 European countries from 2006-11 showed that the exposure of the banking sector to sovereign risk negatively affects the growth of consumer deposits, over and above the impact of macroeconomic conditions. We conclude that (excessive) holdings of sovereign risk may have contributed to deposit outflows (and possibly to deleveraging) in Europe. However, this relationship is none-linear. While all banks benefit from their perceived relations to the sovereign during tranquil times, banks that are in the news *during* crisis more often are punished by the depositors during the crisis. We also find that depositors pay closer attention to banks' financial performance during tranquil times but financial performance becomes less of a factor during the crisis times (with perceived risks taking driver's seat in determining depositors' choices). Finally, with the exception of one specification, we found no evidence of "too big to fail" effect from the depositors' perspective.

These findings offer a somewhat gloomy picture for banks in a region that is likely to have elevated debt levels for years to come. While policy measures to weaken the link between sovereign risk and deposit contraction are limited to fiscal tightening and liability management exercises (aimed at reducing short-run gross borrowing needs) knowing the nature and strength of this link can nevertheless be helpful *inter alia* for better understanding the pressures faced by banks. New regulations, which could encourage banks to hold more government debt (e.g., for liquidity purposes) should be introduced with care and their (undesirable) impact should, if possible, be mitigated.

However, on a positive side, the results suggest that measures to improve bank efficiency may help boost depositor confidence and help stabilize deposits. In general, building sufficient buffers—both for banks (in the form of more capital and liquidity) and sovereigns (in the form of lower levels of debt and quasifiscal activity)—would be key to building resilience to fiscal and financial shocks and weakening the sovereign-bank nexus.

Finally, to the extent that the observed negative link between sovereign risk and ability to collect deposits may limit the banks' ability to lend (as documented by Popov and van Horen (2013), and Acharya *et al.* (2014), among others), it strengthens the pro-cyclical role played by the banks in the transmission of fiscal shocks in Europe. If so, this may call for a more explicit inclusion of banks in the traditional macro models to account for a full pass-through of the shocks to the real economy and improve the accuracy of macroeconomic projections.

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Appendix I. Description of DEA Methodology and Choice of Inputs/Outputs

Data Envelopment Analysis (DEA) is used in the literature extensively to evaluate productivity and performance of banks. It is a non-parametric method that allows one to account for a wide range of functions performed by the banks. This method compares relative performance of banks by building a frontier comprised of the most efficient banks and focusing on how close other banks are to this frontier. Thus this method provides a measure of relative efficiency. In practice, this was first implemented by Charnes, Cooper, and Rhodes (1978), who used a linear-programming method to identify the efficient decision-making units and coined the method DEA.[16] DEA has since been used extensively in studies of the banking industry in developed and developing market economies, for individual countries as well as inter-country comparisons.[17]

To arrive at basic specification of a linear-programming model underlying the DEA, *K* inputs and *M* outputs are assumed for every bank. For the i^{th} bank the inputs and outputs are represented by vectors x_i and y_i respectively. For each bank the method aims to obtain a measure of the ratio of all outputs over all inputs, such as $u_i' y_i / v_i' x_i$, where u_i and v_i are vectors of weights. To select the optimal weights, the following linear programming problem is typically proposed:

$$\begin{aligned} \max_{u_{ik}, v_{im}} \ & \frac{u_i' y_i}{v_i' x_i} \\ s.t. \ & \frac{u_i' y_j}{v_i' x_j} \le 1 \\ & u_{ik}, v_{im} \ge 0 \\ & i, j = 1,2,...N \\ & k = 1,2,...K \\ & m = 1,2,...M \end{aligned} \qquad \text{(A-1)}$$

Using the duality property of this linear programming problem, Charnes, Cooper, and Rhodes (1978) derive an equivalent envelopment form as:

[16] Their method is based on the assumption that the production units have constant returns to scale. Banker, Charnes, and Cooper (1984) later relaxed the assumption and proposed a model with variable returns to scale. Theoretical extensions of these methods and empirical applications are discussed in Seiford (1996) and Cooper, Seiford, and Tone (2000).

[17] See Berger and Humphrey (1997) for a detailed survey.

$$\begin{aligned} &\min_{\theta,\lambda} \theta_i \\ &s.t. \; -y_i + Y\lambda_i \geq 0 \\ &\quad \theta_i x_i - X\lambda_i \geq 0 \\ &\quad \lambda_{in} \geq 0 \end{aligned} \tag{A-2}$$

where λ is an $(N \times 1)$ vector of weights assigned to each observation; and $\theta_i \in [0.\ 1]$ a scalar, is the efficiency score for the i^{th} DMU.[18] Essentially, θ_i is an indicator of how close a bank is to the efficiency frontier, with $\theta_i < 1$ implying that the bank is inside the frontier (i.e., it is an inefficient bank), while $\theta_i = 1$ implying that the bank is on the frontier (i.e., it is an efficient bank). Due to a fewer number of constraints, the formulation presented in Equation 2 is typically used for computations.[19]

Following Grigorian and Manole (2006), we specify the following three inputs to the banking "production process": *labor, fixed assets,* and *interest expenditures*. Doing so accounts for all three essential inputs to commercial bank operations: (1) personnel and management, (2) computer hardware and premises (which also captures the extensiveness of a bank's branch network), and (3) leveraged funds, respectively.

Next, we define the outputs as follows: (1) *revenues* (defined as the sum of interest and non-interest income), (2) *net loans* (defined as loans net of loan loss provisions), and (3) *liquid assets (defined as sum of* cash, balances with monetary authorities, and holdings of treasury bills).

Holding output (however specified) and two other inputs constant, the lesser amount of the third input used in the "production" would imply higher efficiency.

The results of DEA simulations using the above input-output combinations are reported in Appendix II below.

[18] $X = [x_1,..., x_N]$ is a $(K \times N)$ input matrix with columns x_i and $Y = [y_1,..., y_N]$ is an $(M \times N)$ output matrix with columns y_i.

[19] The efficiency indexes calculated in such a way are termed overall technical efficiency indexes and can subsequently be decomposed into pure technical and scale efficiency indexes, to help identify the source of inefficiency of each sample DMU.

Appendix II. Average DEA Indices by Country and Year

	2006	2007	2008	2009	2010	2011	Average
AUSTRIA	0.769	0.601	0.516	0.578	0.608	0.596	0.611
BELGIUM	0.559	0.657	0.600	0.609	0.760	0.844	0.672
BULGARIA	0.566	0.613	0.567	0.593	0.628	0.645	0.602
CYPRUS	0.443	0.481	0.466	0.626	0.598	0.517	0.522
CZECH REPUBLIC	0.612	0.654	0.662	0.766	0.768	0.792	0.709
DENMARK	0.689	0.672	0.569	0.598	0.646	0.610	0.631
ESTONIA	0.364	…	0.353	0.472	0.471	0.492	0.430
FINLAND	0.559	0.770	0.779	0.763	0.688	0.667	0.704
FRANCE	0.659	0.643	0.632	0.669	0.684	0.700	0.665
GERMANY	0.588	0.556	0.512	0.686	0.534	0.857	0.622
GREECE	0.576	0.530	0.499	0.528	0.514	0.499	0.524
HUNGARY	0.587	0.557	0.511	0.511	0.623	0.592	0.564
IRELAND	0.643	0.660	0.696	0.677	0.684	0.702	0.677
ITALY	0.557	0.584	0.502	0.629	0.657	0.600	0.588
LATVIA	0.563	0.558	0.520	0.536	0.496	0.533	0.534
LITHUANIA	0.527	0.524	0.489	0.466	0.467	0.492	0.494
LUXEMBOURG	0.481	0.502	0.523	0.545	0.538	0.560	0.525
MALTA	0.490	0.483	0.424	0.534	0.552	0.517	0.500
NETHERLANDS	0.465	0.568	0.561	0.612	0.602	0.599	0.568
NORWAY	…	…	0.686	0.748	0.744	0.823	0.750
POLAND	0.610	0.597	0.539	0.586	0.638	0.638	0.601
PORTUGAL	0.545	0.569	0.490	0.520	0.539	0.573	0.540
ROMANIA	0.442	0.463	0.461	0.460	0.525	0.486	0.473
SLOVAKIA	0.520	0.514	0.551	0.608	0.730	0.690	0.602
SLOVENIA	0.487	0.527	0.481	0.541	0.584	0.545	0.527
SPAIN	0.543	0.551	0.541	0.602	0.621	0.597	0.576
SWEDEN	0.848	0.827	0.850	0.807	0.792	0.698	0.804
SWITZERLAND	0.672	0.710	0.555	0.777	0.796	0.812	0.720
UNITED KINGDOM	0.626	0.628	0.627	0.693	0.677	0.752	0.667

Appendix III: Country Classifications

EU 27	EZ 17	EZ Periphery	Core EZ	Emerging Europe	Non-EZ Advanced Europe
Austria	Austria		Austria		
Belgium	Belgium		Belgium		
Bulgaria				Bulgaria	
Cyprus	Cyprus			Cyprus	
Czech Republic				Czech Republic	
Denmark					Denmark
Estonia	Estonia			Estonia	
Finland	Finland		Finland		
France	France		France		
Germany	Germany		Germany		
Greece	Greece	Greece			
Hungary				Hungary	
Ireland	Ireland	Ireland			
Italy	Italy	Italy			
Latvia				Latvia	
Lithuania				Lithuania	
Luxembourg	Luxembourg		Luxembourg		
Malta	Malta			Malta	
Netherlands	Netherlands		Netherlands		
Poland				Poland	
Portugal	Portugal	Portugal			
Romania				Romania	
Slovakia	Slovakia			Slovakia	
Slovenia	Slovenia			Slovenia	
Spain	Spain	Spain			
Sweden					Sweden
United Kingdom					United Kingdom
					Norway
					Switzerland