



Bank credit risk and sovereign debt exposure: Moral hazard or hedging?

Laura Baselga-Pascual^{a,*}, Lidia Loban^a, Emma-Riikka Myllymäki^b

^a University of Deusto. Deusto Business School, Department of Finance and Economics. Mundaiz Kalea, 50, 20012 Donostia, Gipuzkoa, Spain

^b Audencia Business School, Department of Accounting, Management Control and Economics, 8 route de la Jonelière, 44312 Nantes, France

ARTICLE INFO

JEL classifications:

G21
G28
G32

Keywords:

Financial institutions
Bank risk
Credit risk
Sovereign debt nexus

ABSTRACT

This study investigates the relationship between credit risk and bank exposure to sovereign debt. Using an international dataset of commercial banks from 2002 to 2022, we apply various regressions and panel data models to address potential endogeneity issues. Our results reveal that banks with higher levels of impaired loans tend to hold more sovereign debt. Furthermore, we observe that this relationship is stronger in countries with high sovereign credit ratings. This suggests that banks, when confronted with elevated credit risk from impaired loans, may seek safety in sovereign debt as a seemingly secure investment.

1. Introduction

As key investors in sovereign debt, banks leverage their liquidity to meet both regulatory mandates and internal risk management objectives. The relationship between sovereign and bank credit risk, often termed the 'Sovereign-Bank diabolic loop' (Brunnermeier et al., 2016), has gained prominence, especially after the recent failures of several banks, including Silicon Valley Bank and Credit Suisse. Given the critical role banks play in maintaining societal and economic stability, we examine the relationship between bank credit risk and sovereign debt exposure.

Empirical literature on banks' sovereign debt exposure largely focuses on the correlation between banks and sovereign credit default swaps (CDS). Most previous studies have concentrated on emerging economies (e.g., Feyen and Zuccadi, 2019; Hardy and Zhu, 2023) or Europe, often examining the Financial Crisis period (e.g., Ejsing and Lemke, 2011; Andreeva and Vlassopoulos, 2016; Fratzscher and Rieth, 2019), the impact of regulatory changes (e.g., Lamers et al., 2023; Fiordelisi et al., 2020), or peripheral European countries (e.g., Acharya et al., 2012; Li and Zinna, 2018; Gomez-Puig et al., 2019). However, the recent defaults of several U.S. banks

We would like to thank participants of the 31st Finance Forum, the Deusto Business School seminars, Reint Gropp, Denis Davydov, and Mariña Martínez-Malvar for their valuable comments. Laura Baselga-Pascual is grateful to grant IT-1497-22 from the Department of Education of the Basque Government. This paper was partially written during Laura Baselga-Pascual's research visit at Audencia, Nantes, and Lidia Loban's at ESSEC Business School, Paris.

* Corresponding author.

E-mail addresses: lbaselga@deusto.es (L. Baselga-Pascual), lidia.loban@deusto.es (L. Loban), ermyllymaki@audencia.com (E.-R. Myllymäki).

<https://doi.org/10.1016/j.frl.2024.106454>

Received 31 January 2024; Received in revised form 2 September 2024; Accepted 11 November 2024

Available online 16 November 2024

1544-6123/© 2024 The Authors. Published by Elsevier Inc. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

demonstrate that exposure to treasury debt also poses risks even in highly rated countries.

While many studies examine the effects of financial crises on government bond yields and the banking sector, few have explored the determinants of banks' sovereign debt exposure (Basse, 2014; Sibbertsen et al., 2014; Moro, 2014; and Gruppe et al., 2017)¹. Buch et al. (2016) found that weakly capitalized German banks hold more sovereign debt, while Lamas and Mencía (2019) and Martínez Malvar and Baselga-Pascual (2022) identified a positive correlation between credit quality and sovereign debt exposure in small European banks.

Our study explores the relationship between bank credit risk, proxied by non-performing loans (*NPLr*), and sovereign debt exposure. Given previous literature, our first hypothesis (H1) states as follows:

H1: The higher the credit risk of banks, the higher their sovereign debt exposure

Our second objective is to examine whether banks acquire sovereign debt primarily due to moral hazard or hedging purposes. Despite Basel regulations aimed at reducing risks, the relationship between banks and sovereign debt remains strong (e.g., Acharya et al., 2012; Reinhart & Rogoff, 2015; Cooper & Nikolov, 2018; Leonello, 2018; Jobst & Rösch, 2021; Mitchener & Trebesch, 2023)².

Boumparis et al. (2019) highlight a feedback loop where downgrades in sovereign ratings worsen banks' financial health, reducing lending and increasing defaults, particularly during crises. Drago and Gallo (2017) and Gennaioli et al. (2018) found that negative sovereign rating changes reduce lending by domestic banks, while Crosignani (2021) argued that low-capital banks tend to invest in government bonds, linking their success to government stability.

While the literature suggests that sovereign debt exposure can negatively impact the banking industry, there is no evidence on whether banks in high credit quality countries are more inclined to invest in their own sovereign debt as a hedging strategy, building a risk-free asset portfolio. Therefore, we hypothesize the following (H2):

H2: The effect of banks' credit risk on their exposure to sovereign debt is greater in low sovereign risk countries than in high sovereign risk countries.

Our findings corroborate H1, showing that banks with higher *NPLr* tend to hold more sovereign debt. This trend remains consistent across diverse economic environments, including countries with different GDP growth rates and sovereign credit ratings. For H2, we also find evidence suggesting that the impact of credit risk on sovereign debt is enhanced by the sovereign credit rating, indicating that banks with high credit risk will be more prone to increase their sovereign debt portfolio in low-risk countries.

We contribute to the existing literature that links bank and country risk by providing empirical evidence on the relationship between credit risk and sovereign debt exposure. Our study is the first to examine the moderating effect of sovereign credit ratings on the relationship between *NPLr* and Treasury debt exposure. Our research offers critical insights for regulators, suggesting that banks may increase their sovereign debt holdings to mitigate credit risk, which could lead to instability in scenarios with rising interest rates and a high correlation between bank and country risk. This underscores the need for continued regulatory vigilance and potential adjustments to address this ongoing risk.

2. Data and methodology

2.1. Sample

Our study examines an international sample comprising an unbalanced panel of more than 20,000 bank-year observations from 49 countries from 2002 to 2022.

We sourced bank-specific data from Refinitiv Eikon, while macroeconomic and regulatory data were obtained from the World Bank Database. The dataset includes commercial banks from 49 countries³ with numeric variables standardized in USD for consistency.

Bank-specific indicators are calculated on a non-consolidated basis, treating banking subsidiaries and foreign branches as separate credit institutions, minimizing aggregation bias (Delis & Staikouras, 2011). Merged banks are treated as separate entities before and as a single entity post-merger. Ratios capturing bank characteristics are standardized according to global accounting standards. Outliers with abnormal ratios or extreme values were excluded, and all continuous variables were winsorized at the 1st and 99th percentiles for reliability. The full sample distribution is detailed in Annex 1.

2.2. Variables

We use the ratio of treasury debt to total assets (*Sovereign debt ratio*) as a proxy for each bank's sovereign debt exposure (Gennaioli et al., 2018). Credit risk is proxied by the *NPLr*, a common measure of bank soundness (Berger & DeYoung, 1997; Delis & Kouretas, 2011; Festic, Kavkler, & Repina, 2011;). A higher *NPLr* indicates a greater likelihood of bank default.

¹ Sibbertsen et al. (2014) suggest that, after the financial crisis, euro area markets began focusing more on sovereign credit risk and potential currency redenomination when pricing government debt. Basse (2014) notes that France's credit risk perception shifted post-crisis, likely due to concerns about a Eurozone breakup (see Moro, 2014; Gruppe et al., 2017 for further reviews).

² For example, Acharya et al. (2012) argue that European banks' risks from 2007 to 2013 resembled a carry trade, partly because Basel II assigned a zero-risk weight to sovereign debt. Jobst and Rösch (2021) further suggest that capital requirements under Basel's Internal Ratings Based Approach are significantly higher than under the Standardized Approach, indicating that the latter's zero-risk weights may not reflect actual economic risk and could enable regulatory arbitrage.

³ We categorize the sample as "Commercial Banks" using codes 6021-6022-6029 in Refinitiv Eikon.

Following banking literature (e.g., De Jonghe, 2010; Gennaioli et al., 2018; Martínez Malvar and Baselga-Pascual, 2022), we organize variables using the CAMEL framework⁴. *Capitalization* is proxied by equity-to-total assets; the *Loan to assets* ratio reflects asset quality; *Profitability* is proxied by return on assets; management efficiency is measured by the Cost to income ratio (*CIR*); and liquidity is assessed through the *Customer deposits ratio*. We also control for *Revenue diversification* using the proportion of non-interest income to total operating income.

Macroeconomic controls include *Bank concentration* (the market share of the three largest banks by total assets), the *Inflation rate* (annual CPI change), and *GDP growth* (annual real GDP growth) (Uhde and Heimeshoff, 2009; Gennaioli et al., 2018; Buljan et al., 2020). A dummy variable indicates whether a bank is US-based, as half of the observations are from US banks. Sovereign risk is controlled using Standard & Poor's 2023 *Sovereign ratings*, numerically converted and mean centered⁵. Differences in banking regulations across countries are controlled using the *Activity Restrictions* indicator from the World Bank's Bank Regulation and Supervision database (Barth et al., 2019)⁶.

Table 1 presents descriptive statistics of the variables used. The average *Sovereign debt ratio* is 6.22 %, with a maximum of 33 % in some banks. The average *NPLr* is 5.80 %, with notable variability. *Capitalization* is relatively stable, while *Profitability* averages 2.7 %, with some banks reporting negative values. *Loan to assets* and *Customer deposit* ratios show moderate variability. *Sovereign ratings*, *Activity restrictions*, and macroeconomic indicators like *GDP growth* and *Inflation* rates vary moderately across the dataset.

2.3. Method

To test H1, our baseline equation is as follows:

$$\begin{aligned} \text{Treasury Debt exposure}_{j,t} = & \alpha + \beta_1(\text{Credit risk})_{j,t} + \beta_{2-7}(\text{Bank - specific controls})_{j,t} \\ & + \beta_{8-10}(\text{Macroeconomic and Regulatory controls})_{i,t} \\ & + \beta_{11-13}(\text{Macroeconomic and Regulatory time invariant controls})_i + \varepsilon_{j,i,t} \end{aligned} \quad (1)$$

where the dependent variable is *Treasury debt exposure* for bank *j* at time *t*, calculated as the treasury debt-to-total asset ratio. The main explanatory variable (*NPLr*) is the ratio of impaired loans to gross loans. We include six bank-specific controls (*Capitalization*, *Profitability*, *Loan to Assets*, *Cost to Income*, *Customer deposits to Assets*, and *Revenue diversification*), three macroeconomic controls (*HHI Concentration*, *Inflation*, and *GDP Growth*), and three time-invariant controls (*Sovereign Credit rating*, *Activity restrictions*, and *U.S. country dummy*).

To test H2, we add to the Eq. (1) the interaction between *NPLr* and *Sovereign rating*:

$$\begin{aligned} \text{Treasury Debt exposure}_{j,t} = & \alpha + \beta_1(\text{Credit risk})_{j,t} + \beta_2(\text{NPLrxSovereign})_{j,t} + \beta_{3-8}(\text{Bank - specific controls})_{j,t} \\ & + \beta_{9-11}(\text{Macroeconomic and Regulatory controls})_{i,t} \\ & + \beta_{12-14}(\text{Macroeconomic and Regulatory time invariant controls})_i + \varepsilon_{j,i,t} \end{aligned} \quad (2)$$

To address potential endogeneity, we conducted several model specifications, including OLS and fixed effects regressions, and performed a Propensity Score Matching analysis. We employ Driscoll-Kraay standard errors to control for cross-section dependence.

3. Results, discussion, and future research

Table 2 presents the coefficients and standard errors for the explanatory variables in our baseline models. We test H1 across all models and H2 in Models 2, 4, 8, 10, and 14, which include the interaction between *Sovereign* debt rating and *NPLr*. Ordinary Least Squares (OLS) is employed in Models 1, 2, 7, 8, 9, and 10, accounting for bank-specific and macroeconomic factors. Models 3 and 4 incorporate time and country fixed effects, while Models 5 and 6 include bank fixed effects. Models 7 and 8 focus on high credit quality countries, contrasting with Models 9 and 10, which examine low credit quality countries. To address endogeneity, Models 11 and 12 use bank fixed effects with lagged explanatory variables, and Model 13 applies Propensity Score Matching estimates⁷. All models use robust standard errors, with Driscoll-Kraay standard errors applied in Model 14 to address cross-section dependence.

Our findings consistently support Hypothesis 1 (H1) across all models (1-14), with the *NPLr* coefficient being positive and

⁴ Capitalization, Asset Quality, Management, Earnings, and Liquidity.

⁵ We give numeric values to each rating from 1 to the lowest (CCC) to 21 to the highest (AAA) and apply mean centering technique by subtracting mean values from the ratings.

⁶ The Bank Regulation and Supervision Survey (BRSS) is a unique source of comparable economy-level data on how banks are regulated and supervised around the world. Previous rounds were completed in 1999, 2003, 2007 and 2012. The most recent survey was started in 2017 and completed in 2019. It provides information on bank regulation and supervision for 160 jurisdictions. The activity restrictions index measures the degree to which banks face regulatory restrictions on their activities in securities markets, insurance, real estate, and owning shares in nonfinancial firms, with higher values indicating greater restrictions. This database is available from the World Bank website at <https://www.worldbank.org/en/research/brief/BRSS>

⁷ To conduct the PSM analysis, we convert the main explanatory variable into a dummy variable. Specifically, we assign a value of 1 to observations with an *NPLr* above the median, and 0 otherwise. We then match observations with similar bank-specific characteristics.

Table 1
Descriptive statistics.

| Variables | Observations | Mean | Std.Dev. | Min | Max | Data source |
|-------------------------|--------------|-------|----------|--------|-------|-----------------|
| Sovereign debt ratio | 23835 | 6.22 | 7.93 | 0 | 33.10 | Refinitiv Eikon |
| NPLr | 23835 | 5.80 | 123.2 | 0 | 9605 | Refinitiv Eikon |
| Capitalization | 23835 | 13.70 | 0.09 | 0.20 | 29.20 | Refinitiv Eikon |
| Profitability | 23835 | 2.70 | 2.30 | -2.50 | 5.60 | Refinitiv Eikon |
| Loan to Assets | 23835 | 66.40 | 18.20 | 26.10 | 91.70 | Refinitiv Eikon |
| CIR | 23835 | 5.13 | 102.10 | -43.10 | 72.70 | Refinitiv Eikon |
| Customer deposit ratio | 23835 | 77.30 | 17.30 | 14.30 | 93.80 | Refinitiv Eikon |
| Revenue diversification | 23835 | 31.71 | 21.65 | 0.72 | 65.45 | Refinitiv Eikon |
| Bank concentration | 23835 | 50.17 | 21.18 | 28.80 | 99.94 | Word Bank |
| Inflation rate | 23835 | 2.94 | 2.85 | -0.92 | 12.35 | Word Bank |
| GDP growth | 23835 | 2.66 | 3.05 | -5.83 | 11.24 | Word Bank |
| US | 23772 | 0.50 | 0.50 | 0 | 1 | Word Bank |
| Sovereign rating | 23730 | 17.76 | 3.754 | 1 | 21 | Word Bank |
| Activity restrictions | 23541 | 4.09 | 0.30 | 3.91 | 4.61 | Word Bank |

This table shows the descriptive statistics of the dependent and explanatory variables in our model's specification. Bank specific variables are sourced from Refinitiv Eikon. The *Sovereign debt ratio* is calculated as the ratio of sovereign debt holdings to total assets. *NPLr* is the ratio of non-performing loans to gross loans. *Capitalization* is measured as the ratio of equity over total assets. *Profitability* is the ratio of pretax returns on total assets. *Loan to Assets* is the ratio of total loans on total assets. *CIR* (Cost to Income Ratio) is calculated as operating costs divided by operating income. The *Customer deposit ratio* is the ratio of customer deposits to total assets. *Revenue diversification* is the proportion of non-interest income on total operating income. Macroeconomic controls are taken from the World Bank database. *Bank concentration* refers to the percentage share of the three largest banks in a country based on total assets. The *Inflation rate* is the annual average rate change in CPI from the International Monetary Fund. *GDP growth* is the annual percentage change in real GDP. *US* is a dummy variable that takes the value of 1 if the bank is located in the US. *Sovereign rating* is the country sovereign debt rating by Standard & Poor's data from 2023; ratings are converted to numeric values from 1 (lowest, CCC) to 21 (highest, AAA) and are mean-centered for analysis. *Activity restrictions* is a regulatory indicator that reflects the degree of restrictions on bank activities, based on data from the World Bank's Bank Regulation and Supervision database, as developed by Barth et al. (2019).

significant, indicating a strong relationship between higher non performing loan ratios and increased sovereign debt exposure. This aligns with Bunch et al. (2016) but contrasts with Lamas and Mencía (2019) and Martínez-Martínez Malvar and Baselga-Pascual, 2022, who found a negative correlation between poorly capitalized or low-quality banks and their sovereign debt exposure.

To test Hypothesis 2 (H2), we conducted a moderation analysis (Models 2, 4, 8, 10, and 14) using the interaction term *NPLr x Sovereign*. All models, except Model 10, show a significant relationship, suggesting that sovereign credit ratings amplify the link between *NPLr* and *Sovereign debt exposure*. The lack of significance in Model 10 implies that this moderating effect is less pronounced in low credit quality countries, supporting the hedging hypothesis.

Our analysis provides strong evidence that banks with higher credit risk tend to hold more Treasury debt, with the relationship between *NPLr* and *Treasury debt exposure* being stronger in countries with higher sovereign ratings. This challenges the moral hazard view, suggesting that banks facing default risk may prefer safer investments over higher yields in lower-rated countries.

Consistent with Buljan et al. (2020), we find that bank characteristics like *Capitalization*, *Profitability*, *Cost to income ratios*, *Liquidity*, and *Revenue diversification* are positively correlated with greater sovereign debt exposure. Conversely, a higher *Loan to assets* ratio generally reduces Treasury debt exposure. Macroeconomic factors such as bank asset *Concentration* and higher *Sovereign ratings* also positively influence sovereign debt exposure, while *Inflation* rates, *GDP growth*, *US* location, and regulatory *Activity restrictions* are negatively correlated.

Our study enhances the existing body of literature on the link between bank and country risk by empirically exploring the connection between credit risk and sovereign debt risk and identifying bank characteristics that influence Treasury debt exposure. Uniquely, we investigate the moderating role of sovereign credit ratings in the relationship between *NPLr* and *Treasury debt exposure*. Our findings highlight the need for regulatory vigilance, as banks may increase their Treasury debt holdings to mitigate credit risk, potentially leading to instability in rising interest rate environments.

Our study presents limitations that suggest areas for future research. Exploring the maturity structure of banks' sovereign debt holdings could provide further insights. Additionally, examining the quality and growth of bank deposits may help regulators assess the risk of potential bank runs. Further research into the influence of bank governance characteristics could deepen the understanding of the dynamics between credit risk and sovereign debt exposure.

CRedit authorship contribution statement

Laura Baselga-Pascual: Writing – original draft, Methodology, Formal analysis. **Lidia Loban:** Writing – original draft, Data curation, Conceptualization. **Emma-Riikka Myllymäki:** Writing – original draft, Formal analysis.

Table 2
Multivariate analysis.

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|------------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|---------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|---------------------|
| NPLr | 0.002*** (0.001) | 0.002*** (0.001) | 0.003*** (0.001) | 0.003*** (0.001) | 0.002*** (0.001) | 0.002*** (0.001) | 0.002*** (0.001) | 0.002*** (0.001) | 0.002*** (0.001) | 0.002*** (0.001) | 0.002*** (0.001) | 0.002*** (0.001) | 0.042*** (0.003) | 0.024*** (0.001) |
| Nplr x Sovereign | | 0.000*** (0.000) | | 0.000*** (0.000) | | | | 0.000** (0.000) | | 0.000 (0.000) | | | | 0.000*** (0.001) |
| Capitalization | 0.145*** (0.018) | 0.140*** (0.018) | 0.184*** (0.018) | 0.185*** (0.018) | 0.044 (0.044) | 0.115*** (0.021) | 0.216*** (0.024) | 0.215*** (0.024) | 0.150*** (0.026) | 0.149*** (0.026) | 0.042 (0.044) | 0.198*** (0.019) | 0.029 (0.018) | 0.034 (0.496) |
| Profitability | 0.004*** (0.001) | 0.003*** (0.001) | 0.004*** (0.0) | 0.003*** (0.0) | 0.001 (0.001) | 0.003*** (0.001) | 0.005*** (0.001) | 0.005*** (0.001) | 0.0 (0.001) | 0.0 (0.001) | -0.002 (0.001) | 0.002*** (0.001) | 0.006*** (0.001) | 0.001 (0.001) |
| Loan to assets | -0.021** (0.008) | -0.018** (0.007) | -0.023*** (0.007) | -0.022*** (0.018) | -0.058*** (0.018) | -0.043** (0.018) | 0.064*** (0.010) | 0.065*** (0.010) | -0.164*** (0.011) | -0.164*** (0.011) | -0.058*** (0.018) | -0.022*** (0.008) | 0.009 (0.008) | -0.050* (0.029) |
| CIR | 0.001*** (0.000) | 0.001*** (0.000) | 0.001*** (0.000) | 0.001*** (0.000) | 0.001*** (0.000) | 0.001*** (0.000) | 0.001*** (0.000) | 0.001*** (0.000) | 0.001*** (0.000) | 0.001*** (0.000) | 0.001*** (0.000) | 0.001*** (0.000) | 0.001*** (0.000) | 0.001*** (0.001) |
| Customer deposit ratio | 0.101*** (0.006) | 0.102*** (0.006) | 0.069*** (0.007) | 0.071*** (0.007) | 0.087*** (0.021) | 0.081*** (0.019) | 0.038*** (0.010) | 0.038*** (0.010) | 0.132*** (0.009) | 0.132*** (0.009) | 0.083*** (0.020) | 0.072*** (0.007) | 0.069*** (0.007) | 0.100*** (0.016) |
| Revenue diversification | 0.0*** (0.0) | 0.0*** (0.0) | 0.0*** (0.0) | 0.0*** (0.0) | 0.001*** (0.0) | 0.001*** (0.0) | 0.0 (0.0) | 0.0 (0.0) | 0.001*** (0.0) | 0.001*** (0.0) | 0.001*** (0.0) | 0.0*** (0.0) | 0.001*** (0.0) | 0.001*** (0.000) |
| Bank concentration | 0.0*** (0.0) | 0.0*** (0.0) | -0.001 (0.001) | -0.001** (0.001) | 0.001*** (0.0) | 0.001*** (0.0) | 0.001*** (0.0) | 0.001*** (0.0) | 0.0 (0.0) | 0.0 (0.0) | 0.001*** (0.0) | 0.061*** (0.007) | 0.001*** (0.0) | 0.001*** (0.002) |
| Inflation rate | -0.001** (0.0) | -0.001** (0.0) | | | -0.002*** (0.001) | | -0.010*** (0.001) | -0.010*** (0.001) | 0.002*** (0.0) | 0.002*** (0.0) | -0.003*** (0.001) | | -0.002*** (0.0) | -0.002 (0.001) |
| GDP growth | -0.001*** (0.0) | -0.001*** (0.0) | | | 0.000 (0.0) | | 0.002*** (0.001) | 0.002*** (0.001) | -0.001*** (0.0) | -0.001*** (0.0) | | | -0.001*** (0.0) | -0.004 (0.002) |
| US | -0.091*** (0.003) | -0.088*** (0.003) | | | | | -0.039*** (0.005) | -0.039*** (0.005) | | | 0.094*** (0.017) | | | |
| Sovereign rating | 0.002*** (0.0) | 0.002*** (0.0) | | | | | 0.003 (0.003) | 0.003** (0.003) | 0.003*** (0.001) | 0.003*** (0.001) | | | -0.004*** (0.000) | 0.001*** (0.003) |
| Activity restrictions | -0.046*** (0.003) | -0.046*** (0.003) | | | | | -0.058*** (0.008) | -0.057*** (0.008) | -0.039*** (0.004) | -0.039*** (0.004) | | | 0.002*** (0.0) | |
| Intercept | 0.305*** (0.016) | 0.302*** (0.016) | 0.026*** (0.007) | 0.030*** (0.007) | 0.081*** (0.016) | 0.063*** (0.016) | 0.247*** (0.037) | 0.243*** (0.036) | 0.352*** (0.021) | 0.351*** (0.021) | | | 0.086*** (0.009) | |
| Lagged explanatory variables | No | No | No | No | No | No | No | No | No | No | Yes | Yes | No | No |
| Bank FE | No | No | No | No | Yes | Yes | No | No | No | No | Yes | Yes | No | Yes |
| Country FE. | No | No | Yes | Yes | No | Yes | No | No | No | No | No | Yes | No | No |
| Time FE | No | No | Yes | Yes | No | Yes | No | No | No | No | No | Yes | No | No |
| Observations | 23499 | 23499 | 23730 | 23730 | 23835 | 23835 | 14910 | 14910 | 8589 | 8589 | 22700 | 22640 | 22140 | 22140 |
| Adj. R-squared | 0.38 | 0.38 | 0.47 | 0.47 | 0.26 | 0.34 | 0.44 | 0.44 | 0.30 | 0.30 | 0.18 | 0.42 | 0.30 | 0.26 |
| F-test | 2159.27 | 2084.50 | 506.11 | 511.69 | 169.10 | 85.31 | 1725.53 | 1593.61 | 749.70 | 692.85 | 124.47 | 757.69 | 2259.88 | 27561.74 |

Table 2 reports the estimates of 14 alternative versions of our hypothesis, standard errors (in parentheses). Models 1, 2, 7, 8, 9, and 10 apply Ordinary Least Squares (OLS), addressing bank-specific and macroeconomic aspects. Models 3 and 4 incorporate time and country fixed effects. Models 5 and 6 use individual fixed effects. High credit quality countries are examined in Models 7 and 8, in contrast to low credit quality countries in Models 9 and 10. Models 11 and 12 apply individual fixed effects with lagged variables, Model 13 employs Propensity Score Matching for regression analysis; and in model 14 we run fixed effects regression with Driscoll-Kraay standard errors to overcome cross-section dependence. The interaction of sovereign debt rating with treasury debt exposure is featured in Models 2, 4, 8, 10 and 14. We apply robust standard errors which are adjusted for heteroskedasticity and within-firm clustering. ***, **, and * denote statistical significance at the 0.01, 0.05, and 0.10 levels, respectively.

Annex 1: Observations per country

| Country | No observation | Percentage (%) | Country | No observation | Percentage (%) |
|--------------------|----------------|----------------|--------------------|----------------|----------------|
| Argentina | 189 | 0.80 | Japan | 1,764 | 7.42 |
| Australia | 168 | 0.71 | Korea (South) | 210 | 0.88 |
| Austria | 189 | 0.80 | Lithuania | 21 | 0.09 |
| Belgium | 42 | 0.18 | Luxembourg | 21 | 0.09 |
| Brazil | 252 | 1.06 | Malasya | 21 | 0.09 |
| Bulgaria | 84 | 0.35 | Malta | 105 | 0.44 |
| Canada | 231 | 0.97 | Mexico | 168 | 0.71 |
| China | 1,302 | 5.48 | Netherlands | 63 | 0.27 |
| Croatia | 189 | 0.80 | Poland | 252 | 1.06 |
| Cyprus | 21 | 0.09 | Portugal | 84 | 0.35 |
| Czech Republic | 21 | 0.09 | Romania | 63 | 0.27 |
| Denmark | 420 | 1.77 | Russian Federation | 273 | 1.15 |
| Estonia | 42 | 0.18 | Saudi Arabia | 231 | 0.97 |
| Finland | 84 | 0.35 | Singapore | 126 | 0.53 |
| France | 483 | 2.03 | Slovakia | 84 | 0.35 |
| Georgia | 21 | 0.09 | Slovenia | 42 | 0.18 |
| Germany | 147 | 0.62 | South Africa | 147 | 0.62 |
| Greece | 273 | 1.15 | Spain | 210 | 0.88 |
| Hungary | 42 | 0.18 | Sweden | 210 | 0.88 |
| India | 1,008 | 4.24 | Switzerland | 378 | 1.59 |
| Indonesia | 1,092 | 4.59 | Turkey | 231 | 0.97 |
| Ireland | 84 | 0.35 | United Kingdom | 252 | 1.06 |
| Italy | 525 | 2.21 | United States | 11,907 | 50.09 |
| Accumulated | 6,909 | 29.09 | Accumulated | 16,863 | 70.94 |
| | | | Total | 23,772 | 100.00 |

The table shows the number and percentage of observations per country.

Data availability

Data will be made available on request.

References

- Acharya, V.V., Drechsler, I., Schnabl, P., 2012. A tale of two overhangs: the nexus of financial sector and sovereign credit risks. *J. Financ. Stab.* 16, 119–134.
- Andreeva, D., Vlassopoulos, T., 2016. Home bias in bank sovereign bond purchases and the bank-sovereign nexus. *J. Financ. Stab.* 27, 111–124.
- Barth, J.R., Caprio, G., Levine, R., 2019. The regulation and supervision of banks around the world: a new database. World Bank Policy Research Working Paper, No. WPS 2588. World Bank Group, Washington, D.C. <http://documents.worldbank.org/curated/en/981551468739510139/The-regulation-and-supervision-of-banks-around-the-world-a-new-database>
- Basse, T., 2014. Searching for the EMU core member countries. *Eur. J. Polit. Econ.* 34, S32–S39.
- Berger, A.N., DeYoung, R., 1997. Problem loans and cost efficiency in commercial banks. *J. Bank. Financ.* 21 (6), 849–870.
- Boumparis, P., Milas, C., Panagiotidis, T., 2019. Non-performing loans and sovereign credit ratings. *Int. Rev. Financ. Anal.* 64, 301–314.
- Brunnermeier, M.K., Garicano, L., Lane, P.R., Pagano, M., Reis, R., Santos, T., Vayanos, D., 2016. The sovereign-bank diabolic loop and ESBies. *Am. Econ. Rev.* 106 (5), 508–512.
- Buch, C.M., Koetter, M., Ohls, J., 2016. Banks and sovereign risk: a granular view. *J. Financ. Stab.* 25, 1–15.
- Buljan, A., Deskar-Skrbić, M., Dumičić, M., 2020. What drives banks' appetite for sovereign debt in CEE countries? *Public Sector Econ.* 44 (2), 180–201.
- Cooper, R., Nikolov, K., 2018. Government debt and banking fragility: the spreading of strategic uncertainty. *Int. Econ. Rev. (Philadelphia)* 59 (4), 1905–1925.
- Crosignani, M., 2021. Bank capital, government bond holdings, and sovereign debt capacity. *J. Financ. Econ.* 141, 693–704.
- De Jonghe, O., 2010. Back to the basics in banking? A micro-analysis of banking system stability. *J. Financ. Intermediation* 19 (3), 387–417.
- Delis, M.D., Kouretas, G.P., 2011. Interest rates and bank risk-taking. *J. Bank. Financ.* 35 (4), 840–855. <https://doi.org/10.1016/j.jbankfin.2010.09.032>.
- Delis, M.D., Staikouras, P.K., 2011. Supervisory effectiveness and bank risk. *Rev. Financ.* 15 (3), 511–543.
- Drago, D., Gallo, R., 2017. The impact of sovereign rating changes on the activity of European banks. *J. Bank. Financ.* 85, 99–112.
- Ejsing, J., Lemke, W., 2011. The Janus-headed salvation: sovereign and bank credit risk premia during 2008–2009. *Econ. Lett.* 110 (1), 28–31.
- Festic, M., Kavkler, A., Repina, S., 2011. The macroeconomic sources of systemic risk in the banking sectors of five new EU member states. *J. Bank. Financ.* 35 (2), 310–322.
- Feyen, E., & Zuccardi Huertas, I.E. (2019). The sovereign-bank nexus in EMDEs: what is it, is it rising, and what are the policy implications? World Bank Policy Research Working Paper, No. 8950.
- Fiordelisi, F., Girardone, C., Minnucci, F., Ricci, O., 2020. On the nexus between sovereign risk and banking crises. *J. Corp. Financ.* 65, 101717.
- Fratzschler, M., Rieth, M., 2019. Monetary policy, bank bailouts and the sovereign-bank risk nexus in the euro area. *Rev. Financ.* 23 (4), 745–775.
- Gennaioli, N., Martin, A., Rossi, S., 2018. Banks, government bonds, and default: what do the data say? *J. Monet. Econ.* 98, 98–113.
- Gomez-Puig, M., Singh, M.K., Sosvilla-Rivero, S., 2019. The sovereign-bank nexus in peripheral euro area: Further evidence from contingent claims analysis. *N. Am. J. Econ. Finance* 49, 1–26.
- Gruppe, M., Basse, T., Friedrich, M., Lange, C., 2017. Interest rate convergence, sovereign credit risk and the European debt crisis: a survey. *J. Risk Finance* 18 (4), 432–442.
- Hardy, B., Zhu, S., 2023. Covid, central banks and the bank-sovereign nexus. *BIS Quarterly Rev.* (27), 25–39.
- Jobst, R., Rösch, D., 2021. Euro zone sovereign default risk and capital—a Bayesian approach. *The J. of Fixed Income* 31 (2), 57–74.
- Lamas, M. and Mencia, J. (2019) What Drives Sovereign Debt Portfolios of Banks in a Crisis Context? ESRB: Working Paper Series No. 2019/88, Available at SSRN: <https://ssrn.com/abstract=3723444> or [10.2139/ssrn.3723444](https://doi.org/10.2139/ssrn.3723444).

- Lamers, M., Present, T., Soenen, N., Vander Vennet, R., 2023. BRRD credibility and the bank-sovereign nexus. *Appl. Econ. Lett.* 30 (10), 1308–1313.
- Leonello, A., 2018. Government guarantees and the two-way feedback between banking and sovereign debt crises. *J. Financ. Econ.* 130 (3), 592–619.
- Li, J., Zinna, G., 2018. How much of bank credit risk is sovereign risk? Evidence from Europe. *J. Money Credit Bank.* 50 (6), 1225–1269.
- Martínez Malvar, M., Baselga-Pascual, L., 2022. Sovereign debt exposure of European less significant banks: too small to be bailed. *UCJC Bus. Soc. Rev. (formerly known as Universia Bus. Rev.)* 19 (74), 101–125.
- Mitchener, K.J., Trebesch, C., 2023. Sovereign debt in the twenty-first century. *J. Econ. Lit.* 61 (2), 565–623.
- Moro, B., 2014. Lessons from the European economic and financial great crisis: a survey. *Eur. J. Polit. Econ.* 34, S9–S24.
- Reinhart, C.M., Rogoff, K.S., 2015. Financial and sovereign debt crises: some lessons learned and those forgotten. *J. Bank. Financ. Econ.* 2 (4), 5–17.
- Sibbertsen, P., Wegener, C., Basse, T., 2014. Testing for a break in the persistence in yield spreads of EMU government bonds. *J. Bank. Financ.* 41, 109–118.
- Uhde, A., Heimeshoff, U., 2009. Consolidation in banking and financial stability in Europe: empirical evidence. *J. Bank. Financ.* 33 (7), 1299–1311.