Common Funding and Sovereign Demand of Banks *

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Abstract

Do banks actively seek assets that are widely held across the financial system? We measure the extent to which sovereigns are systemically linked by a common bank investor base, and show that banks have a unique preference *for* funding commonality. Banks are 10% more likely to hold bonds of more commonly funded sovereigns, consistent with the anticipation of regulatory coordination in the event of distress. A structural portfolio demand system quantifies the bond pricing implications of this preference. Counterfactual analysis shows that in the absence of these preferences, borrowing costs would increase, raising yields by about 1% on average.

JEL classification: G11,G21,G23

Keywords: financial networks, portfolio choice, sovereign bonds, banking, systemic risk

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1 Introduction

Do banks actively seek assets that are widely held across the financial system? Standard portfolio theory predicts that investors allocate capital across assets based on risk and return considerations. But *bank* investors may also care about how widely an asset is held by other banks. Seminal theories link such a preference to financial regulation and bailout incentives (Acharya and Yorulmazer, 2007; Farhi and Tirole, 2012; Acharya et al., 2016). When distress affects a large number of financial institutions simultaneously, regulators face stronger incentives to intervene, in order to prevent systemic instability. Anticipating such regulatory actions, banks may prefer assets whose risks are shared across the financial system.[1]

This paper studies whether such incentives shape the sovereign bond portfolios of European banks and whether they affect sovereign bond prices. Despite theoretical foundations, the incentives to seek common Euro Area (EA)-wide exposures has remained an open empirical question for two key reasons. First, European banks are characterized by home bias, i.e., a strong nexus between banks and domestic sovereigns (Brunnermeier et al., 2016; Ongena et al., 2019).[2] To the extent such investments provide bailout guarantees from domestic governments (De Bruyckere et al., 2013), it may be optimal for banks to prioritize the funding of their own sovereigns, as against correlating their exposures with the broader network. Second, common exposures to the same asset, if driven by portfolio diversification, can increase the risk of fire sales/joint liquidation (Wagner, 2011). Arguably, banks have incentives to shun common exposures to avoid such risks.

Using detailed data on bank–sovereign exposures from the European Banking

[1]In the context of EU banks, these systemic exposures may extend beyond national borders because bank resolution often involves cross-country spillovers and coordination among European regulators. When distress affects sovereigns that are widely funded by banks from multiple countries, the resulting losses may propagate through the financial system and increase the likelihood of coordinated regulatory intervention. For example, the EU Single Resolution Board coordinated cross-border resolution efforts for Banco Popular (2017) and Sberbank Europe (2025). More recently, the revised EU Crisis Management and Deposit Insurance framework emphasizes a stronger role for EU-wide coordination in bank resolution.

[2]In Altavilla et al. (2017) and Ongena et al. (2019), governments persuade banks to invest in own sovereign bonds (“moral suasion”) and in Becker and Ivashina (2018), they use government ownership and board seats to increase own government holdings.

Authority, we are among the first studies to disentangle these effects and show that banks have a preference *for* systemic exposure. Banks are more likely to hold, and hold larger quantities of sovereign bonds that share a more common bank investor base. A s.d. change in commonality increase the holding probability by 10%. Our results are suggestive of a mechanism where banks anticipate future regulatory intervention (Farhi and Tirole, 2012). We account for a range of alternative explanations, including home bias in holdings, sovereign yields, and macroeconomic fundamentals of the issuing country. We measure the commonality of sovereign funding using eigenvector centrality in the network that captures similarity of sovereign financing. Our measure captures the extent to which sovereigns share the same bank investors. A sovereign has higher commonality if it is funded by many banks, especially by banks that themselves fund other widely funded sovereigns. Our definition of commonality captures how similar the funding structures of sovereigns are across banks, rather than how similar banks' portfolios are, across assets. Thus, our approach focuses on how sovereigns are financed across the banking system—the structure of their bank investor base. This method reveals commonality as a characteristic of the sovereign, helping quantify how commonality and yields are jointly determined in equilibrium—a key contribution of the paper.

To quantify the effect of banks' preference for systemic exposure on asset prices, we estimate a structural portfolio demand system for sovereign bonds. We adapt the characteristics-based demand framework of Koijen and Yogo (2019), in which asset demand depends on prices and asset characteristics. In our setting, commonality enters as a network characteristic of the asset that captures the similarity of its bank investor base to that of other sovereigns. This framework allows us to jointly analyze portfolio allocations and sovereign bond prices in equilibrium. The structural demand estimates imply that banks value sovereign bonds with more common investor bases—beyond what can be explained by home bias, macroeconomic fundamentals, or prices.[3] In addition to employing an IV for yields, we use an instrument for commonality that plausibly isolates variation linked to the likelihood of coordinated regulatory intervention. We then use the estimated demand system to quantify the equilibrium impact of this preference on

[3]Our elasticity estimates are significant: the elasticity with respect to commonality for the average exposure in the sample is 2.9.

sovereign yields. In counterfactual exercises where banks no longer value commonality, sovereign yields would be approximately one percentage point higher on average, with larger effects for sovereigns that are most central in the banking network. These results suggest that the network structure of sovereign funding across banks plays an important role in determining sovereign borrowing costs.

These findings make three key contributions. First, the demand-system asset pricing and intermediary asset demand literature (He et al. (2017); Koijen and Yogo (2019); Koijen et al. (2021)) emphasizes how investor heterogeneity and institutional constraints affect asset prices. We are among the first studies to introduce a network-based characteristic—commonality of the bank investor base—to show that it significantly affects sovereign bond demand and pricing, connecting the financial networks literature to the pricing of sovereign debt. Second, the analysis of bank incentives for correlated exposures driven by bailout expectations has largely been confined to theory (Acharya and Yorulmazer, 2007; Farhi and Tirole, 2012; Acharya et al., 2016). We provide unique empirical evidence consistent with this mechanism by using an instrument that isolates variation related to the likelihood of coordinated regulatory intervention. Third, our results uncover economic drivers for bank sovereign portfolios that go beyond the bank–sovereign nexus in the Eurozone (Altavilla et al. (2017), Ongena et al. (2019), Becker and Ivashina (2018)). We show that these portfolios reflect network effects operating across countries, whereby sovereign bonds that share a more common bank investor base attract greater demand from banks across the Eurozone.

Our results have direct relevance for the discussion on sovereign bond market design in the European Union, particularly proposals to introduce a common asset such as European Safe Bonds (Brunnermeier et al., 2017). The introduction of such an asset could weaken investors' demand for commonly-funded sovereigns. First, a common safe asset can provide banks with an alternative instrument for holding systemically shared exposures, reducing the need to concentrate on existing sovereigns that are widely funded by other banks. Second, a shift in bank demand toward the new common asset (and the resulting change in the composition of sovereign funding) could reduce the overlap in existing sovereign investor bases. Our findings highlight a mechanism by which

European Safe Bonds could materially increase sovereign borrowing costs, a consideration that should be taken into account when weighing the benefits of introducing common European debt instruments.

[Figure 1 about here.]

We begin our analysis with a network visualization of the similarity of European sovereign funding composition across banks.[4] Figure 1 shows the cosine similarities between sovereigns' funding structures in the Eurozone banking network, reflecting the extent to which sovereigns share the same bank investors. These similarities form the basis of our commonality measure. In the baseline reduced-form analysis, we examine how this measure relates to banks' sovereign exposures along both the extensive and intensive margins. Higher (lagged) sovereign commonality is associated with a greater probability that a bank holds that sovereign, and conditional on holding it, with larger exposure. Our baseline specification controls for a range of sovereign- and bank-level characteristics—including country's economic performance indicators, bank risk exposure, and Tier 1 capital ratios—as well as time fixed effects to capture aggregate shocks. Notably, the variation in commonality itself does not appear to be driven by differences in macroeconomic performance across Eurozone countries.[5]

[Figure 2 about here.]

A key contribution of the paper is to model banks' preference for sovereigns with a common bank investor base within a mean–variance framework, motivated by prior work emphasizing the role of financial intermediaries in determining asset prices (He et al., 2017; Haddad and Muir, 2021). Our goal is to quantify how preferences for systemic exposure affect sovereign bond yields in equilibrium. To this end, our main empirical analysis estimates a structural portfolio demand system for sovereign bonds following the characteristics-based demand framework of Koijen and Yogo (2019). In this setting, banks' demand depends on asset prices and observable characteristics, one of which is sovereign

[4]See also Figure A.1 in the Appendix illustrating the bipartite nature of the network. The network has a total of 144 nodes and 1,202 edges.

[5]Figure 2 shows that most economic indicators across sovereigns are only weakly correlated with the commonality measure.

commonality—capturing the structure of the sovereign's bank investor base within the Eurozone banking network. The structural approach allows us to jointly analyze banks' portfolio allocations and sovereign bond prices, a core result in the paper.

Our demand system estimation shows that the commonality of a sovereign's funding structure is an economically (and statistically) significant determinant of bank sovereign exposure, even after accounting for asset price variation and other observable characteristics. To interpret the demand system, we address the identification problem arising from the joint determination of yields, bank exposures, and sovereign commonality in equilibrium. In the absence of plausibly exogenous variation in asset prices and commonality, it would be difficult to separate their effects from other factors influencing sovereign demand. We address this challenge in two ways.

First, we exploit exogenous variation in sovereign yields arising from the European Central Bank's Public Sector Purchase Programme (PSPP). During our sample period (2015–2019), the ECB conducted sovereign bond purchases according to the "capital key," a rule based on each country's share of Eurozone GDP and population. Following Koijen et al. (2021), we construct an instrument for sovereign yields based on predicted ECB purchases implied by the capital key allocation. After instrumenting for sovereign yields using this policy-driven variation, we continue to find that banks allocate larger portfolio shares to sovereigns with more common bank investor bases.

A second identification concern is that sovereign commonality may be correlated with time-varying unobservable characteristics such as liquidity or collateral eligibility, which could influence bank demand independently of the preference for systemic exposure. To address this concern, we instrument for sovereign commonality using the geographic centrality of the sovereign's country within the Eurozone. The instrument is based on the spatial network of shared borders between Eurozone countries. We expect countries that are spatially close to be culturally similar, so they operate with historically shared institutional knowledge. If geographic, institutional, or linguistic differences increase the costs of cross-border bank resolution—as evidenced by Beck et al. (2023)—then sovereigns located in more geographically central countries may be more likely to benefit from coordinated regulatory intervention. Geographic centrality therefore provides a source of predetermined variation that affects sovereign commonality while abstracting from contemporaneous demand conditions.

Using the geographic centrality instrument together with the capital-key instrument for yields, we find a robust and economically significant association between sovereign commonality and banks' sovereign exposures. These results support the interpretation that banks place additional value on sovereign bonds that share a broader bank investor base across the Eurozone. Finally, we use the estimated demand system to quantify the implications of this preference for sovereign bond prices. We simulate a counterfactual equilibrium in which banks do not place value on sovereign commonality. In this scenario, banks' demand for sovereign bonds depends only on prices and characteristics unrelated to the structure of the investor base. Comparing the counterfactual equilibrium to observed yields allows us to quantify the contribution of commonality to sovereign borrowing costs. We find that, in the absence of this preference, sovereign yields would be approximately one percentage point higher on average, with larger increases for sovereigns that occupy more central positions in the banking network.

2 Related Literature

Our paper relates to research on the role of sovereign governments in determining bank exposures to sovereign debt. Ongena et al. (2019) find that domestic banks in the Eurozone are more likely to purchase their own sovereigns than foreign banks. This tendency, "moral suasion", is driven by less-capitalized banks that are motivated to be on good terms in the event of a need for government assistance in the future. Their findings confirm earlier work by Altavilla et al. (2017). Acharya and Steffen (2015) show that, during the 2007–2013 period, the increase in home bias among GIIPS banks is consistent with moral suasion by domestic sovereigns. Becker and Ivashina (2018) document that governments can also use formal channels, such as ownership stakes and board representation, to increase domestic banks' holdings of sovereign debt. Regulatory arbitrage opportunities may also be greater for domestic assets relative to foreign ones (Liu, 2021). This literature emphasizes domestic political and regulatory motives for sovereign bond demand. We complement it by showing that banks' sovereign portfolios also reflect a broader, cross-country network motive: banks tilt toward sovereigns that share a more common investor base across the Eurozone.

Our paper also contributes to the literature on financial fragility, bailout incentives, and correlated risk-taking by banks. Acharya and Yorulmazer (2007) show that banks have incentives to herd and choose correlated risks because regulators are more likely to intervene when many institutions fail at the same time. Acharya and Yorulmazer (2008) and Farhi and Tirole (2012) develop related theories in which expectations of collective rescue distort banks' portfolio choices toward systemically shared risks. We bring this logic to sovereign bond markets. Importantly, our empirical object is not the similarity of banks' overall portfolios, but the commonality of sovereign funding structures—that is, the extent to which sovereigns are financed by the same set of banks. We show that banks prefer sovereigns with a more common investor base, consistent with theories in which exposures that are more broadly shared across the financial system carry special value.

More broadly, our paper relates to the literature on financial networks and overlapping portfolios. Prior work studies how overlapping asset holdings can amplify contagion, fire sales, and systemic risk (Caccioli et al. (2014); Vodenska et al. (2021)). Other papers examine the incentives that generate correlated investments or common exposures (Elliott et al. (2014); Jackson and Pernoud (2021), Jackson and Pernoud (2024)). Our contribution differs in two respects. First, we focus on a sovereign-level network characteristic: the structure of sovereign funding across banks, rather than portfolio similarity across banks. Second, we show that this network characteristic affects not only systemic risk, but also equilibrium asset demand and prices. In this sense, the paper links the financial networks literature to the pricing of sovereign debt.

Our analysis is also closely related to the literature on investor-base asset pricing and demand-system estimation. Koijen and Yogo (2019) show how asset demand can be estimated as a function of prices and characteristics in a characteristics-based demand system, while Koijen et al. (2021) apply this framework to Eurozone sovereign bonds and exploit the ECB's capital key to identify demand elasticities. We build on this framework by introducing a network-based asset characteristic: the commonality of a sovereign's bank investor base. In our setting, what matters for demand is not only the asset's own yield or observable fundamentals, but also how its funding structure is positioned in the banking network. This allows us to show that the network structure of investor bases is priced in sovereign bond markets.

Our paper also speaks to the literature on diversification and the costs of common exposures. Wagner (2010, 2011), Elliott et al. (2014), and related work show that diversification can increase systemic fragility when it generates common exposures across intermediaries. Georg et al. (2023) provide evidence consistent with a demand for diversity among U.S. money market funds, while Cai et al. (2018) show that overlap in syndicated loan portfolios is associated with systemic risk. Our results complement this literature by showing that, in the context of Eurozone sovereign debt, banks do not simply avoid common exposures. Instead, they appear to value sovereigns with more common funding structures, suggesting that the benefits of sharing risks across the system may dominate the costs associated with joint liquidation or contagion.

Finally, our paper is relevant for work on regulation-induced commonality. Bräuning and Fillat (2023) show that stress testing increased portfolio similarity among large U.S. banks, while Kosenko and Michelson (2022) show that exposure limits can inadvertently raise asset commonality and fragility. Our findings are complementary, but conceptually distinct. Rather than studying how regulation changes the similarity of bank portfolios, we study how the commonality of sovereign funding across banks enters banks' demand for sovereign bonds and affects equilibrium yields. This distinction is important because it shifts the focus from portfolio overlap *per se* to the network structure of the investor base, which is the object directly priced in our demand system.

3 Hypothesis Development

A sovereign with a more common bank investor base exposes a larger set of banks to the same underlying risk. When distress affects a sovereign that is widely funded across the banking system, losses are distributed across many institutions simultaneously. In such situations, regulators may face stronger incentives to intervene in order to prevent systemic instability. As a result, banks may place value on holding sovereign bonds whose risks are shared more broadly across the financial system.

To formalize this idea, consider the portfolio share of sovereign j in the portfolio of bank i at time t, denoted with $w_{i,j,t}$. We model portfolio demand as:

$$\frac{w_{i,j,t}}{w_{i,0,t}} = \exp(\beta_Y \text{Yield}_{j,t} + \beta_C \text{Commonality}_{j,t-1} + \Gamma X_{i,j,t-1})\varepsilon_{i,j,t},$$

where $j = 0$ is an "outside" asset, for instance, the sovereign holdings outside the Eurozone. The parameter β_C measures the sensitivity of bank portfolio demand to the commonality of sovereign j's bank investor base within the Eurozone banking network. Depending on the underlying economic forces, the sensitivity of demand to commonality may be positive, negative, or close to zero. We therefore consider three competing hypotheses.

Domestic Relationship Hypothesis. A large literature emphasizes that banks' sovereign portfolios are strongly shaped by their relationships with domestic governments. For instance, Altavilla et al. (2017) and Ongena et al. (2019) show that domestic banks increase their holdings of home sovereign debt during periods of fiscal stress, a phenomenon commonly referred to as "moral suasion." Acharya and Steffen (2015) provide evidence that domestic governments can encourage banks to absorb sovereign debt when demand from other investors is limited. Becker and Ivashina (2018) further show that governments may use formal mechanisms such as ownership stakes or board representation to increase domestic banks' holdings of government bonds. De Bruyckere et al. (2013) find that correlations between bank and sovereign default risk are stronger within countries, consistent with expectations of domestic bailouts.

Taken together, these findings suggest that banks may prioritize relationships with their own sovereigns rather than the broader structure of sovereign funding across the banking system. If domestic political and regulatory considerations dominate portfolio choices, banks' demand for sovereign bonds should depend primarily on domestic exposures rather than the commonality of the sovereign's investor base across the Eurozone.

Hence, if bank portfolio demand is dominated by strategic relationships with domestic governments, we expect the sensitivity to EA-wide commonality of sovereign funding to be small or insignificant ($\beta_C \approx 0$).

Joint Liquidation Risk Hypothesis. Another possibility is that banks actively avoid sovereign bonds that share common investors with other sovereigns because such exposures increase joint liquidation risk. When many financial institutions hold similar assets, shocks may trigger simultaneous sales and fire-sale dynamics, amplifying price declines. Wagner (2010) shows that joint liquidation risk can influence equilibrium asset prices. Cai et al. (2018) document that overlap in syndicated loan portfolios among banks is associated with greater systemic risk, while Chu et al. (2020) find that asset similarity can increase systemic vulnerability in the context of geographic bank expansion.

If sovereign bonds with more common investor bases are more exposed to joint liquidation risk, banks may reduce their exposure to such assets as part of risk management. In this case, banks would tilt their portfolios away from sovereigns that are widely funded by other banks.

Hence, if banks avoid sovereign bonds whose risks are widely shared across the banking system because of joint liquidation concerns, the sensitivity of bank demand to sovereign commonality should be negative ($\beta_C < 0$).

Systemic Exposure Hypothesis. Finally, theories of bailout incentives suggest that banks may prefer exposures that are widely shared across the financial system. Acharya and Yorulmazer (2007) show that banks have incentives to take correlated risks when regulators are more likely to intervene if many institutions are simultaneously distressed. Farhi and Tirole (2012) demonstrate that expectations of collective rescue can lead banks to coordinate on correlated exposures. Acharya et al. (2016) similarly show that bailout expectations can encourage excessive risk-taking when losses are system-wide.

In the context of sovereign bonds, this mechanism implies that banks may prefer sovereigns that are widely funded by other banks. When a sovereign with a broad bank investor base experiences distress, the resulting losses are more likely to affect many banks simultaneously, increasing the likelihood of coordinated regulatory intervention. As a result, banks may tilt their portfolios toward sovereigns that share a more common bank investor base across the Eurozone.

Hence, if banks anticipate coordinated rescue efforts in response to system-wide distress, bank demand should increase with the commonality of the sovereign's bank investor base ($\beta_C > 0$), even after controlling for domestic sovereign exposures.

4 Data, Summary Statistics, and Commonality of Sovereign Financing

We collect bank level data on sovereign exposures from the European Banking Authority (EBA) transparency exercise files. Our data covers the period 2014 to 2019 at a semi-annual frequency. A typical EBA disclosure of the transparency exercise consists of 4 "template" files: credit risk, market risk, sovereign and other templates. Our data is sourced from the sovereign templates.[6] Based on total assets, the EBA transparency exercise covers 80% of the EU banking sector.[7]

4.1 Sample Construction and Exposure by Sovereign

We use direct sovereign exposures on balance sheet, which represents the total gross carrying amount of non-derivative financial assets that are sovereigns. We total exposures across all maturities. Our focus is on sovereigns of the Euro area member states. In all we have 19 sovereigns and a total of 123 banks across six-monthly periods from Dec 2014 to Dec 2019. The total number of observations in our dataset is 16,929. Table 1 provides an overview of our sample. The average sovereign exposure in our sample is €1.32bn with a standard deviation of €7.2bn. The risk weighted assets for the average

[6]https://www.eba.europa.eu/risk-analysis-and-data/EA-wide-transparency-exercise/

[7]Estimate based on the Risk Assessment Report published by the EBA in November 2019 [pg.11].

bank is €22.65bn.The Tier 1 Capital ratio is 16.9%. We use long-term (10-year) bond yields sourced from Eurostat. The average yield for sovereigns in our sample is 0.975 percentage points, with a standard deviation of 0.897.

[Table 1 about here.]

Table 2 presents exposures by sovereign, averaged across all periods. N refers to the number of banks across which the statistics are computed. Average sovereign exposures (Dec 2014 to Dec 2019) are highest for France (FR) with €5.4bn, followed by Germany (DE) with €4.5bn and Italy (IT) at €3.9bn. High values of standard deviation show that there is significant variation in sovereign holdings across banks. As a result, median exposures are an order of magnitude smaller than averages. In terms of median exposure, Italy (IT) is highest at €346mn. The average bank holds 8.6 different sovereigns, and the average sovereign is held by 72 different banks.

[Table 2 about here.]

4.2 Construction of the Sovereign Commonality Measure

We measure the commonality of sovereigns using their eigenvalue centrality in the projection of the bipartite exposure network onto the sovereign dimension. First, we capture the funding structure of a sovereign across the universe of banks in the sample. For each sovereign j (omitting time index for simplicity), we define a vector $s_j = (s_{1j}, s_{2j}, ..., s_{Nj})'$, where the element $s_{i,j}$ represents the holdings of sovereign j by bank i as a fraction of the total funding for that sovereign in the banking system. Thus, the vector s_j captures the share of funding across all N banks in the sample. The vectors s_j for each sovereign together gives us a matrix of funding structures $S_{N\times M} = (s_1, s_2, ..., s_M)$.

We then calculate the projection of this network onto the sovereign dimension, which captures the cosine similarity between pairs of sovereigns. That is, we define a matrix A whose typical element is

$$a_{lk} = \frac{s_l' s_k}{h_l h_k}, \quad h_j = \sqrt{\sum_{i=1}^{M} s_{i,j}^2}. \tag{1}$$

Namely, a_{lk} is the cosine similarity of sovereign l's and sovereign k's exposure portfolios: it is equal to 1 if the two sovereigns have identical funding structures, and zero if they are "orthogonal", i.e., if the two sovereigns are held by different banks. Since $s_j \geq 0$, $a_{lk} \in [0, 1]$. From this perspective, A can be viewed as the adjacency matrix of a network of sovereigns where sovereigns are "close" to each other if there is a non-empty set of banks who fund them in similar proportions. Figure 1 shows a heat map visualization of the adjacency matrix. We see from the heat map that sovereign pairs such as (Portugal, Spain) and (Germany, Austria) have highly similar funding structures.

Finally, the commonality of a sovereign is determined by its entry in the eigenvector of the similarity matrix associated with the largest eigenvalue of $A-I$, where I is an identity matrix.[8] This measure of commonality is recursive, as sovereigns are considered more "central" if they are commonly funded by banks that also fund other central sovereigns. Importantly, this measure captures similarity in sovereign funding structures—that is, the extent to which sovereigns share the same bank investors—rather than similarity in banks' portfolio allocations. Note also that we calculate sovereign commonality period-by-period, so our variable has both time-series and cross-sectional variation. Cross-sectional differences, however, are more dominant than the time-series dimension.

4.3 Baseline result: Sovereign exposure and commonality

In our baseline tests, we analyze the relation between the exposure of bank i to sovereign j in period t ($y_{i,j,t}$) and the sovereign's commonality. We use the following model for estimation:

$$y_{i,j,t} = \beta \text{Commonality}_{j,t-1} + \Gamma X_{i,j,t-1} + \epsilon_{i,j,t} \quad (2)$$

To capture the extensive margin effect, we use an indicator variable for positive exposures, $y_{i,j,t} = 1\{\text{Exposure}_{i,j,t} > 0\}$. For the intensive margin, we use $y_{i,j,t} = \ln \text{Exposure}_{i,j,t}$. Control variables X include GDP per capita (in logs), GDP growth, Risk weighted assets (in logs), Bank's Tier 1 capital ratios, and an indicator variable for own-sovereign exposures.

[8] We normalize the eigenvectors such that their L2-norm is equal to 1.

The goal of our baseline regressions is to test whether commonality is associated with sovereign holdings, even after controlling for price effects, sovereign-specific and bank-specific observables.

Table 3 shows the results. Columns (1)–(3) test for extensive margin effects. We find that Commonality is statistically significant: a one s.d. increase in commonality leads to a 10% increase in the probability of exposure to the given sovereign (column (3) of Table 3). Since commonality reflects the structure of sovereign funding across banks rather than similarity in bank portfolios, this result indicates that banks tilt their portfolios toward sovereigns with a more common investor base.

One may worry that most of the variation in the commonality variable is attributable to time-series effects, which in turn may be driven by common macro shocks that affect all sovereigns in the Euro area. So, in column (2) of Table 3, we control for temporal shocks with the inclusion of time fixed effects. There is virtually no change in the magnitude of the coefficient on Commonality, suggesting that aggregate shocks are unlikely to be a main driver of our results.

[Table 3 about here.]

In column (3) of Table 3, we use bank-level and sovereign-level observables to test whether the effect on commonality is still significant. For instance, a large literature documents the home bias of institutional investors (Hau and Rey (2008), Darvas and Schoenmaker (2017) and related cites). We find that the coefficient on the home-sovereign indicator is positive and strongly significant, consistent with the findings of the home bias literature. Note that home-sovereign indicator is defined at the bank-sovereign level, whereas sovereign commonality is at the sovereign level. Nevertheless, one might worry that variation in sovereign commonality is driven by sovereigns that are more prone to be held by banks from their own countries. But, Column (3) of Table 3 shows that the variation in Commonality cannot fully be attributed to home bias effects.

In Columns (4)–(6) of Table 3 we test for intensive margin effects using the dependent variable $y_{i,j,t} = \ln \text{Exposure}_{i,j,t}$. Conditional on having exposure to a particular sovereign, we want to estimate the extent to which higher commonality is associated with greater sovereign holdings. The number of observations for the intensive margin tests are smaller than Columns (1)–(3) of Table 3 because sovereign investments are not well diversified across banks and, hence, exposures of many banks to many sovereigns are zero. We find consistent results—we find that one s.d. increase in commonality leads to a 40% higher exposure to the given sovereign (column (6) of Table 3). For an average bond holding, this is equivalent to a 10% effect in terms of standard deviations of positive exposures. Similar to Columns (1)–(3) of Table 3, we control for variation in yields, home bias factor, GDP growth, risk weighted assets (bank risk exposure), and tier 1 capital ratio. We continue to find consistent results. The level of exposure of a bank to a particular sovereign is greater if that sovereign is more central in the banking network.

5 Main result: Estimating a demand system for sovereign bonds

What are the market implications of banks' preference for similarly funded sovereigns? To quantify the impact on sovereign yields, we estimate a structural demand system for Eurozone banks. We adopt the characteristics-based demand framework of Koijen and Yogo (2019) in which asset demand (exposures) depends on asset prices and observable characteristics such as commonality.[9] In our setting, commonality enters as an asset characteristic capturing the position of the sovereign's investor base within the Eurozone banking network. Estimating this demand system allows us to analyze how sovereign funding structures and asset prices interact in equilibrium. It also enables us to conduct policy-relevant counterfactuals, such as assessing how sovereign yields would change if banks did not place value on sovereigns with more common investor bases.

We begin by assuming banks have mean-variance preferences to estimate a demand curve for sovereign bonds based on these preferences. Koijen and Yogo (2019) show that optimal portfolio weights for any asset $w_{i,j,t}$ (bank i, asset j, time t) can be expressed as

[9] We acknowledge that the quantification of our effects can be affected by the demand system specification. Recently, alternative demand estimations have been proposed (Fuchs et al., 2025). In their response to criticisms of the characteristics-based demand system, Koijen and Yogo (2025) clarify that using a cross-sectional instrumental variables estimator consistently identifies elasticities when demand is specified as a logit function.

a logit function of prices (in our case, $\text{Yield}_{j,t}$), characteristics of the asset j ($X_{j,t}$), and an investor-specific latent demand factor $\epsilon_{i,j,t}$ which captures the unobserved, heterogeneous beliefs of investors. Our demand estimation methodology is similar to Koijen et al. (2021) and Bretscher et al. (2025).

We estimate the following equation:

$$\frac{w_{i,j,t}}{w_{i,0,t}} = \exp(\beta_Y \text{Yield}_{j,t} + \beta_C \text{Commonality}_{j,t-1} + \Gamma \text{X}_{i,j,t-1})\varepsilon_{i,j,t} \tag{3}$$

where $w_{i,j,t}$ is the weight of a sovereign j in the portfolio of bank i at a given time t. $w_{i,0,t}$ is the portfolio weight on the outside asset. We define outside asset as the sum of sovereign holdings outside the Euro zone and bank liquidity held in the central banks. We use the generalized method of moments (GMM) for this estimation to account for both extensive and intensive margins in the same specification. Another important difference between the statistical model of eq. (2) and the demand system eq. (3) is that portfolio demand (and, hence, portfolio weight $w_{i,j,t}$) is determined *relative to the outside asset*, $w_{i,0,t}$. Table 5 is the core result of our paper. In column (1), we estimate asset demand with only commonality and yield as the explanatory variables. Thus, the moment condition for Column (1) of Table 5 is:

$$E\left[\epsilon_{i,j,t} \mid \text{Yield}_{j,t}, \text{Commonality}_{j,t-1}, X_{i,j,t-1}\right] = 1 \tag{4}$$

As Table 5 shows, commonality has an independent, statistically significant effect on sovereign demand, after controlling for variation in yields. But the challenge of interpreting Column (1) of Table 5 is that it can be hard to justify the assumption that prices are exogenous to the quantities demanded, in the absence of an instrument. So, in Section 5.1, we instrument for prices using a capital key instrument, motivated by Koijen et al. (2021). In subsequent analyses, we address the potential concern with the assumption that sovereign commonality is exogenous to latent demand $\epsilon_{i,j,t}$. In Section 5.2, we weaken the exogeneity assumption on commonality using the spatial centrality instrument.

5.1 Instrumenting for sovereign yields in the demand system

Over the past decade, the ECB's monetary policy involved purchases of euro-denominated debt instruments, announced under the Public Sector Purchase Programme (PSPP). The schedule of these purchases is shown in Table 4. The distribution of asset purchases across euro countries was proportional to the capital key defined as the average of country's share of GDP and population. We use the official capital key values published by the ECB. Koijen et al. (2021) construct a capital key instrument that exploits the cross-sectional variation in this instrument (unrelated to bank-specific factors), and the time-series variation in market reactions to these (plausibly unexpected) announcements. We employ the Koijen et al. (2021) IV by extending their sample from 2017 to 2019 and including additional ECB announcements during this period.

[Table 4 about here.]

Using the information of planned monthly purchases, we first calculate the Total Announced ECB purchases A_t (Column (5) of Table 4) as the sum of purchases in period t implied by all previous and current announcements.[10] Using the capital key $K_{j,t}$ and the predicted government purchases A_t, we can define the instrument for sovereign bond yields:

$$Z_{j,t} = \frac{K_{j,t} A_t}{M_{201412,j}} \tag{5}$$

where M is the sovereign's government debt at the beginning of our sample period (as in Koijen et al. (2021)).

We begin demand estimation by maintaining the assumption that banks take *other* asset characteristics (including $\text{Commonality}_{j,t}$) as a given. Note that this assumption is also used in the demand estimation of Koijen and Yogo (2019) and Koijen et al. (2021). So

[10] Similar to Koijen et al. (2021), we assume the predicted government purchases, A_t, to be 73% of the total announced purchases reported in the Table 4.

the moment condition is:

$$E\left[\epsilon_{i,j,t} \mid Z^{Y}_{j,t}, \text{Commonality}_{j,t-1}, X_{i,j,t-1}\right] = 1 \tag{6}$$

The use the capital key instrument $Z^{Y}_{j,t}$ for yields weakens the moment condition of eq. (4). The GMM estimation employs the capital key instrument in Columns (2)-(5) of Table 5. The table shows that, after controlling for price variation, bank portfolio choice reflects a demand for commonality. The coefficient on the (instrumented) yield is positive and significant, showing that the demand curve is downward sloping (i.e., lower prices are associated with greater asset demand).

[Table 5 about here.]

5.2 Instrumenting for commonality in the demand system

So far, we have argued that greater commonality of sovereign bond financing results in banks having higher exposures to those sovereigns. We interpret this behavior as a preference for commonly-funded sovereigns, potentially driven by expectations of coordinated regulatory intervention. While this interpretation has strong theoretical foundations (Acharya and Yorulmazer, 2007; Farhi and Tirole, 2012; Acharya et al., 2016), it can be confounded by omitted factors (with potentially opposing effects). Despite controlling for plausibly exogenous variation in yields and economic performance (GDP), our measure of commonality may proxy for the sovereign's liquidity or collateral eligibility. This collateral eligibility factor could bias towards finding an association between exposures and commonality. On the other hand, greater asset commonality may also signal a higher risk of joint liquidation (Wagner, 2011), so banks' incentives to avoid joint liquidation risk can attenuate the relationship.

We approach this problem by using an instrument for commonality with two empirical goals: a) since the time-varying nature of omitted variables (liquidity, collateral eligibility, or joint liquidation risk of sovereigns) is related to *current* demand conditions, we aim to isolate "pre-determined" cross-sectional variation that abstracts away from such factors, and b) we want an instrument that correlates with the likelihood of intervention from supranational bank regulators. To this end, we use the centrality (commonality) of the geographic location of a sovereign's country in the Euro zone. This instrument—*spatial centrality*—measures how central a particular country is, relative to the geographic location of other countries in the Euro zone. For every country in our sample, we use an indicator variable to code the countries with which it shares a border (border indicator). The border indicator variable gives us a spatial network of connections between Euro countries. We calculate the eigenvector centrality of the spatial network, so countries which share more borders will be more central to the Eurozone relative to those that share very few borders. For instance, Portugal will have a lower score on the spatial centrality measure compared to Belgium. Figure 3 provides a visual. The geographic centrality (Z_j^C) will be our instrument for sovereign commonality.

Two aspects of this IV make it relevant to our setting. First, since geographic networks are pre-determined, the IV isolates cross-sectional variation that is plausibly exogenous to current demand conditions such as liquidity or collateral eligibility of the sovereign.[11] Our argument is similar to Koijen and Yogo (2019) who use a pre-determined investment mandate to generate exogenous variation in prices. In a recent paper on the econometrics of demand-system asset pricing, Koijen and Yogo (2025) clarify that using a *cross-sectional* IV estimator consistently identifies elasticities when demand is specified as a logit function. Recent evidence in Beck et al. (2023) suggests that our IV captures the likelihood of bailout from supranational bank regulators. In their study on the effectiveness of regulatory cooperation, Beck et al. (2023) show that supervisory cooperation is not necessarily optimal for all country-pairs due to country heterogeneity. In particular, geographic, institutional, and linguistic differences can hinder supranational cooperation as they increase the costs of bank resolution. Thus, the likelihood of supranational bank rescue will be higher in country pairs that have common borders, due to lower resolution costs. This argument forms the basis for the relevance of our spatial centrality IV. From the bank's perspective, incentives for herding vis à vis Farhi and Tirole (2012), may be

[11]By using a pre-determined network structure that is based on geographic boundaries, the IV addresses the reverse-causality concern that the network structure of banks' sovereign holdings is an outcome, rather than a driver of the bank's decision to hold particular sovereigns.

greater for those that are located in spatially central regions.[12]

[Figure 3 about here.]

The correlation of this instrument with sovereign commonality is shown in Figure 4. The first stage F statistic is large by all standards.[13] The exclusion restriction of the spatial centrality IV requires that cross-sectional variation in Z_j^C affects a bank's preference for holding a sovereign only through its effect on sovereign commonality based on the network of portfolio holdings. For the exclusion restriction to be violated, it would have to be the case that spatial commonality (or, equivalently, cultural distance) affects the risk-return tradeoff for a bank through unobserved asset characteristics unrelated to sovereign commonality. While the exclusion restriction can never be formally tested, we note that these unobserved risk factors should be unrelated to movements in asset prices as well, in order to violate the exclusion. For instance, the alternate factor cannot be related to economic performance/sovereign quality, because we are already instrumenting for yields using the capital key instrument Z_j^Y.

[Figure 4 about here.]

The GMM moment condition of eq. (6) is now weakened to:

$$E\left[\epsilon_{i,j,t} \mid Z_{j,t}^Y, Z_j^C, X_{i,j,t-1}\right] = 1 \tag{7}$$

Here, Z_j^C is the spatial centrality instrument based on geographic borders of euro zone countries, as discussed above. Column (4)-(5) of Table 5 presents the estimation results. We continue to find a strong preference for commonality by banks, after controlling for variation in sovereign yields. The use of both instruments, along with a battery of robustness tests (discussed in Section 7) gives us confidence in a causal interpretation.

The spatial centrality instrument is based purely on the "extensive margin" of overlap i.e., we only consider the existence of overlap, not the intensity of it. For instance,

[12] This conjecture is also supported by Karolyi (2016) who argues that gravity-based approaches can explain differences in investment behavior.

[13] Using a panel at the sovereign level, the F-statistic for spatial centrality exceeds 35.

we use an indicator variable to capture shared geographic borders of sovereigns. This formulation gives us a matrix of zeros and ones which we use to calculate the centrality of the sovereign network. While the goal of the instrument is to capture the "cultural distance" between two countries, we do not consider the actual extent of overlap—our formulation ignores the *length* of the border shared between two countries. Arguably, a country with a longer shared border may share more similarities to a given country, than another with a shorter border.

To ensure our results are not sensitive to this formulation, we obtain data on the lengths of borders between Euro area countries. We then recalculate our centrality measure using these distance measures. We then test whether our main result survives using this newly constructed instrument. Column (5) of Table 5 shows the estimate of equation 3 using this instrument. Under the new instrument, the GMM moment condition is:

$$E\left[\epsilon_{i,j,t} \mid Z^{Y}_{j,t}, D^{C}_{j}, X_{i,j,t-1}\right] = 1 \tag{8}$$

Here, D^C_j is the spatial centrality instrument based on the overlap using actual common border lengths of euro zone countries. As Column (5) of Table 5 shows, we continue to find a statistically and economically significant effect using this new instrument. Based on the coefficient on commonality from Column (5) and the logit model, we estimate the elasticity with respect to commonality for the average exposure in the sample to be around 2.9.[14]

6 Counterfactual Exercises

We use the demand system estimates obtained in Section 5 to quantify the role of commonality in the determination of prices and elasticities. Specifically, we conduct empirical exercises in which we eliminate the demand for commonality by setting β_C in Equation (3) to zero and calculate the resulting sovereign debt yields and elasticities in the new equilibrium. This can be interpreted as a scenario in which banks place no additional value on commonly funded sovereigns. In these exercises, we assume a fixed supply of

[14]We estimate the elasticity as $\eta^{avg}_j \equiv \beta_C \times C^{avg}_{j,t-1} \times (1 - w^{avg}_{i,j,t}) = 1.7 \times 1.763 \times (1 - 0.0342)$.

bonds, meaning the quantity of bonds held by the banks in our sample remains constant, and bond prices serve as the sole margin for equilibrium adjustment. Additionally, we assume that other determinants of demand are held constant at their observed levels, and that the unobserved component of demand remains fixed at the level that equates actual yields with the demand system under the parameter values from Section 5.

6.1 How does a preference for commonality affect sovereign yields?

In this counterfactual exercise, we analyze the effect of commonality on yields. Specifically, we calculate the yields in a counterfactual scenario where banks do not exhibit preference for commonality. We perform the analysis by setting β_C to zero and compare the outcomes with the observed yields.

For each sovereign j, equilibrium in the sovereign bond market requires that the total exposure of banks to that sovereign equals the market value of the outstanding stock of debt, $E_j + E_j^O = Q_j(1+Y_j)^{-10}$, where Q_j denotes the exogenous quantity of debt, Y_j the 10-year yield, E_j^O are debt holdings of outside investors, and E_j is the sum of the exposures of individual banks included in the sample: $E_j \equiv \sum_i E_{i,j} = \sum_i w_{i,j} E_i$. We treat the total exposure of bank i, E_i, as an exogenous parameter, and allow the portfolio share allocated to sovereign j, $w_{i,j}$, to change according to the estimated demand system.

Consider a counterfactual change in portfolio commonality that alters portfolio shares from $w_{i,j}$ to $w'_{i,j}$ while keeping debt quantities and bank balance-sheet sizes fixed. The proportional change in equilibrium yields must then satisfy

$$\frac{E'_j}{E_j} = (1+\mu_j)\left(\frac{1+Y_j}{1+Y'_j}\right)^{10} - \mu_j, \tag{9}$$

where $\mu_j = E_j^O/E_j$, and the proportional change in aggregate exposure can be written as a weighted average of the proportional changes in bank-level portfolio shares,

$$\frac{E'_j}{E_j} = \sum_i s_{i,j}\frac{w'_{i,j}}{w_{i,j}}, \quad s_{i,j} \equiv \frac{E_{i,j}}{E_j}. \tag{10}$$

Portfolio shares are determined by the demand system equation (3). In the counterfactual scenario, the effect of commonality is shut down by setting $\beta_C = 0$, while all other parameters and characteristics are held fixed. This implies that the proportional change in each bank's portfolio weight can be expressed as

$$\frac{w'_{i,j}}{w_{i,j}} = \exp\big(\beta_Y (Y'_j - Y_j) - \beta_C C_j\big) \frac{1 + \sum_k \exp(\beta_Y Y_k + \beta_C C_k + \Gamma X_{i,k})\epsilon_{i,k}}{1 + \sum_k \exp(\beta_Y Y'_k + \Gamma X_{i,k})\epsilon_{i,k}}, \tag{11}$$

where the second factor reflects the re-normalization of portfolio shares implied by the demand structure.

Substituting (11) into the aggregation equation (10) and combining it with equation (9) gives a system of nonlinear equations that jointly determines the vector of counterfactual yields Y'_j. Solving this system delivers the counterfactual equilibrium yields consistent with the new pattern of portfolio allocations implied by the removal of the commonality component from banks' sovereign bond demand.

The results of the exercise are summarized in Figure 5, which plots the change in sovereign yields in the equilibrium with no preference for commonality against its level. See also Table 6. We compute the yield change for each period in our sample and average the results by country, alongside the observed commonality. Given that the actual valuations of commonality are positive ($\beta_C > 0$), its contribution to equilibrium prices is also positive. Consequently, in an equilibrium where banks do not exhibit preferences for commonality, we observe lower bond prices and higher yields. On average, we find that sovereign yields would be 1 percentage point higher in the absence of these tastes, with yields for sovereigns whose debt is more popular among banks being up to twice as high.

[Figure 5 about here.]

6.2 How does a preference for commonality affect elasticities of sovereign yields?

We next derive semi-elasticity of aggregate bank demand for sovereign bonds with respect to the sovereign yield and show how it changes when portfolio commonality is altered.

The semi-elasticity of aggregate demand with respect to the yield is, $\xi_j \equiv \partial E_j / \partial Y_j$, which is

$$\xi_j = \sum_i s_{i,j}\, \xi(w_{i,j}, Y_j), \tag{12}$$

where $\xi(w_{i,j}, Y_j)$ is the bank-level semi-elasticity of sovereign's portfolio share. Under the demand specification (3), $\xi(w_{i,j}, Y_j) = \beta_Y(1 - w_{i,j})$, which together with (12) implies

$$\xi_j = \beta_Y \Big(1 - \sum_i s_{i,j} w_{i,j}\Big).$$

Hence, the responsiveness of aggregate bank demand depends on the distribution of portfolio shares across banks. Changes in portfolio commonality affect the semi-elasticity through their impact on portfolio allocations $w_{i,j}$ and therefore on the funding structure $s_{i,j}$; in equilibrium, they also alter the equilibrium yield Y_j. To quantify this effect, we recompute all relevant objects—portfolio shares, funding weights, and equilibrium yields—under the counterfactual scenario in which $\beta_C = 0$, and evaluate the resulting semi-elasticity using these counterfactual values.

Table 6 shows that removing the preference for commonality makes the demand for sovereign bonds by banks more elastic with respect to yields. When banks value commonly held sovereigns, their demand is less sensitive to yield changes because part of the demand reflects a network-based preference. As a result, commonly funded sovereigns benefit from a relatively inelastic investor base. Once this preference is removed, banks' portfolio allocations become more responsive to yields, increasing the price sensitivity of demand. Economically, this implies that the network structure of bank portfolios dampens the responsiveness of sovereign bond demand to yield movements. Consequently, commonly held sovereigns face lower yields but also a more stable demand base, while eliminating commonality preferences would both raise yields and make sovereign bond demand more sensitive to price changes.

[Table 6 about here.]

7 Alternate Explanations and Robustness

7.1 Controlling for Trade Network Centrality

Our instrument for sovereign commonality is based on the centrality of the geographic network of Eurozone countries. This formulation raises a potential concern: prior research has shown that centrality of *trade* networks can affect interest rates (Richmond, 2019). These factors, in turn, can affect bank exposures. Thus, to the extent our instrument is correlated with the centrality of trade flows in the Eurozone, we might be worried that our results are explained by trade flows (and associated changes in interest rates), rather that the centrality of sovereign bonds. In this section, we perform a test that allays these concerns.

We obtain bilateral trade flow data (exports/imports) for all sovereigns in our sample from the UN-Comtrade database.[15] We construct a trade flow network and compute its centrality. We then introduce trade flow centrality as a control variable in our demand estimation equations. We estimate the following equation:

$$\frac{w_{i,j,t}}{w_{i,0,t}} = \exp(\beta_Y \text{Yield}_{j,t} + \beta_C \text{Commonality}_{j,t-1} + \beta_{TC} \text{TradeCentrality}_{j,t-1} + \Gamma \text{X}_{i,j,t-1})\varepsilon_{i,j,t} \tag{13}$$

where $\text{TradeCentrality}_{j,t-1}$ is the eigenvector centrality of trade (exports-imports) using trade flows from the UN-Comtrade database for Eurozone countries.

Table 7 presents the results. We see that the instruments perform well even when controlling for trade centrality, and that the results remain both statistically and economically significant.

[Table 7 about here.]

[15] See https://comtradeplus.un.org/

7.2 Instrumenting for Yields Using Actual Purchases under PSPP

Our capital key instrument in Section 5.1 was based on PSPP purchases that included ECB purchases up to an announcement (Table 4 Panel (a) lists ECB announcements) plus those *implied* by the current announcement. But actual purchases typically varies from the implied announcement. We may expect that actual purchases may be more relevant in explaining the variation in yields compared to the implied purchases at the time of the announcement. So, in the section we perform a robustness test that uses an alternate capital key instrument based on the actual net purchases of the ECB.

Table 8 presents the results. Similar to the estimation in Table 5, we begin by assuming that banks take *other* asset characteristics (including $\text{Commonality}_{j,t}$) as a given. Note that this moment condition is also used in the demand estimation of Koijen and Yogo (2019) and Koijen et al. (2021). We also weaken this moment condition since time-varying demand shocks across large banks can potentially change the commonality of the sovereign itself. Using the spatial centrality instrument from Section 5.2, the GMM moment condition in Column (3) of Table 8 is the same as equation (7) where Z_j^C is now the spatial centrality instrument based on geographic borders of euro zone countries.

The results in Table 8 with the alternate instrument confirms our main hypothesis. Bank portfolio choice includes a preference/demand for commonality that is not captured by variation in yields. Note that the coefficient on yields is positive and significant, showing that the demand curve is downward sloping (i.e., lower prices are associated with greater asset demand).

[Table 8 about here.]

7.3 Are results being driven by the concentrated holdings of a few large banks?

Another potential concern is that our commonality measure may be driven primarily by the portfolio decisions of a small number of very large banks. Large banks tend to hold multiple sovereign bonds and in large quantities. If these banks systematically appear in the funding structures of many sovereigns, the measured overlap between sovereigns could partly reflect the presence of these institutions rather than a broader pattern in how sovereigns are funded across the banking system.

To evaluate this possibility, we perform a randomization exercise that breaks the link between particular banks and the sovereigns they fund while preserving the overall funding structure of each sovereign. Specifically, for each sovereign we randomly reassign exposures across the banks that fund it, keeping the set of banks funding the sovereign unchanged. This procedure preserves the distribution of funding shares across banks for each sovereign but eliminates the systematic co-holding patterns generated by particular institutions.

After performing this reshuffling, we recompute the sovereign commonality measure using the randomized funding structures and re-estimate the demand specification. Importantly, this randomization removes the exact co-funding relationships across sovereigns while preserving the overall concentration patterns in their funding profiles. As a result, the recomputed measure reflects overlap in sovereign funding structures that is not driven by systematic co-holding patterns of particular large banks. We include the commonality measure recalculated from the randomized exposures as the main variable in the estimation.

Table 9 presents the results. Column (1) uses the geographic centrality instrument Z^C, while Column (2) uses the alternative instrument based on the lengths of shared borders. In both specifications, the core commonality measure remains statistically and economically significant. These results suggest that our findings are not driven by the concentrated holdings of a few large banks, but instead reflect broader similarities in how sovereigns are funded across the banking network.

[Table 9 about here.]

7.4 Controlling for Sovereign Credit Risk

We may be concerned that credit risk is driving our results. So, we obtain credit rating data from Bloomberg and test whether introducing credit rating controls explicitly alters our result. If our results were sensitive to credit ratings, then we may worry that omitted variables associated with sovereign risk could confound our interpretation.

We estimate the following equation:

$$\frac{w_{i,j,t}}{w_{i,0,t}} = \exp(\beta_Y \text{Yield}_{j,t} + \beta_C \text{Commonality}_{j,t-1} + \beta_{TC} \text{InvestmentGrade}_{j,t-1} + \Gamma \text{X}_{i,j,t-1}) \varepsilon_{i,j,t} \tag{14}$$

where $\text{InvestmentGrade}_{j,t-1}$ is the credit rating of the sovereign.

Table 10 presents the results. We see that the instruments perform well even when controlling for credit ratings, and that the results remain both statistically and economically significant.

[Table 10 about here.]

7.5 Demand estimation using an alternate specification for commonality

In our demand estimation eqn.(3), we used the lagged measure $\text{Commonality}_{j,t-1}$ in order to avoid a mechanical link between exposures $w_{i,j,t}$ and the main independent variable. But, this choice of specification may raise concerns that our results are sensitive to the lagged measure on the right-hand side. Since exposures, commonality, and yields are jointly determined in equilibrium, one could argue that all these variables need to be measured in a contemporaneous manner – i.e., $\text{Commonality}_{j,t}$ instead of $\text{Commonality}_{j,t-1}$. To ensure our results are not sensitive to this measurement, in Table 11 we repeat the entire demand estimation using the contemporaneous measure of commonality. As the results in Table 11 show, we continue to find consistent results.

[Table 11 about here.]

7.6 Measuring Commonality in a Constant Sample of Banks

Our data is sourced from the European Banking Authority (EBA) transparency exercise files. In these datasets, while the large banks are repeatedly sampled across the years, some small banks may drop out or get included in specific years. To allay concerns that our results are not being driven by changes in sample size, we perform a robustness test in Table 12 that maintains a constant sample of banks throughout the whole period.

[Table 12 about here.]

As Table 12 shows, we find consistent results by restricting the sample to a repeated cross-section of banks. Overall, these tests provide further support to the role of asset commonality in bank portfolio choice.

8 Conclusion

Using data from sovereign bond holdings by European banks, we measure the eigenvector centrality (commonality) of a sovereign bond within the banking network. We are among the first studies to show that asset commonality is an important factor in determining bank sovereign portfolio holdings and bond yields, connecting the literature on financial networks to research on sovereign debt pricing. Sovereign bonds that have a more common investor base in the banking network have a greater probability of being held by a given bank. To support a causal interpretation, we introduce a new instrument for asset commonality—spatial centrality—based on the shared geographic borders of Euro area countries. From a mean-variance tradeoff perspective, higher commonality implies lower expected returns because of expectations of regulatory intervention. We model banks as mean-variance optimizers, estimating a demand curve for sovereign bonds using the Koijen and Yogo (2019) framework. This estimation allows us analyze a policy-relevant counterfactual scenario where the absence of a preference for commonality could affect asset prices. In this scenario, we find that bond yields will be around 1pp *higher* in the absence of a preference for commonality. Our results imply that the network structure of bank portfolios dampens the responsiveness of sovereign demand to yield movements.

The evidence on bank preference for similarly-funded sovereigns has two key implications. First, prior literature has conjectured the importance of investor heterogeneity in understanding variation in asset prices. Our result show that banks have unique preferences—their portfolio choices may reflect expectations of regulatory intervention via demand for sovereigns with a more common bank investor base. This matters because, to the extent banks are marginal investors in sovereign markets, such preferences affect equilibrium yields and elasticities. Second, we inform the policy debate on the "diabolic doom loop" between sovereign risk and the financial sector of a country (Brunnermeier et al., 2016) and its implications for cross-country contagion. While European safe bonds have been proposed as a potential solution for avoiding the bank-sovereign nexus, our counterfactual exercise shows that, to the extent this solution eliminates the preference for commonality, it can result in higher sovereign yields. Commonly held sovereigns face lower yields but also a more stable demand base. So, an increase in borrowing costs could partially offset the positive effect of the increase in safety by introducing a new common asset.

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Figure 1: Cosine Similarity of Sovereign Financing

This plot shows a visualization of the adjacency matrix which captures the cosine similarity of funding structures between pairs of sovereigns. This adjacency matrix A is the basis for our measure of commonality, which is defined as the eigenvector associated with the largest eigenvalue of $A - I$, where I is the identity matrix. Refer to Equation (1) for the definition of cosine similarity. A high value of cosine similarity implies that the two sovereigns are "close" in the sense that the underlying banks fund them in similar proportions. Taking Italy (IT) as an example, the plot shows that Italian sovereigns are most similar to (AT) Austrian sovereigns, suggest that the underlying banks hold them in similar proportions.

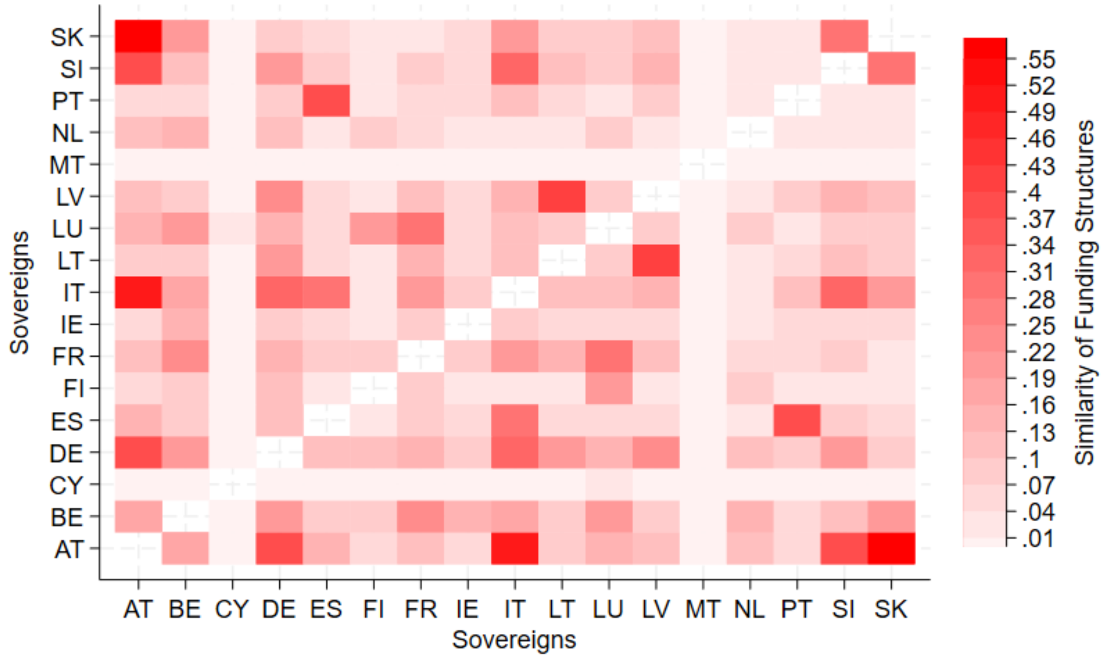


Figure 2: Commonality and Economic Performance in the Cross-Section

This figure shows scatter plots of lagged average commonality against average values of yields, GDP, average risk-weighted assets, and average Tier 1 capital for all the sovereigns in the sample. The plots provides suggestive evidence that variation in average commonality across sovereigns cannot be purely attributed to differences in economic performance, health and size of the respective banking systems, or movements in assets prices. In our baseline tests, we control for all these performance indicators. Average yields and commonality appear to be (weakly) negatively correlated in the cross-section. In our subsequent analysis, we use instruments to isolate plausibly exogenous variation in yields.

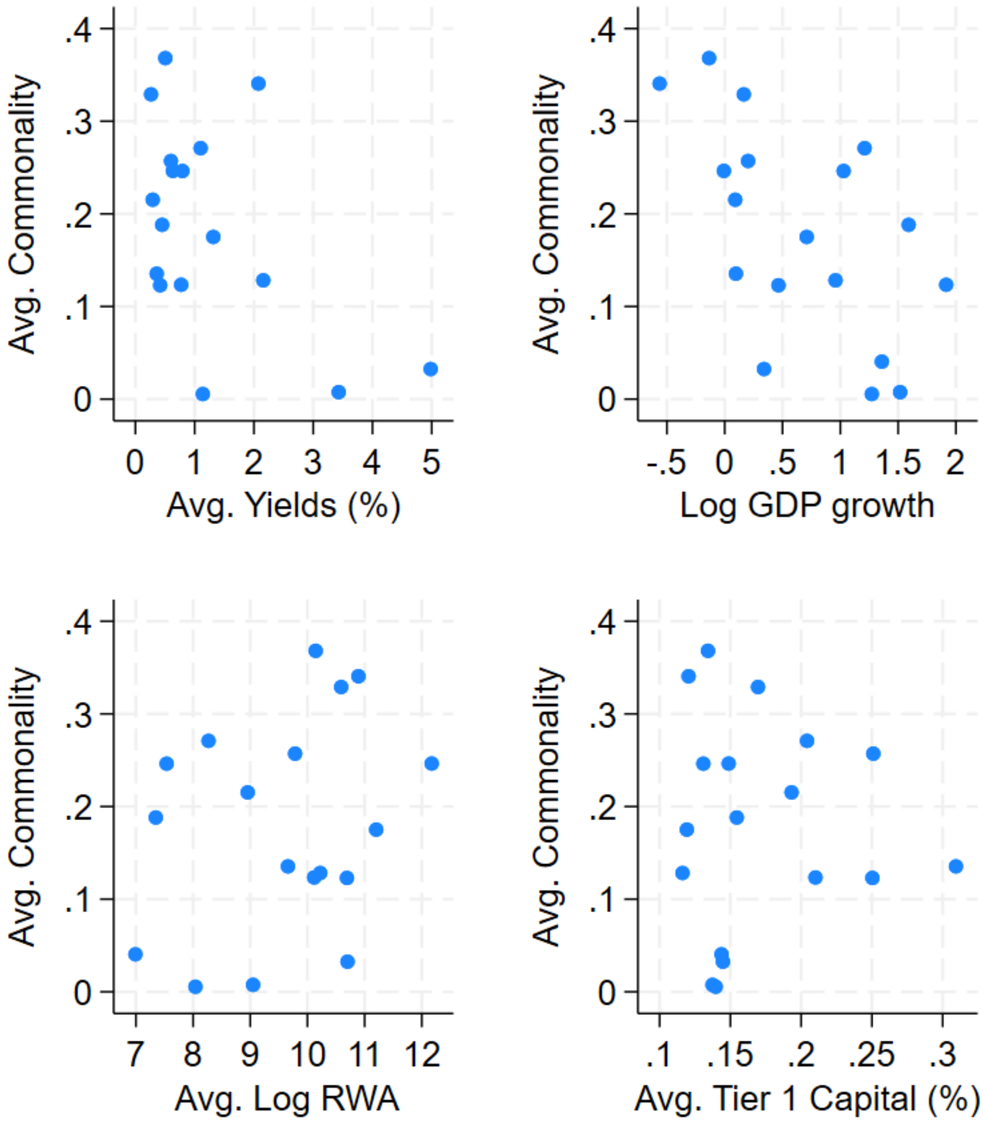
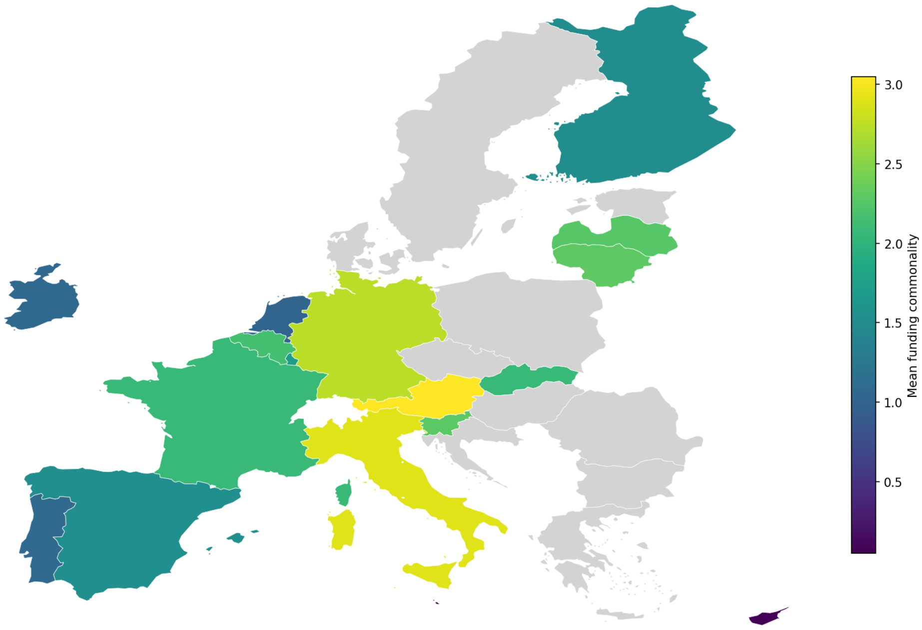
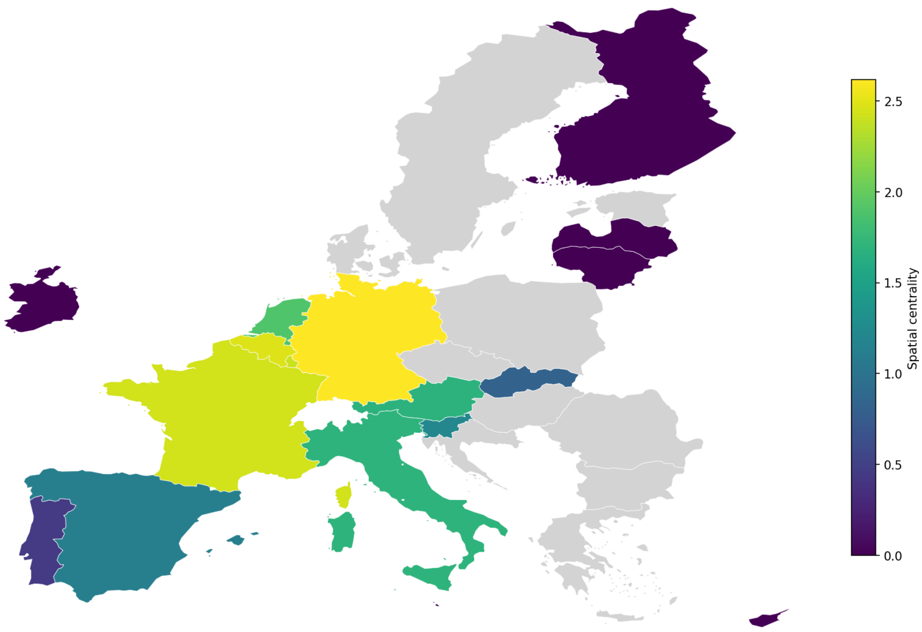


Figure 3: Visualization of the Spatial Centrality Instrument

This graph provides a visual of the spatial centrality instrument by plotting the average funding commonality across sovereigns (Panel (a)) and comparing it to our IV based on shared borders (Panel (b)). We use indicator variables to code the countries with which they share a border. Since we calculate the eigenvector centrality of the spatial network, countries which share more borders will be more central to the Eurozone relative to those that share very few borders. Thus, for example, the Netherlands will have a higher centrality score than Portugal. The shape files for the map are obtained from Sevdari and Marmullaku (2023).



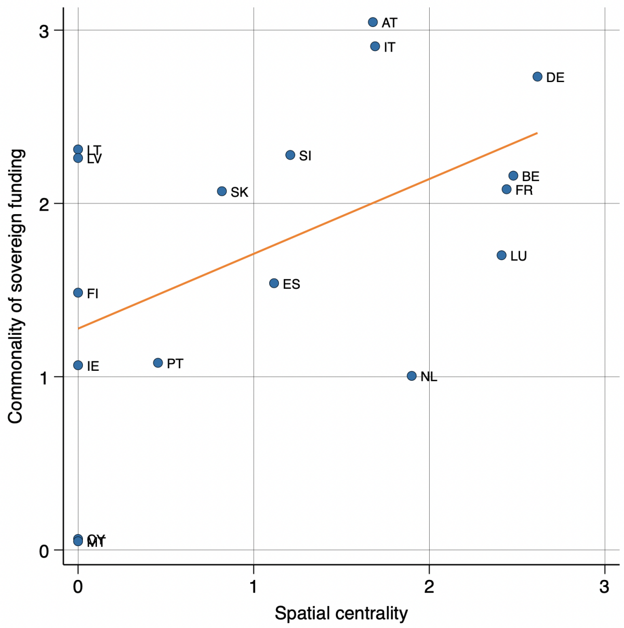
(a) Funding commonality across sovereigns



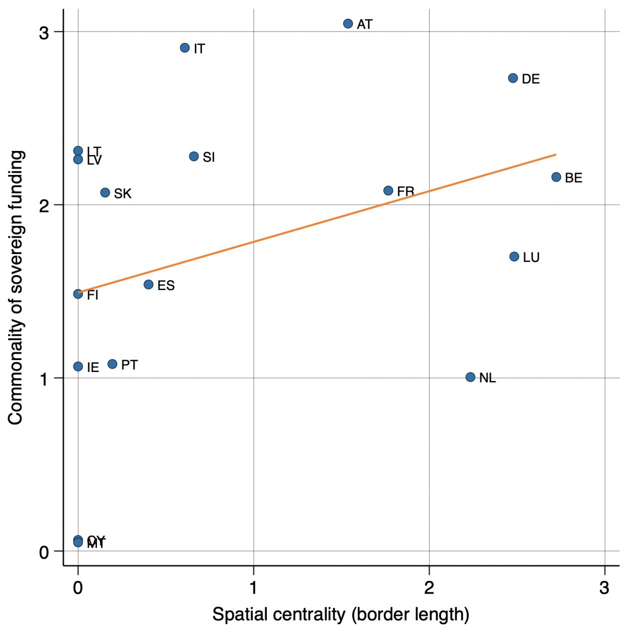
(b) Commonality IV based on shared borders

Figure 4: Instrumenting for Sovereign Commonality

We instrument for sovereign commonality using *spatial centrality*, which measures how central a particular country is, relative to the geographic location of other countries in the Euro zone. The shared borders of Euro zone countries gives us a spatial (geographic) network of connections. The eigenvector centrality of this border network is our IV. Panel (a) is based on shared border indicators whereas Panel (b) is based on actual lengths of shared borders.



(a) IV based on common border indicators



(b) IV based on length of common borders

Figure 5: Commonality and the counterfactual change in sovereign yields

This graph plots the impact on sovereign yields in a counterfactual equilibrium where banks did not exhibit a preference for commonality. The y-axis shows the change in yields, while the x-axis is the sovereign commonality. We compute the yield change for each period in our sample and average the results by country, alongside the observed commonality. Given that the actual valuations of commonality are positive ($\beta_C > 0$), its contribution to equilibrium prices is also positive. The plot shows that sovereign yields would be 1 percentage point higher, on average, in the absence of these preferences.

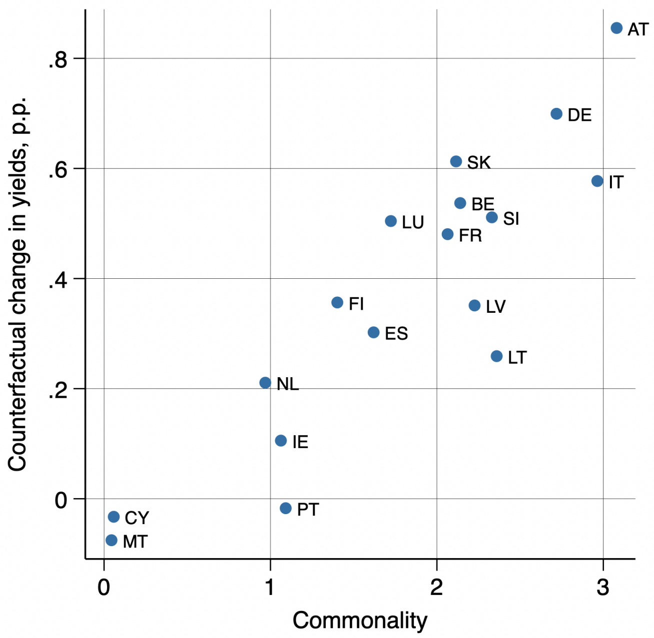


Table 1: Summary Statistics

This table summarizes the main sample used in the analysis. Our data is at the Bank × Sovereign × Period level. We have a total of 123 banks, 19 sovereigns, and 11 semi-annual periods (from Dec 2014 to Dec 2019). *Exposure* represent the total gross carrying amount of non-derivative financial assets that are sovereigns (item 20810). All variables are defined in the appendix. Data is sourced from the "sovereign templates" of the ECB transparency exercise: https://www.eba.europa.eu/risk-analysis-and-data/EA-wide-transparency-exercise/

	Count	Mean	SD	p10	p90
Exposure	13702	1319.0	7210.3	0	1629.3
ln Exposure	6878	4.914	3.169	1.591	8.546
1{Exposure > 0}	13702	0.502	0.500	0	1
Portfolio share $w_{i,j,t}$	13702	0.0342	0.444	0	0.0378
Portfolio share ratio $\frac{w_{i,j,t}}{w_{i,0,t}}$	13697	0.125	1.135	0	0.108
Commonality	13702	1.763	0.960	0.0853	2.971
Yield	13702	0.975	0.897	0.112	2.307
Home Sovereign	13702	0.0556	0.229	0	0
ln GDP Per Capita	13702	10.28	0.512	9.612	10.94
GDP Growth	13702	2.763	2.891	0.530	5.095
ln Risk Weighted Assets	13702	10.35	1.505	8.299	12.64
Tier 1 Capital Ratio	13702	0.169	0.102	0.111	0.243

Table 2: Exposure Statistics by Sovereign

Sovereign exposure refers to the total gross carrying amount of non-derivative financial assets classified as direct sovereign exposures on balance sheet (item 20810 in the EBA sovereign transparency file). Exposures are totaled across all maturities. The table shows 19 sovereigns held across 123 banks from Dec 2014 to Dec 2019. All variables are defined in the Appendix.

	Sovereign Exposure (€mn)			
	Mean	Std. Dev.	p50	p99
FR	5 631	21 161	191	123 837
DE	4 712	10 072	173	41 989
IT	4 196	11 205	402	64 286
ES	3 562	10 680	208	51 726
NL	1 486	6 457	12	34 187
BE	1 409	4 868	75	24 633
AT	768	2 236	35	12 296
PT	596	1 920	4	10 859
FI	370	1 787	0	10 556
LU	312	1 253	0	5 439
IE	291	1 309	0	6 441
GR	174	958	0	4 140
SK	158	746	0	4 264
SI	63	205	0	1 217
CY	33	245	0	637
LT	11	37	0	170
MT	11	94	0	688
LV	10	32	0	193
EE	5	62	0	46

Table 3: Baseline: Commonality and Bank Sovereign Holdings

This table reports the results of OLS estimation of the equation

$$y_{i,j,t} = \beta \text{Commonality}_{j,t-1} + \Gamma X_{i,j,t-1} + \theta_t + \varepsilon_{i,j,t},$$

where $y_{i,j,t}$ is an indicator variable of a positive exposure of bank i to sovereign j in period t (in Columns (1)–(3)) or log of exposure (in Columns (4)–(6)), and θ_t is time fixed effect. The definitions of all variables are listed in the appendix. Standard errors are clustered at the bank level. $^{*}p < 0.1, ^{**}p < 0.05, ^{***}p < 0.01$

	Extensive margin			Intensive margin		
	(1)	(2)	(3)	(4)	(5)	(6)
Commonality	0.12***	0.12***	0.10***	0.49***	0.49***	0.39***
	(0.0082)	(0.0083)	(0.0079)	(0.10)	(0.10)	(0.080)
Home Sovereign			0.43***			4.09***
			(0.037)			(0.20)
GDP Per Capita			0.14***			0.42**
			(0.021)			(0.21)
GDP Growth			−0.015***			−0.13***
			(0.0023)			(0.023)
Risk Weighted Assets			0.080***			0.52***
			(0.016)			(0.059)
Tier 1 Capital Ratio			0.29*			5.63***
			(0.16)			(0.89)
Controls	No	No	Yes	No	No	Yes
Time fixed effects	No	Yes	Yes	No	Yes	Yes
R^2	0.05	0.06	0.18	0.02	0.02	0.25
# observations	13702	13702	12410	6878	6878	6366

Table 4: Announcements of the ECB's Asset Purchase Programme

This table shows the timing of the announcements of the ECB's public sector purchase programme. We use these purchases to formulate the capital key instrument (Z^Y) for sovereign yields. The construction of this instrument follows Koijen et al. (2021). While their sample ends in 2017, we extend it to 2019. Note that the November 2019 purchase program did not have an explicit "end date" when it was announced in September 2019. We set an end date of March 2022 based on ex-post information. In any case, since our sample ends in 2019, this assumption will not affect our main results. Total Announced (€mn) refers to the purchases upto the announcement point including the current announcement (i.e., monthly purchases times the number of months). Predicted government purchases, A_t, is assumed to be 73% of the total announced purchases following Koijen et al. (2021). Details of these announcements are obtained from the ECB's website: https://www.ecb.europa.eu/mopo/implement/app/html/ecb.faq_pspp.en.html

Start Date	End Date	# of months	Monthly purchases (€mn)	Total Announced (€mn)
(1)	(2)	(3)	(4)	(5)
March-15	September-16	19	60	1140
September-16	March-17	6	60	1500
April-16	March-17	12	80	2460
April-17	December-17	9	60	3000
January-18	September-18	9	30	3270
October-18	December-18	3	15	3315
November-19	March-22*	29	20	3895

Table 5: Estimates of Sovereign Bond Demand of Banks

This table reports results of estimation using the characteristics-based demand system:

$$\frac{w_{i,j,t}}{w_{i,0,t}} = \exp(\beta_Y \text{Yield}_{j,t} + \beta_C \text{Commonality}_{j,t-1} + \Gamma X_{i,j,t-1})\varepsilon_{i,j,t}$$

where $w_{i,j,t}$ is the weight of a sovereign j in the portfolio of a bank i at a given time t. $w_{i,0,t}$ is the portfolio weight on the outside asset, referring to sovereign holdings outside the Euro zone and liquidity kept in the central banks. Yield-to-maturity on 10-year sovereign bonds is instrumented using the accumulated announced purchases by the ECB under the Public Sector Purchase Programme, $Z^Y_{j,t}$ (Koijen and Yogo (2019), Koijen et al. (2021)). The moment condition in columns (2) and (3) is:

$$E\left[\epsilon_{i,j,t} \mid Z^Y_{j,t}, \text{Commonality}_{j,t-1}, X_{i,j,t-1}\right] = 1.$$

In columns (4) and (5), the exogeneity assumption on commonality is weakened to:

$$E\left[\epsilon_{i,j,t} \mid Z^Y_{j,t}, Z^C_j, X_{i,j,t-1}\right] = 1, \quad \text{and} \quad E\left[\epsilon_{i,j,t} \mid Z^Y_{j,t}, D^C_j, X_{i,j,t-1}\right] = 1,$$

where Z^C_j (border-indicator) and D^C_j (border-length) are spatial centrality measures based on geographic centrality of euro zone countries. All controls are lagged. The definitions of all variables are listed in the appendix. Standard errors are clustered at the bank level. $^{*}p < 0.1,^{**} p < 0.05,^{***} p < 0.01$

	(1)	(2)	(3)	(4)	(5)
Commonality	0.54***	0.56***	0.67***	2.26***	1.70***
	(0.12)	(0.16)	(0.14)	(0.31)	(0.40)
Yield	0.40**	1.04***	1.15***	0.72***	0.81***
	(0.17)	(0.22)	(0.20)	(0.19)	(0.18)
Home Sovereign			3.82***	4.29***	4.11***
			(0.23)	(0.33)	(0.32)
GDP Per Capita			1.42***	1.11**	1.15***
			(0.36)	(0.46)	(0.41)
GDP Growth			−0.068***	0.036	0.0056
			(0.026)	(0.028)	(0.021)
Risk Weighted Assets			−0.37***	−0.33***	−0.35***
			(0.088)	(0.091)	(0.096)
Tier 1 Capital Ratio			−3.39***	−2.30**	−2.79**
			(0.96)	(1.10)	(1.20)
Instruments		Z^Y	Z^Y	Z^Y and Z^C	Z^Y and D^C
# observations	13697	13697	12405	12405	12405

Table 6: Counterfactual Yields and Elasticities in the Absence of a preference for Commonality

This table reports results of a counterfactual estimation where a preference for commonality is absent. Our goal is to understand how yields and elasticities change if banks do not exhibit a preference for commonality. We use the characteristics-based demand system as a basis to estimate the proportional change in banks' portfolio weights:

$$\frac{w'_{i,j}}{w_{i,j}} = \exp\big(\beta_Y(Y'_j - Y_j) - \beta_C C_j\big) \frac{1 + \sum_k \exp(\beta_Y Y_k + \beta_C C_k + \Gamma X_{i,k})\epsilon_{i,k}}{1 + \sum_k \exp(\beta_Y Y'_k + \Gamma X_{i,k})\epsilon_{i,k}}$$

where $w'_{i,j}$ refers to the counterfactual change in portfolio share as a result of shutting down the commonality preference, while keeping debt quantities and bank balance-sheet sizes fixed. Y'_j refers to the change in equilibrium yields in the counterfactual scenario. Semi-elasticities, $\xi_j \equiv \partial \log E_j / \partial Y_j$, are estimated as described in Section 6.2. *IV for Yields only* refers to Column (3) of Table 5 and *IV for Yields and Commonality* refers to Column (5) of Table 5. Δ refers to the change under the counterfactual scenario. The counterfactual exercise shows that we observe higher yields/elasticities across most sovereigns when a preference for commonality is absent.

			IV for Yields only			*IV for Yields and Commonality*		
	Commonality	Yield	Δ Yield	ξ	$\Delta\xi$	Δ Yield	ξ	$\Delta\xi$
AT	3.08	0.49	0.86	1	0.07	1.89	0.7	0.1
IT	2.96	2.01	0.58	0.84	0.16	1.33	0.59	0.2
DE	2.72	0.24	0.7	0.82	0.17	1.59	0.58	0.21
LT	2.36	1.16	0.26	1.09	0.02	0.52	0.77	0.03
SI	2.33	1.03	0.51	0.94	0.09	1.3	0.66	0.12
LV	2.23	0.76	0.35	1.12	0.02	0.76	0.79	0.02
BE	2.14	0.6	0.54	0.93	0.06	1.68	0.65	0.09
SK	2.12	0.74	0.61	1.08	0.03	1.81	0.76	0.04
FR	2.06	0.61	0.48	0.71	0.12	1.42	0.5	0.19
LU	1.72	0.31	0.5	0.99	0.05	2.04	0.7	0.05
ES	1.62	1.33	0.3	0.84	0.14	1.14	0.59	0.15
FI	1.4	0.44	0.36	0.93	0.04	0.94	0.65	0.05
PT	1.09	2.15	−0.02	0.86	0.08	0.47	0.61	0.06
IE	1.06	0.75	0.11	0.88	0.08	0.46	0.62	0.1
NL	0.97	0.4	0.21	0.8	0.11	0.91	0.56	0.12
CY	0.06	2.92	−0.03	0.91	0.05	−0.01	0.64	0.04
MT	0.04	1.11	−0.08	0.89	0.04	−0.11	0.63	0.03
Average		0.91	0.48	0.8	0.14	1.36	0.56	0.17

Table 7: Demand Estimation Controlling for Trade Centrality

This table reports results of estimation using the characteristics-based demand system:

$$\frac{w_{i,j,t}}{w_{i,0,t}} = \exp(\beta_Y \text{Yield}_{j,t} + \beta_C \text{Commonality}_{j,t-1} + \beta_{TC} \text{Trade Centrality}_{j,t-1} + \Gamma X_{i,j,t-1})\varepsilon_{i,j,t}$$

where $w_{i,t}(j)$ is the weight of a sovereign j in the portfolio of a bank i at a given time t. $w_{i,t}(0)$ is the portfolio weight on the outside asset, referring to sovereign holdings outside the Euro zone and liquidity kept in the central banks. Yield-to-maturity on 10-year sovereign bonds is instrumented using the accumulated announced purchases by the ECB under the Public Sector Purchase Programme, $Z^Y_{j,t}$ (Koijen and Yogo (2019)). TradeCentrality$_{j,t-1}$ is the eigenvector centrality of trade (exports-imports) using trade flows from the UN-Comtrade database for Eurozone countries. The construction of this variable is described in Section 7.1. The moment condition in Column (1) is:

$$E\left[\epsilon_{i,j,t} \mid Z^Y_{j,t}, \text{Commonality}_{j,t-1}, X_{i,j,t-1}\right] = 1.$$

In Column (2), the exogeneity assumption on commonality is weakened to:

$$E\left[\epsilon_{i,j,t} \mid Z^Y_{j,t}, Z^C_j, X_{i,j,t-1}\right] = 1,$$

where Z^C_j is the spatial centrality instrument based on geographic centrality of euro zone countries. Other controls $X_{i,j,t-1}$ include GDP growth, Risk weighted assets (in logs), bank's Tier 1 capital ratios, and an indicator variable for own sovereign exposures. All controls are lagged. The definitions of all variables are listed in the appendix. Standard errors are clustered at the bank level. $^*p < 0.1, ^{**}p < 0.05, ^{***}p < 0.01$

	(1)	(2)	(3)	(4)	(5)
Commonality	0.54***	0.60***	0.69***	2.16***	1.73***
	(0.12)	(0.16)	(0.16)	(0.24)	(0.35)
Yield	0.41**	0.98***	1.08***	0.69***	0.73***
	(0.18)	(0.20)	(0.22)	(0.18)	(0.17)
Trade Centrality	3.77	3.46	3.84	3.75	5.59
	(2.77)	(3.14)	(4.40)	(4.30)	(4.23)
Home Sovereign			3.82***	4.26***	4.13***
			(0.23)	(0.32)	(0.32)
GDP Per Capita			1.30***	0.93**	0.90***
			(0.32)	(0.38)	(0.34)
GDP Growth			−0.067**	0.033	0.0097
			(0.027)	(0.026)	(0.023)
Risk Weighted Assets			−0.36***	−0.33***	−0.34***
			(0.086)	(0.091)	(0.093)
Tier 1 Capital Ratio			−3.41***	−2.49**	−2.89**
			(0.95)	(1.09)	(1.16)
Instruments		Z^Y	Z^Y	Z^Y and Z^C	Z^Y and D^C
# observations	13697	13697	12405	12405	12405

Table 8: Demand Estimation Using an Alternative Instrument for Yields

This table reports results of estimation using the characteristics-based demand system:

$$\frac{w_{i,j,t}}{w_{i,0,t}} = \exp(\beta_Y \text{Yield}_{j,t} + \beta_C \text{Commonality}_{j,t-1} + \Gamma X_{i,j,t-1})\varepsilon_{i,j,t}$$

where $w_{i,t}(j)$ is the weight of a sovereign j in the portfolio of a bank i at a given time t. $w_{i,t}(0)$ is the portfolio weight on the outside asset, referring to sovereign holdings outside the Euro zone and liquidity kept in the central banks. Yield-to-maturity on 10-year sovereign bonds is instrumented the actual net purchases of sovereign bonds by the ECB under the Public Sector Purchase Programme, $Z^Y_{j,t}$. The moment condition in Columns (1) and (2) is:

$$E\left[\epsilon_{i,j,t} \mid Z^Y_{j,t}, \text{Commonality}_{j,t-1}, X_{i,j,t-1}\right] = 1.$$

In Column (3), the exogeneity assumption on commonality is weakened to:

$$E\left[\epsilon_{i,j,t} \mid Z^Y_{j,t}, Z^C_j, X_{i,j,t-1}\right] = 1,$$

where Z^C_j is the spatial centrality instrument based on geographic centrality of euro zone countries. Controls $X_{i,j,t-1}$ include GDP growth, Risk weighted assets (in logs), bank's Tier 1 capital ratios, and an indicator variable for own sovereign exposures. All controls are lagged. The definitions of all variables are listed in the appendix. Standard errors are clustered at the bank level. $^{*}p < 0.1, ^{**}p < 0.05, ^{***}p < 0.01$

	(1)	(2)	(3)	(4)
Commonality	0.55***	0.69***	2.26***	1.59***
	(0.13)	(0.12)	(0.31)	(0.43)
Yield	0.59***	0.80***	0.63***	0.65***
	(0.22)	(0.22)	(0.21)	(0.20)
Home Sovereign		3.82***	4.30***	4.09***
		(0.21)	(0.33)	(0.30)
GDP Per Capita		1.24***	1.04**	1.04***
		(0.34)	(0.44)	(0.38)
GDP Growth		−0.062**	0.038	0.0023
		(0.026)	(0.029)	(0.020)
Total Risk Exposure		−0.36***	−0.32***	−0.34***
		(0.10)	(0.092)	(0.10)
Tier 1 Capital Ratio		−3.61***	−2.33**	−2.96**
		(1.06)	(1.10)	(1.29)
Instruments	Z^Y	Z^Y	Z^Y and Z^C	Z^Y and D^C
# observations	13697	12405	12405	12405

Table 9: Demand Estimation by breaking the Concentration of bank holdings

This table reports results of estimation using the characteristics-based demand system:

$$\frac{w_{i,j,t}}{w_{i,0,t}} = \exp(\beta_Y \text{Yield}_{j,t} + \beta_C \text{RM}^C_{j,t-1} + \Gamma \text{X}_{i,j,t-1})\varepsilon_{i,j,t}$$

where $w_{i,t}(j)$ is the weight of a sovereign j in the portfolio of a bank i at a given time t. $w_{i,t}(0)$ is the portfolio weight on the outside asset, referring to sovereign holdings outside the Euro zone and liquidity kept in the central banks. $RM^C_{j,t-1}$ is the eigenvector centrality of bank-sovereign portfolios that are randomly assigned. Yield-to-maturity on 10-year sovereign bonds is instrumented using the accumulated announced purchases by the ECB under the Public Sector Purchase Programme, $Z^Y_{j,t}$ (Koijen and Yogo (2019)). The moment condition is:

$$E\left[\epsilon_{i,j,t} \mid Z^Y_{j,t}, RM^C_{j,t-1}, X_{i,j,t-1}\right] = 1,$$

Note that the randomization is for the funding structure within a sovereign (i.e., reshuffling across banks). In Column (1), we use the commonality instrument Z^C, whereas in Column (2), we use the instrument based on actual border lengths Z^C. Controls $\text{X}_{i,j,t-1}$ include GDP growth, Risk weighted assets (in logs), bank's Tier 1 capital ratios, and an indicator variable for own sovereign exposures. All controls are lagged. The definitions of all variables are listed in the appendix. Standard errors are clustered at the bank level. $^{*}p < 0.1,^{**} p < 0.05,^{***} p < 0.01$

	(1)	(2)
Commonality	2.00***	1.38**
	(0.44)	(0.55)
Yield	0.59**	0.58***
	(0.25)	(0.20)
Concentration	−2.46	−4.53*
	(2.14)	(2.46)
Home Sovereign	4.39***	4.35***
	(0.31)	(0.30)
GDP Per Capita	1.18***	1.25***
	(0.37)	(0.32)
GDP Growth	0.042	0.024
	(0.028)	(0.019)
Total Risk Exposure	−0.34***	−0.37***
	(0.093)	(0.10)
Tier 1 Capital Ratio	−2.47**	−2.92**
	(1.12)	(1.22)
Instruments	Z^Y and Z^C	Z^Y and D^C
# observations	12405	12405

Table 10: Demand Estimation Controlling for Credit Ratings

This table reports results of estimation using the characteristics-based demand system:

$$\frac{w_{i,j,t}}{w_{i,0,t}} = \exp(\beta_Y \text{Yield}_{j,t} + \beta_C \text{Commonality}_{j,t-1} + \beta_{TC} \text{InvestmentGrade}_{j,t-1} + \Gamma X_{i,j,t-1})\varepsilon_{i,j,t}$$

where $w_{i,t}(j)$ is the weight of a sovereign j in the portfolio of a bank i at a given time t. $w_{i,t}(0)$ is the portfolio weight on the outside asset, referring to sovereign holdings outside the Euro zone and liquidity kept in the central banks. Yield-to-maturity on 10-year sovereign bonds is instrumented using the accumulated announced purchases by the ECB under the Public Sector Purchase Programme, $Z^Y_{j,t}$ (Koijen and Yogo (2019)). InvestmentGrade$_{j,t-1}$ is the credit rating of the sovereign sourced from Bloomberg. The moment condition in Column (1) is:

$$E\left[\epsilon_{i,j,t} \mid Z^Y_{j,t}, \text{Commonality}_{j,t-1}, X_{i,j,t-1}\right] = 1.$$

In Column (2), the exogeneity assumption on commonality is weakened to:

$$E\left[\epsilon_{i,j,t} \mid Z^Y_{j,t}, Z^C_j, X_{i,j,t-1}\right] = 1,$$

where Z^C_j is the spatial centrality instrument based on geographic centrality of euro zone countries. Other controls $X_{i,j,t-1}$ include GDP growth, Risk weighted assets (in logs), bank's Tier 1 capital ratios, and an indicator variable for own sovereign exposures. All controls are lagged. The definitions of all variables are listed in the appendix. Standard errors are clustered at the bank level. $^{*}p < 0.1, ^{**}p < 0.05, ^{***}p < 0.01$

	(1)	(2)	(3)
Commonality	0.60***	2.87***	4.03***
	(0.12)	(0.35)	(1.29)
Yield	1.15***	0.53**	0.36
	(0.23)	(0.23)	(0.39)
Upper Investment Grade	0.92***	0.43	0.33
	(0.31)	(0.45)	(0.57)
Home Sovereign	3.71***	4.36***	4.69***
	(0.20)	(0.31)	(0.48)
GDP Growth	−0.021	0.086***	0.12***
	(0.024)	(0.028)	(0.039)
Total Risk Exposure	−0.38***	−0.32***	−0.28***
	(0.099)	(0.099)	(0.10)
Tier 1 Capital Ratio	−3.32***	−1.27	−0.63
	(0.95)	(1.01)	(1.09)
Instruments	Z^Y	Z^Y and Z^C	Z^Y and D^C
# observations	12405	12405	12405

Table 11: Demand estimation using an alternate specification for sovereign commonality

This table reports results of estimation using the characteristics-based demand system:

$$\frac{w_{i,j,t}}{w_{i,0,t}} = \exp(\beta_Y \text{Yield}_{j,t} + \beta_C \text{Commonality}_{j,t} + \Gamma X_{i,j,t-1})\varepsilon_{i,j,t}$$

where $w_{i,j,t}$ is the weight of a sovereign j in the portfolio of a bank i at a given time t. $w_{i,0,t}$ is the portfolio weight on the outside asset, referring to sovereign holdings outside the Euro zone and liquidity kept in the central banks. Yield-to-maturity on 10-year sovereign bonds is instrumented using the accumulated announced purchases by the ECB under the Public Sector Purchase Programme, $Z^Y_{j,t}$ (Koijen and Yogo (2019), Koijen et al. (2021)). The moment condition in columns (2) and (3) is:

$$E\left[\epsilon_{i,j,t} \mid Z^Y_{j,t}, \text{Commonality}_{j,t}, X_{i,j,t-1}\right] = 1.$$

In columns (4) and (5), the exogeneity assumption on commonality is weakened to:

$$E\left[\epsilon_{i,j,t} \mid Z^Y_{j,t}, Z^C_j, X_{i,j,t-1}\right] = 1, \quad \text{and} \quad E\left[\epsilon_{i,j,t} \mid Z^Y_{j,t}, D^C_j, X_{i,j,t-1}\right] = 1,$$

where Z^C_j and D^C_j are spatial centrality measures based on geographic centrality of euro zone countries. All controls are lagged. The definitions of all variables are listed in the appendix. Standard errors are clustered at the bank level. $^{*}p < 0.1,^{**} p < 0.05,^{***} p < 0.01$

	(1)	(2)	(3)	(4)	(5)
Commonality	0.60***	0.63***	0.86***	2.28***	1.77***
	(0.12)	(0.16)	(0.079)	(0.25)	(0.43)
Yield	0.41**	1.06***	1.05***	0.61***	0.72***
	(0.17)	(0.20)	(0.20)	(0.20)	(0.16)
Home Sovereign			3.89***	4.36***	4.18***
			(0.22)	(0.28)	(0.29)
GDP Per Capita			1.48***	1.40***	1.40***
			(0.36)	(0.40)	(0.37)
GDP Growth			−0.062***	0.012	−0.0095
			(0.021)	(0.022)	(0.017)
Total Risk Exposure			−0.37***	−0.34***	−0.35***
			(0.094)	(0.100)	(0.11)
Tier 1 Capital Ratio			−3.30***	−2.37**	−2.76**
			(1.03)	(1.11)	(1.31)
Instruments		Z^Y	Z^Y	Z^Y and Z^C	Z^Y and D^C
# observations	15142	15142	12405	12405	12405

Table 12: Demand Estimation Using Commonality Measured in a Fixed Sample of Banks

This table reports results of estimation using the characteristics-based demand system:

$$\frac{w_{i,j,t}}{w_{i,0,t}} = \exp(\beta_Y \text{Yield}_{j,t} + \beta_C \text{Commonality}_{j,t-1} + \Gamma X_{i,j,t-1})\varepsilon_{i,j,t}$$

where $w_{i,t}(j)$ is the weight of a sovereign j in the portfolio of a bank i at a given time t. $w_{i,t}(0)$ is the portfolio weight on the outside asset, referring to sovereign holdings outside the Euro zone and liquidity kept in the central banks. Yield-to-maturity on 10-year sovereign bonds is instrumented using the accumulated announced purchases by the ECB under the Public Sector Purchase Programme, $Z^Y_{j,t}$ (Koijen and Yogo (2019)). The moment condition is:

$$E\left[\epsilon_{i,j,t} \mid Z^Y_{j,t}, \text{Commonality}^C_{j,t-1}, X_{i,j,t-1}\right] = 1,$$

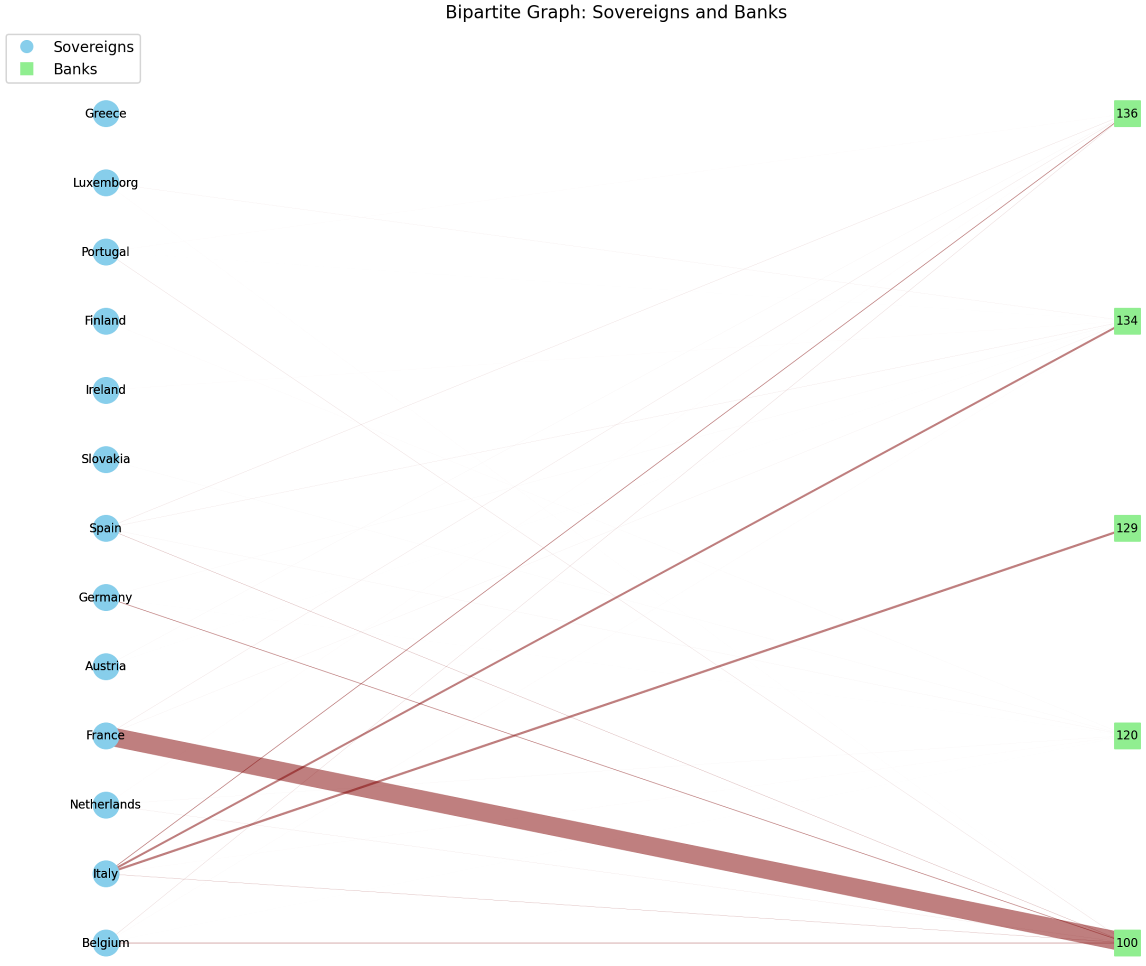
where D^C_j is the spatial centrality instrument based on the overlap in actual border lengths of euro zone countries. Other controls $X_{i,j,t-1}$ include GDP growth, Risk weighted assets (in logs), bank's Tier 1 capital ratios, and an indicator variable for own sovereign exposures. All controls are lagged. The definitions of all variables are listed in the appendix. Standard errors are clustered at the bank level. $^{*}p < 0.1,^{**} p < 0.05,^{***} p < 0.01$

	(1)	(2)	(3)	(4)	(5)
Commonality	0.48***	0.54***	0.39**	2.20***	1.92***
	(0.11)	(0.17)	(0.16)	(0.32)	(0.40)
Yield	0.43**	1.14***	1.30***	0.76***	0.83***
	(0.17)	(0.25)	(0.21)	(0.18)	(0.19)
Home Sovereign			3.74***	4.18***	4.10***
			(0.21)	(0.34)	(0.33)
GDP Per Capita			1.45***	0.29	0.39
			(0.34)	(0.48)	(0.47)
GDP Growth			–0.087***	0.073***	0.053**
			(0.026)	(0.026)	(0.022)
Total Risk Exposure			–0.36***	–0.38***	–0.38***
			(0.088)	(0.096)	(0.096)
Tier 1 Capital Ratio			–3.49***	–2.55**	–2.72**
			(0.93)	(1.07)	(1.12)
Instruments		Z^Y	Z^Y	Z^Y and Z^C	Z^Y and D^C
# observations	13697	13697	12405	12405	12405

Appendix

Figure A.1: Illustration: Bipartite Network of Banks and Sovereign Holdings

Sovereign holdings of banks can be represented as a bipartite network as shown below. The plot shows a weighted network visualization of sovereign investments for 5 randomly chosen banks in the sample. Bank names are suppressed. Instead, they are denoted by the numbers 136, 134, 129, 120 and 100. Edges represent sovereign holdings of a given bank. For instance, bank "100" is a French bank, hence it has a significant investment in French sovereigns. The green nodes represent banks and the blue nodes represent sovereign bonds. In this random sample, we see that some sovereigns such as Italy are more commonly held relative to others such as Austria. The actual network has a total of 144 nodes (including banks and sovereigns) and 1,202 edges.



A.1 Construction of sovereign commonality using an example of 5 banks and 4 sovereigns

Suppose we have N banks and M sovereigns. Let E be an $N \times M$ matrix of bank exposures (in euros) to sovereigns. Let $T_M = diag(E'1_N)$ be the $M \times M$ matrix containing the total sovereign exposures across all banks for each sovereign on its main diagonal. Let $S = ET_M^{-1}$ be the $N \times M$ matrix of funding structures of sovereigns across banks (i.e., columns of S sum to one). We now describe the construction of the sovereign commonality measure using an example of 5 banks and 4 sovereigns.

Consider the following 5 banks ($N = 5$) from the June 2018 data chosen at random along with their exposure to 4 sovereigns ($M = 4$) (also chosen at random). The matrix E is a 5×4 matrix of bank exposures (in euros) to sovereigns.

$$E_{5\times4} = \begin{bmatrix} 1897 & 325 & 92278 & 18 \\ 0 & 107 & 0 & 0 \\ 13 & 1039 & 654 & 9 \\ 74 & 200 & 194 & 228 \\ 0 & 537 & 249 & 0 \end{bmatrix}$$

The matrix E' is a 4×5 matrix.

$$E'_{4\times5} = \begin{bmatrix} 1897 & 0 & 13 & 74 & 0 \\ 325 & 107 & 1039 & 200 & 537 \\ 92278 & 0 & 654 & 194 & 249 \\ 18 & 0 & 9 & 228 & 0 \end{bmatrix}$$

Rows 1 to 4 in matrix E' represents one of the following sovereigns: DE, ES, FR and LU respectively. Columns 1 to 5 in matrix E' represents one of the 5 banks chosen at random. For instance, the element (2,3) in the matrix E' represents the exposure of Bank 3 to ES sovereign, which is EUR1039mn in 2018. The following matrix calculations illustrates the step-by-step computation of our measure.

$$T_M = diag(E'1_N) = \begin{bmatrix} 1984.5 & 0 & 0 & 0 \\ 0 & 2208.5 & 0 & 0 \\ 0 & 0 & 93374.9 & 0 \\ 0 & 0 & 0 & 255.2 \end{bmatrix}$$

$$S = ET_M^{-1} = \begin{bmatrix} 0.96 & 0.15 & 0.99 & 0.07 \\ 0 & 0.05 & 0 & 0 \\ 0.01 & 0.47 & 0.01 & 0.03 \\ 0.04 & 0.09 & 0 & 0.89 \\ 0 & 0.24 & 0 & 0 \end{bmatrix}$$

$$\vec{s_1} = \begin{bmatrix} s_{11} \\ s_{12} \\ s_{13} \\ s_{14} \\ s_{15} \end{bmatrix} = \begin{bmatrix} 0.96 \\ 0 \\ 0.01 \\ 0.04 \\ 0 \end{bmatrix}$$

$$\vec{s_2} = \begin{bmatrix} s_{21} \\ s_{22} \\ s_{23} \\ s_{24} \\ s_{25} \end{bmatrix} = \begin{bmatrix} 0.15 \\ 0.05 \\ 0.47 \\ 0.09 \\ 0.24 \end{bmatrix}$$

$$\vec{s_3} = \begin{bmatrix} s_{31} \\ s_{32} \\ s_{33} \\ s_{34} \\ s_{35} \end{bmatrix} = \begin{bmatrix} 0.99 \\ 0 \\ 0.01 \\ 0 \\ 0 \end{bmatrix}$$

$$\vec{s_4} = \begin{bmatrix} s_{41} \\ s_{42} \\ s_{43} \\ s_{44} \\ s_{45} \end{bmatrix} = \begin{bmatrix} 0.07 \\ 0 \\ 0.03 \\ 0.89 \\ 0 \end{bmatrix}$$

$$\tilde{A} = S'S = \left[\vec{s}_l'\vec{s}_k\right]_{4\times 4} = \begin{bmatrix} 0.92 & 0.15 & 0.95 & 0.10 \\ 0.15 & 0.31 & 0.15 & 0.11 \\ 0.95 & 0.15 & 0.98 & 0.07 \\ 0.10 & 0.11 & 0.07 & 0.81 \end{bmatrix}$$

$$H = \sqrt{diag(\tilde{A})} = \begin{bmatrix} 0.957 & 0 & 0 & 0 \\ 0 & 0.559 & 0 & 0 \\ 0 & 0 & 0.988 & 0 \\ 0 & 0 & 0 & 0.901 \end{bmatrix}$$

$$H^{-1} = \begin{bmatrix} 1.05 & 0 & 0 & 0 \\ 0 & 1.79 & 0 & 0 \\ 0 & 0 & 1.01 & 0 \\ 0 & 0 & 0 & 1.11 \end{bmatrix}$$

$$A = \begin{bmatrix} 1 & 0.275 & 0.999 & 0.117 \\ 0.275 & 1 & 0.271 & 0.214 \\ 0.999 & 0.271 & 1 & 0.081 \\ 0.112 & 0.212 & 0.075 & 1 \end{bmatrix}$$

Calculating the eigenvalues of $A - I_N$ gives: $\lambda_1 = 1.16, \lambda_2 = -0.999, \lambda_3 = -0.246, \lambda_4 = 0.0816$ The eigenvector (v_1) associated with the largest eigenvalue ($\lambda_1 = 1.16$) is our commonality measure C.:

$$v_1 = C = \begin{bmatrix} 3.97x \\ 2.04x \\ 3.95x \\ x \end{bmatrix}$$

Figure A.2: Network visualization of banks and sovereigns

This graph shows a network visualization of banks and sovereign connections. The total number of nodes is 144 and edges are 1202. The green nodes represent sovereigns while the red nodes represent banks. Highly connected sovereigns are in the center of the graph, while those in the periphery are less commonly held. For visualization purposes, the edges are not weighted by the magnitude of holdings.

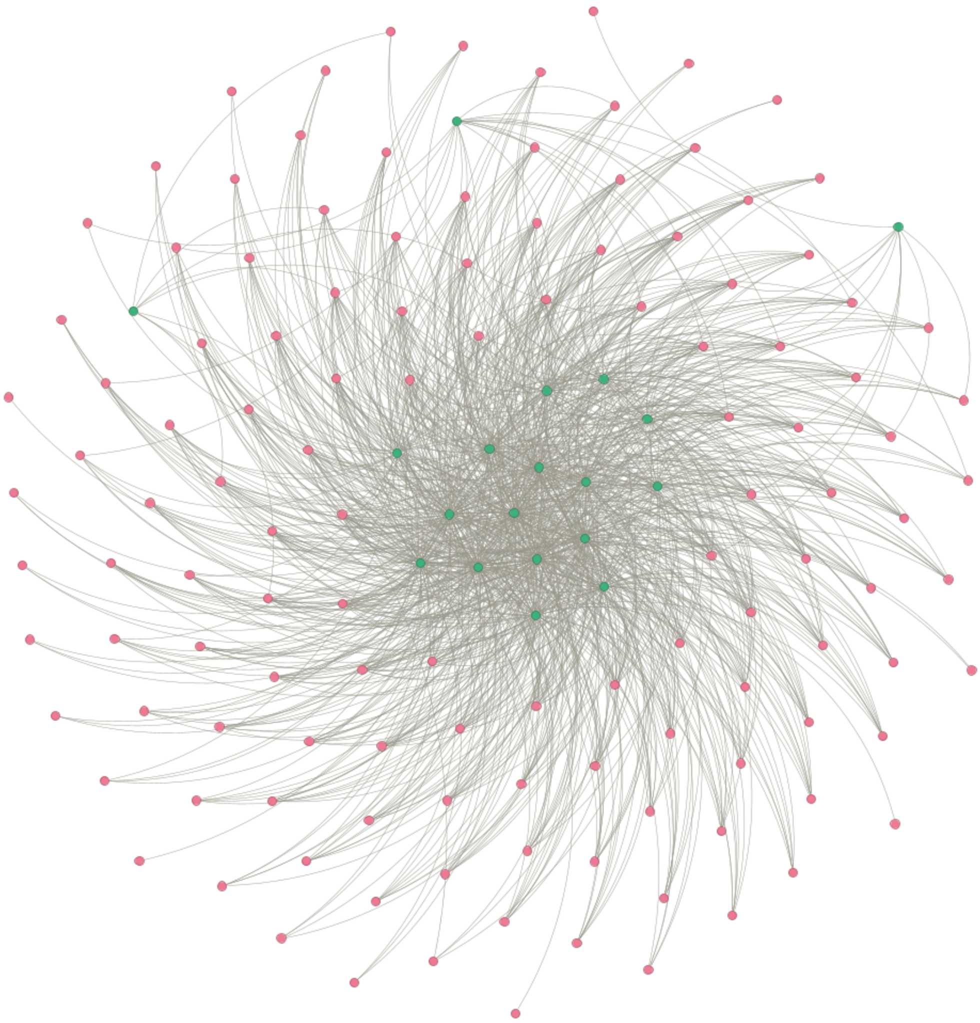


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Table A.1: Variable Definitions

Exposure ($E_{i,j,t}$)	The total gross carrying amount of non-derivative financial assets that are sovereigns (item 20810 in the EBA transparency files). This variable is defined for bank i sovereign j in period t.
Total Exposure of Bank i ($E_{i,t}$)	The sum of all sovereign exposures in the portfolio of bank i in period t
Portfolio Share ($w_{i,j,t}$)	The share of sovereign exposures for sovereign j in the total, for bank i in period t. Thus, $w_{i,j,t} = E_{i,j,t}/E_{i,t}$
Total Exposure of banks to Sovereign j ($E_{j,t}$)	The sum of exposures of individual banks to sovereign j. Thus, $E_{j,t} \equiv \sum_i E_{i,j,t} = \sum_i w_{i,j,t} E_{i,t}$
Outside Asset	Represents the sum of sovereign holdings outside the Euro zone and bank liquidity held in the central banks
Outside Asset Share $w_{i,0,t}$	Represents the share of the outside asset, denoted by 0, in the portfolio of bank i in period t
Portfolio Share Ratio ($w_{i,j,t}/w_{i,0,t}$)	Portfolio share relative to the outside asset for bank i sovereign j in period t
Commonality ($C_{j,t}$)	The eigenvector centrality of sovereign j in period t. This definition captures the funding structure of sovereign j across the bank universe by projecting the bipartite exposure network onto the sovereign dimension. See Section 4.2 for a detailed construction of this measure.
Yield ($Y_{j,t}$)	The 10-year yield on sovereign j averaged over period t sourced from Eurostat.
Home Sovereign	An indicator variable to denote if bank i and sovereign j are representing the same country, such as a French bank holding French sovereigns.
Risk Weighted Assets	The total risk weighted assets of bank i, reported as Total Risk Exposure. Item 20138 in the EBA transparency files.
Tier 1 Capital	The tier 1 capital of bank i reported in item 20146 in the EBA transparency files.
GDP	The gross domestic product for sovereigns sourced from Eurostat.