INTERNATIONAL MONETARY FUND

Barriers to a European Banking Union

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WP/26/123

2026
JUN

WORKING PAPER

 WP/26/123

IMF Working Paper
Research Department

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Authorized for distribution by Maria Soledad Martinez Peria
June 2026

ABSTRACT: We quantify barriers to cross-border banking within the euro area and their consequences for credit allocation and output. Using loan-level data from the European credit registry (AnaCredit) and group structures (RIAD), we estimate barriers to relationship formation, loan pricing, and banks' branching decisions at the country-pair level. We find that barriers to cross-border relationships between banks and firms and cross-border bank entry are large while wedges on interest rates and loan quantities are comparatively small. The estimated wedges are strongly associated with differences in national banking regulations, measured using a novel dataset on regulatory distances. We embed our estimates into a quantitative spatial general equilibrium model with heterogeneous banks and firms subject to cross-border frictions in relationship formation, loan pricing, and bank entry. Partially relaxing frictions predicts sizable and heterogeneous output gains across euro area countries. These gains are primarily driven by increases in capital and labor rather than improvements in allocative efficiency.

JEL Classification Numbers:	F36, G21, O16
Keywords:	cross-border frictions; banks; credit allocation; European financial integration

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* We are grateful to Linda Goldberg for thoughtful conference discussions; and to Leonardo D'Amico, Giovanni Dell'Ariccia, Xiang Ding, Luc Laeven, Rui Mano, Maria Soledad Martinez Peria, Ezra Oberfield, Charly Porcher, and seminar participants at the ECB, Georgetown, and IMF for comments. Pierre Etienne and Ese Onokpasa provided invaluable research assistance. We are indebted to many colleagues at the ECB and the IMF who have taught us much about European Banking Regulation.

WORKING PAPERS

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1 Introduction

Despite major institutional reforms since the European sovereign debt crisis, the European Banking Union remains incomplete and banking markets remain fragmented along national lines. While capital mobility is legally guaranteed within the European Union, de facto financial integration remains limited, with persistent home bias in lending, funding, and bank operations. Regulatory heterogeneity, national resolution frameworks, deposit insurance fragmentation, and supervisory differences are widely viewed as key obstacles to cross-border banking (Enria, 2021). The recent Draghi (2024) Report on European competitiveness emphasizes that incomplete financial integration constrains Europe's growth potential by preventing savings from flowing to their most productive uses across borders.

This paper measures the barriers to cross-border bank lending to firms within Europe and quantifies their implications for credit allocation and aggregate output. We develop a structural model of cross-border banking with heterogeneous firms and banks in which banks choose where to operate, set lending rates, and supply credit, while firms choose which banks to borrow from. The model features three distinct sources of cross-border frictions: barriers to relationship formation between firms and banks, distortions in loan pricing, and impediments to bank entry across countries. We estimate these frictions using granular administrative data from the European credit registry (AnaCredit) combined with bank-group information from RIAD, the ECB's register of businesses and their affiliations. We then show that the estimated frictions are strongly correlated with measures of regulatory fragmentation constructed from a novel dataset on national banking policies. Finally, we calibrate the model using these micro data, quantify the macroeconomic costs of these barriers and simulate counterfactual gains from further integration.

We first present stylized facts that motivate our analysis and the model's structure. Cross-border lending to firms within the euro area is remarkably limited: since 2019, it has accounted for less than 6% of total lending to non-financial corporations, despite the principle of free capital mobility enshrined in the Maastricht Treaty. Cross-border bank entry is similarly sparse, with few banking groups operating in foreign markets. Meanwhile, the regulatory landscape remains fragmented across jurisdictions despite a decade of Banking Union reforms, with measurable differences across countries in prudential rules, resolution regimes, deposit insurance schemes, and other policy domains. Taken together, they suggest that European banking markets remain fragmented both de facto and de jure.

We estimate barriers to cross-border activities directly from micro data with an econometric framework – an approach we call “microeconometric wedge accounting”. The empirical strategy exploits within-firm and within-bank comparisons to isolate country-pair barriers from differences in borrower risk, bank characteristics, or country composition, and recovers wedges non-parametrically using country-pair dummies. On the borrower side, we estimate the likelihood that firms borrow from particular banks. On the creditor side, we estimate banks’ pricing equations. Last, we estimate entry frictions by modeling the probability that banking groups enter foreign markets.

Conditional on these econometric assumptions, we find that cross-border bank-firm links are orders of magnitude less likely than domestic links, implying very large barriers to cross-border relationship formation. Similarly, we find substantial barriers to cross-border bank entry. By contrast, the effects on loan quantities and pricing — conditional on an existing relationship — are modest, highlighting the dominant role of extensive-margin frictions.

The estimated frictions correlate strongly with new measures of cross-country regulatory fragmentation, even after controlling for traditional gravity forces. We construct a novel dataset measuring differences in banking regulations across European countries, harmonizing dispersed information from European authorities and national regulators across multiple policy domains: prudential buffers, supervisory practices, resolution frameworks, deposit insurance schemes, entry costs, and other institutional features. We combine these into bilateral "policy distances" and show they correlate positively with the estimated wedges, after controlling for non-regulatory factors such as geographic, linguistic, and cultural proximity. This suggests that fragmentation in regulatory frameworks is a meaningful impediment to banking integration.

Motivated by these estimates, we build a quantitative spatial general equilibrium model of banking with rich heterogeneity across countries, firms, and banks. The economy consists of households that supply deposits, firms that demand credit to finance capital, and banks that intermediate funds while deciding where to operate and at what rates to lend. Firms choose which banks to borrow from, subject to relationship-specific costs, while banks compete imperfectly in deposit and loan markets and face country-specific operating costs. Cross-border frictions enter the model along three margins: firm-side barriers to relationship formation with foreign banks; bank-side lending costs to foreign borrowers; and the fixed costs of banking groups branching into foreign jurisdictions. These wedges act as implicit taxes on cross-border operations and distort the allocation of bank credit.

We then calibrate the quantitative spatial general equilibrium model to match bank- and firm-level moments in the euro area. A subset of parameters is calibrated externally, including the elasticities of labor supply, output with respect to capital and labor, loan demand, and deposit supply. We then invert the model to recover firm fundamentals, such as productivity and default risk, as well as bank-firm loan demand and pricing shifters and bank-level deposit shifters, so that the model exactly matches the distribution of firm output, default probabilities, and capital intensity; the geography of bank-firm relationships; bank-level lending and deposit shares; and the dispersion in interest rates. To reduce dimensionality while preserving microeconomic heterogeneity, firms are grouped into bins by productivity and default risk within each country. Finally, we infer bilateral fixed costs to cross-border branching from observed entry patterns.

Using the calibrated model, we conduct counterfactual exercises that partially relax cross-border banking barriers, mimicking reforms toward a more integrated European banking market. Our main objective is to quantify their macroeconomic effects in general equilibrium. Our benchmark exercise considers a 10% reduction in cross-border relationship wedges across all euro-area country pairs.

The model predicts a 1.6% increase in euro-area GDP. Somewhat surprisingly, most of the gains arise from capital accumulation and higher labor demand rather than from improvements in allocative efficiency. The main mechanism runs through broader access to foreign financial intermediaries, which increases the cross-border lending share by 1.2 percentage points and lowers firms' effective user cost of capital — incentivizing them to scale up investment and employment. By contrast, improvements in allocative efficiency through the reallocation of capital within and across countries — and therefore gains in total factor productivity — are modest. The gains are also highly heterogeneous: smaller economies and financial centers such as Ireland, Luxembourg, and the Netherlands benefit disproportionately, while gains are smaller in Southern Europe.

Our results provide a new perspective on the likely gains from policy initiatives aimed at completing the Banking Union and advancing the Savings and Investment Union. Conventional views typically emphasize that financial integration should improve the allocation of credit toward more productive firms and regions, or intensify competition and compress markups. We find, however, that reallocation generates comparatively modest gains, as the reforms do not necessarily benefit the firms and countries with the highest marginal product of capital. Instead, the first-order gains arise from access to a broader pool of financial intermediaries and the resulting broad-based decline in firms' effective user cost of capital.

Literature. Our paper contributes to four strands of literature: international capital allocation, real effects of cross-border capital flows, cross-border financial intermediation, and structural models of financial intermediation.

A large and growing literature quantifies distortions to cross-border capital allocation using wedges inferred from aggregate data (Gourinchas and Jeanne, 2013; Gârleanu et al., 2020; Ohanian et al., 2018, 2021; Pellegrino et al., 2025; Capelle and Pellegrino, 2025). These approaches recover country-level frictions from aggregate data, either from national accounts or from external balance sheets. Our contribution is to develop a microeconometric wedge-accounting framework that identifies bilateral frictions directly from bank-firm relationships. By exploiting within-firm and within-bank variation, we purge compositional differences in borrowers and lenders. Our micro-based wedges suggest stronger barriers than macro-based estimates in European banking markets.

We further add to papers studying how cross-border capital flows and reforms to lift cross-border frictions shape allocative efficiency within countries (Gopinath et al., 2017; Saffie et al., 2020; Bertaut et al., 2024; Camêlo, 2024; García-Santana et al., 2025). Using firm-level data, this literature has emphasized firm heterogeneity. By leveraging a cross-country credit registry, we allow for heterogeneity on the firm and on the bank side. This two-sided heterogeneity turns out to be important for explaining the heterogeneous gains across countries and the surprisingly modest reallocation gains across countries and across firms within countries.

Our focus on cross-border banking relates to the empirical literature on international financial intermediation, which has emphasized gravity forces (Buch, 2005; Correa et al., 2022), group structures (Cetorelli and Goldberg, 2012; Beck et al., 2024), and cross-country micro heterogeneity (Altavilla et al., 2024; Kosekova et al., 2024; Degryse et al., 2025). To our knowledge, we are the first to show that cross-border barriers operate primarily along the extensive margin of relationship formation, rather than through interest rates or loan quantities.

A central contribution of this paper is to construct a novel dataset of regulatory distances across euro area countries. We show that these policy distances are key determinants of cross-border wedges, providing suggestive evidence that regulatory heterogeneity hampers financial integration. Our work complements recent efforts to build new datasets in international finance (Mueller et al., 2025; Pellegrino et al., 2025), with a focus on regulatory differences.

We also relate to a growing literature that studies financial intermediation in quantitative spatial general equilibrium environments (Niepmann, 2023; Oberfield et al., 2025; Herreno, 2025; Ji et al., 2023; D'Amico, 2025; Morelli et al., 2024), where frictions shape the allocation of capital across locations and their aggregate consequences. Our contribution is to provide model-consistent micro-estimates of cross-border wedges and to invert the model using granular micro data. This allows us to study a central policy question: how large are cross-border frictions in the euro area, to what extent are they related to regulatory fragmentation and what are the macroeconomic gains from reducing barriers and completing the European Banking Union?

Organization The next section presents stylized facts on *de jure* and *de facto* fragmentation in euro area credit markets. Section 3 introduces our microeconometric wedge accounting framework to measure cross-border friction. Section 4 shows that our estimated barriers strongly correlate to policy distances using a newly constructed dataset on banking regulatory fragmentation. Section 5 develops a spatial general equilibrium model of banking with an endogenous network of deposits and loans. Section 6 calibrates the model and runs counterfactual exercises. Section 7 concludes.

2 Stylized Facts

This section documents that euro area (EA) banking markets remain fragmented across national lines, both *de facto* and *de jure*. First, we document limited cross-border banking flows at the country pair (macro) and bank-firm relationship (micro) levels using AnaCredit. Second, we document limited cross-border bank entry using group structures from RIAD. Facts 1 and 2 together show limited cross-border banking on both the intensive and extensive margins. Third, we construct a novel dataset of policy distances and show that substantial regulatory fragmentation persists across jurisdictions. Appendix B provides additional details on the construction of the data and measures.

Data sources

AnaCredit. We use AnaCredit, a cross-country credit registry for the euro area (ECB, 2016; Israël et al., 2017; ECB, 2018, 2019). The data cover the near-universe of credit instruments originated by euro area banks and their branches to debtors across the world, starting in 2018:Q3, and also include legacy instruments originated prior to this date that were outstanding or drawable at the time of data collection. We clean the data using a standard routine maintained by ECB researchers. We focus on lending to the real sector, excluding borrowing by financial corporations and lending by non-depository institutions. We aggregate the data to the relationship (i.e., bank-firm) level, summing outstanding nominal amounts (ONA) across instrument types within each relationship pair. Interest rates and other contractual characteristics (e.g., maturity) are computed as ONA-weighted averages. We supplement these data with supervisory information on bank-level balance sheets from iBSI, which reports assets and liabilities broken down by counterparty, sector, and maturity. Our final sample spans 2019:Q4 to 2025:Q2.

RIAD. We use RIAD, which covers the near-universe of group structures for euro area banks and firms. A key data challenge is that administrative group structures typically link legal entities by ownership rather than control. The largest shareholders are often large institutional investors — such as pension funds — with no active involvement in banking operations. Using RIAD's ownership and control linkages, we develop an algorithm that assigns each bank to its ultimate parent, defined as the highest-level entity in the ownership tree that is itself a deposit-taking financial institution. Details are provided in Appendix B.

Cross-border definitions. Cross-border relationships can be defined based on either residency or nationality. The residency-based approach defines a cross-border relationship as one in which the immediate lender and the firm are physically located in different countries — the definition used by international statistical frameworks such as the IMF (2006) BPM6, § 4.27-4.33 and BIS (2012) Locational Banking Statistics. For example, consider a firm located in Croatia and a banking group domiciled in Austria, with branches in both countries. Under the residency definition, the firm's borrowing from the Austrian branch constitutes a cross-border relationship, while borrowing from the Croatian branch does not.[1]

The nationality-based approach instead assigns relationships based on ownership. Under this concept, both types of borrowing in the example above would be classified as cross-border: the Croatian branch inherits the Austrian parent's nationality, even though it is not physically located in Austria.[2]

We engage with both definitions. When studying frictions to relationship formation or loan pricing, we use the residency-based definition. This reflects the idea that lending technologies and operations — where loan officers sit, where borrower information is produced, where monitoring occurs, and where loan contracts are legally binding — are primarily local, consistent with a large empirical literature (Buch, 2005; Degryse and Ongena, 2005; Mian, 2006; Agarwal and Hauswald, 2010). When studying frictions to bank entry, we use the nationality-based definition, which better captures cross-border entry decisions (Niepmann, 2015, 2023).

[1] Under IMF BPM reporting, the relationship between the foreign head office and the resident branch is considered cross-border, the one between resident branch and the local borrower is not. The branch-head-office position is part of direct investment, while the branch's loan to a local customer is a domestic loan. Under BIS LBS reporting, the Austrian entity's Croatian branch loan to the Croatian firm is classified as a local claim rather than a cross-border claim. The BIS also defines international claims as cross-border claims plus local claims of foreign affiliates denominated in non-local currencies. So a locally booked foreign-currency loan is still not cross-border, but it can still sit inside BIS international claims. Because our empirical application focuses on euro-area lending, which are overwhelmingly denominated in euro, this currency-denomination distinction is unlikely to drive our classification.

[2] In our example, the Austrian parent holds the banking license in Austria and is then authorized to operate a branch in Croatia by the Croatian national regulator. This is a key distinction between "branches" and "subsidiaries" in European Banking Law: the branch does not hold its own banking license, whereas the subsidiary does. Moreover, subsidiaries have to report their standalone balance sheets, whereas branches consolidate their balance sheet with their parents'. Hence, subsidiaries and branches may be subject to different regulations, even when they operate in the same country. See A.4 for a detailed discussion.

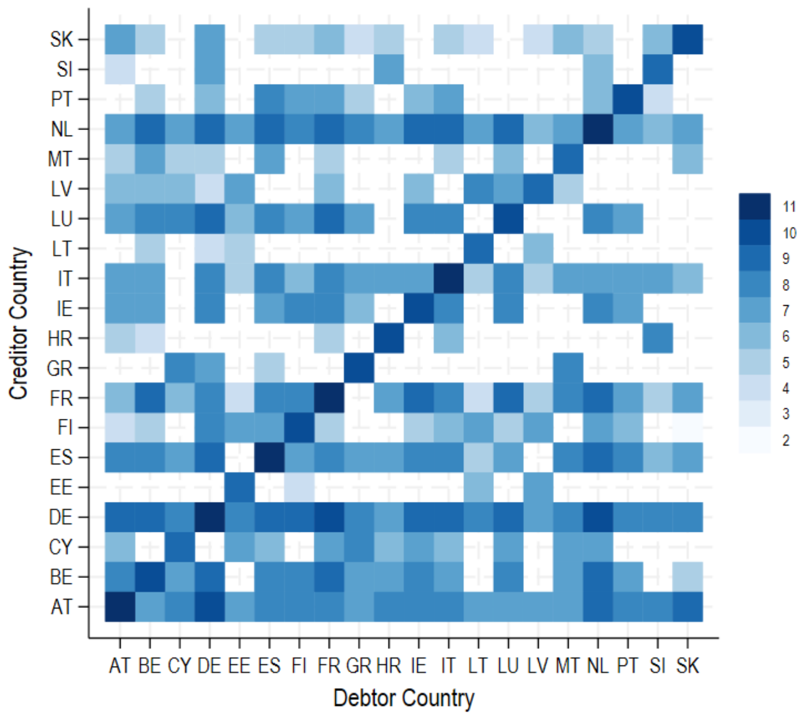
Fact 1: Limited Cross-Border Credit to Firms

While free mobility of capital is a core principle of the European Union, cross-border banking within the euro area remains *de facto* limited. Cross-border lending has averaged 5.6% of total lending within the EA since 2019 (Figure 6), the smallest foreign share across intermediaries and asset classes in this period.[3]

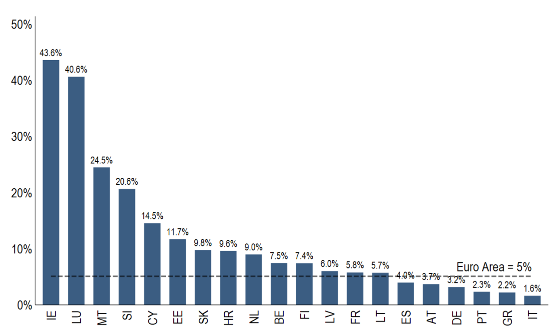
Cross-border banking is highly uneven across countries. Figure 1 Panel (a) plots the full matrix of bilateral positions, with bank countries on the vertical axis and firm countries on the horizontal axis. Positions are expressed in orders of magnitude (log 10). We select 2024:Q3 to focus on cross-sectional differences. The darkest elements lie on the diagonal, reflecting considerable home bias. The off-diagonal terms illustrate the substantial heterogeneity across country pairs, with empty cells corresponding to pairs with no cross-border lending relationships in the data (e.g, Estonian banks had no lending to firms outside the Baltic countries or Finland in 2024:Q3). We then collapse the matrix to the country level in Panels (b) and (c). On the borrowing side, Ireland, Luxembourg and Malta rely most heavily on credit from EA banks. On the lending side, Luxembourg, Ireland and the Netherlands have the largest foreign lending shares. Meanwhile, larger economies tend to show smaller cross-border shares, reflecting both large domestic credit markets and potential barriers to cross-border credit.

The microdata confirm the aggregate picture. Table 1 collects summary statistics on a sample of bank-firm relationships. Panel A presents results at the relationship level. Cross-border relationships account for less than 1% of total relationships. However, they are on average ten times larger in outstanding nominal amounts, an effect driven by the right tail of the cross-border distribution; and are more likely to be syndicated. Cross-border relationships feature slightly lower interest rates on average. This may partly reflect differential credit risk: on average, cross-border relationships have lower shares of collateralized, overdue, or

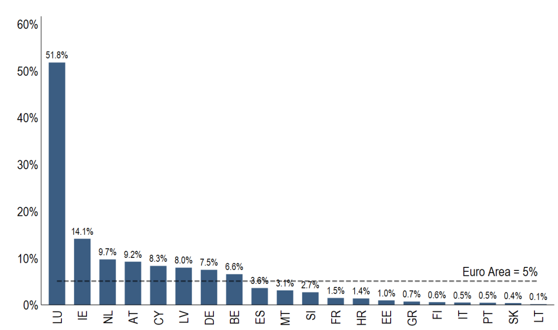
[3] Bank credit is by far the most domestically-concentrated asset class, rivaling the pre-2000 estimates reviewed in Coeurdacier and Rey (2013). For instance, the foreign equity share hovered around 45% (European Central Bank, 2025). Investment funds' foreign share of debt and equity securities stood at 90% (European Central Bank, 2025). Beck et al. (2024) compute home-bias indices for equities and bonds after disentangling investment funds' residency from nationality, finding that (i) while home bias has declined in bonds, it remained pronounced in equities; and (ii) Europe and the US feature similar degrees of home bias in equity portfolios. Pension funds have a foreign share of about 45% (European Central Bank, 2020). Traditional life insurers foreign shares vary dramatically across countries, with sovereign (corporate) bond foreign shares ranging from 25-50% (60-85%) for the largest four euro area economies (Corradin et al., 2025).



(a) Bilateral positions (log 10)



(b) Cross-Border Loan Shares by Debtor Country



(c) Cross-Border Loan Shares by Creditor Country

Figure 1: Geography of Cross-Border Lending in the EA

Notes: Panel (a) illustrates the bilateral network of cross-border lending positions (log scale) between euro area countries, highlighting the core-periphery structure and varying intensities of lending relationships. Panel (b) shows the share of cross-border loans in total loans for each debtor country (i.e., the proportion of borrowing by firms from banks in other countries). Panel (c) presents the corresponding share for each creditor country (i.e., the proportion of lending by domestic banks to firms abroad).

Table 1: Descriptive Statistics: Relationship-Level

	All Relationships						Cross-Border Relationships					
	N	Mean	SD	p50	p90	p99	N	Mean	SD	p50	p90	p99
Relationship-Level												
Shares (%):												
Collateral Ratio (%)	4 630 376	222.58	107.316	456.619	715.697	2441.613	27 315	124.83	97.948	213.884	372.415	1532.500
Gov-guaranteed share (%)	4 630 376	23.37	0.000	80.000	90.009	166.667	27 315	1.69	0.000	0.000	0.000	30.000
Syndicated share (%)	4 630 376	0.90	0.000	0.000	0.000	0.000	27 315	8.46	0.000	0.000	100.000	100.000
Euro denominated share (%)	4 630 376	99.92	100.000	100.000	100.000	100.000	27 315	96.40	100.000	100.000	100.000	100.000
Share of Loans Past Due (%)	4 630 376	3.99	0.000	0.000	0.000	100.000	27 315	2.52	0.000	0.000	0.000	100.000
Credit from banking groups (%)	4 630 376	65.76	100.000	100.000	100.000	100.000	27 315	51.63	100.000	100.000	100.000	100.000
Bank in the SSM? (%)	4 630 376	84.09	100.000	100.000	100.000	100.000	27 315	62.11	100.000	100.000	100.000	100.000
Share of Credit Lines	4 630 376	20.96	0.000	100.000	100.000	100.000	27 315	20.80	0.000	100.000	100.000	100.000
Share of Term Loans	4 630 376	51.04	48.321	100.000	100.000	100.000	27 315	26.68	0.000	100.000	100.000	100.000
Averages:												
Outstanding Amounts (thousands)	4 630 376	629.45	103.357	854.106	1865.027	8864.160	27 315	5956.23	416.733	14 285.714	29 648.473	80 000.000
Interest Rate (%)	4 630 376	3.77	3.660	7.070	8.279	11.846	27 315	3.61	4.145	7.232	8.150	10.480
Debtor Probability of Default (%)	3 088 794	9.89	1.020	19.950	100.000	100.000	10 662	6.09	0.500	20.275	23.360	100.000
Residual Maturity (Years)	4 630 376	5.25	3.382	13.255	16.718	23.942	27 315	3.13	1.611	8.388	13.274	22.348
Original Maturity (Years)	4 630 376	8.92	6.558	19.592	20.929	30.022	27 315	5.87	4.442	15.184	20.011	28.186
Relationship Age (Years)	4 630 306	5.64	4.250	12.417	16.417	26.583	27 268	4.86	3.667	11.250	14.167	21.167
Distance Creditor-Debtor (km)	4 479 582	224.80	121.950	580.620	708.290	1252.220	25 961	673.46	517.360	1453.420	1691.120	2138.350

Note: This table shows summary statistics for all cross-border relationships and a sample of domestic relationships in AnaCredit. The data are as of September 2024. We define cross-border based on operational geography. Statistics are reported unweighted at the relationship level. Collateral ratios are winsorized at 99.9%. Not all banks report probabilities of default for their loans, so smaller sample sizes apply. Distances are calculated using NUTS3 centroids and may differ slightly from actual creditor-debtor differences.

guaranteed loans. Perhaps most telling, we find banks assign on average lower probabilities of default in cross-border relationships.

While roughly 40% of banks in the sample have at least one cross-border relationship, very few firms borrow cross-border (Table 7). Those that do are on average older and considerably larger in terms of turnover, balance sheet size, and number of employees, suggesting that firms face meaningful frictions in accessing cross-border credit, and that only the most mature and least risky borrowers clear these hurdles. On the creditor side, banks engaged in cross-border intermediation are also substantially larger in terms of assets, lending, and deposit-taking. To the extent these attributes are persistent, our estimation will control for them through firm and bank fixed effects, thereby isolating the role of bilateral frictions.

Fact 2: Limited Cross-Border Bank Entry

The geography of cross-border entry by banking groups reveals limited integration in the euro area. Banking groups can expand cross-border either through branches or subsidiaries; we refer to both as "bank entry." We use RIAD to link branches and subsidiaries to their parent banking groups. Figure 2 plots cross-border bank entry at the banking group level as of September 2024. Few banking groups enter across borders. Most off-diagonal entries are empty, reflecting no cross-border entry. Except in five cases, fewer than five banking heads in each origin country move across borders.[4]

Entry patterns differ markedly across countries. Most cross-border banking groups originate in the largest euro area economies or in the Benelux financial hub, and — conditional on going abroad — collectively enter multiple national markets. By contrast, groups originating in smaller countries either enter only neighboring markets or do not expand abroad at all. These sparse entry patterns are reflected in lending volumes, with large cross-border positions concentrated among Germany, France, Italy, Spain, and the Netherlands, while other bilateral exposures are orders of magnitude smaller. Appendix Figure 8 decomposes entry into branches and subsidiaries: while it reveals some cross-country heterogeneity in organizational form, the main message is unchanged — cross-border entry is

[4] In Appendix A, we recompute the cross-border banking positions on a nationality basis (Beck et al., 2024). We find that 11% of loans are cross-border according to this definition, accounting for 14.6% of loan amounts (Figure 7). Home bias in banking positions remains strong even with this definition.

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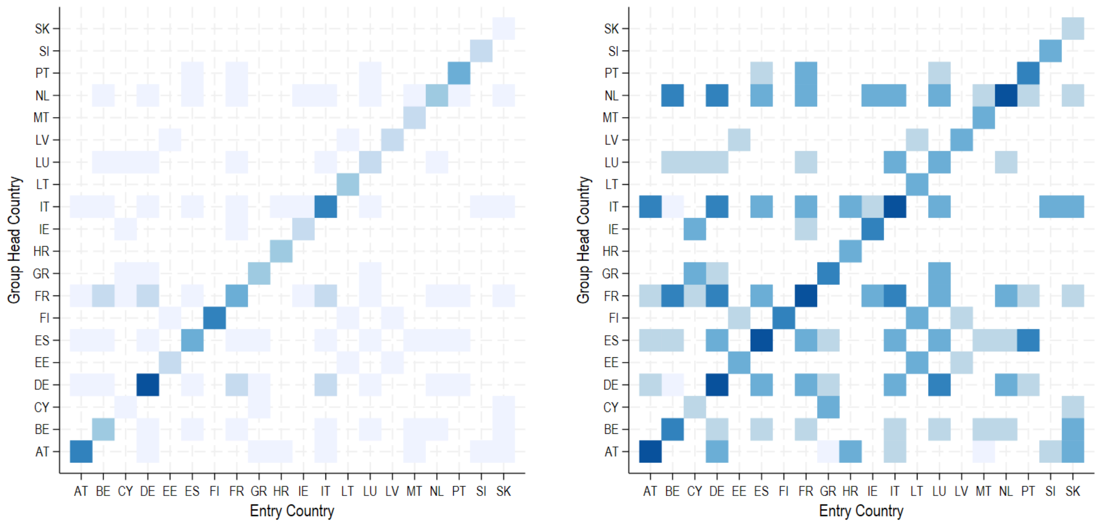


(a) Number of Branches and Subsidiaries

(b) Outstanding Amounts

Figure 2: Cross-Border Entry Patterns

Notes: Panel (a) reports the number of branches or subsidiaries and panel (b) reports outstanding amounts. Values are shown by country of the group head (rows) by country of entry (columns). The diagonal corresponds to domestic positions, and includes (i) entry of group head into its origin country (by definition), and (ii) standalone banks that do not have cross-border operations or are not owned by any major banking groups. For disclosure purposes, numbers are omitted. Empty cells correspond to zero. For panel (a), the color cutoffs correspond to $(< 5, < 10, < 50, < 100, < 500, \geq 500)$ branches or subsidiaries. For panel (b), color cutoffs correspond to $(< 1000, < 1\text{mn}, < 1\text{bn}, < 10\text{bn}, < 100\text{bn})$ EUR.

Fact 3: Fragmented Regulatory Environment

We document regulatory fragmentation in the euro area using a new measure of bilateral policy distances in banking regulation. This measure spans multiple dimensions, including macro- and microprudential rules, supervisory practices, resolution policies, governance and entry requirements, and corporate bankruptcy regimes. Section 4 describes the underlying data and methodology in detail and assesses the quantitative importance of regulatory differences relative to standard gravity factors.[5]

[5] A large literature documents a strong role for "gravity" (e.g., size and distance) for cross-border financial flows. For examples, see Portes and Rey (2005) for equities, Chiţu et al. (2014) for bonds and currency, Brei and von Peter (2018) for banking and Auer et al. (2025) for crypto assets.

Banking regulation remains fragmented across euro area countries despite substantial harmonization efforts over recent decades. Figure 3 plots aggregate policy distance index, where a value of 0 indicates full harmonization and a value of 1 indicates complete fragmentation; intermediate values can be interpreted as the share of policy dimensions on which two countries differ. The average policy distance across any two euro area countries is 25%, with a standard deviation of 4%, implying that a typical pair of countries differs on roughly one in four regulatory dimensions.

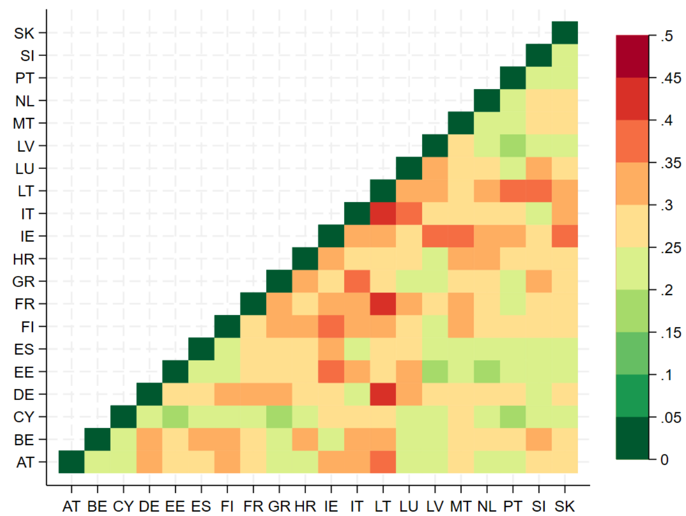


Figure 3: Average Policy Distance by Country Pair

Notes: The figure reports the average bilateral policy-distance index in banking regulation across euro-area country pairs. For each pair, the index aggregates differences across regulatory domains, including macroprudential and microprudential rules, supervision, resolution, governance and entry requirements, and corporate bankruptcy regimes. A value of 0 (respectively, 1) indicates full harmonization (complete fragmentation); intermediate values can be interpreted as the share of policy dimensions in which the two countries differ.

This regulatory fragmentation persists despite substantial harmonization efforts over recent decades. The European Union enshrined free capital mobility in the 1993 Maastricht Treaty. Following the sovereign debt crisis in the EA in the 2010s, which exposed the strong home bias of banks and their exposure to local sovereigns, a series of reforms have been pursued to create a single banking market in the EA. These reforms included the Single Supervisory Mechanism, the Single Resolution Mechanism, and the European Commission resolution on deposit insurance schemes, the so-called “three pillars” of the Banking Union. Yet, across a wide range of regulatory domains, we still see considerable differences.

As policymakers and industry leaders alike suggest, such regulatory fragmentation could be a key driver of shallow cross-border banking (Enria, 2020, 2021; Buch, 2024; Lagarde, 2024; Farkas, 2025). Regulatory differences in legal frameworks and bank regulation can discourage cross-border bank lending by raising compliance or entry costs. For example, a bank deciding to expand abroad may need to familiarize itself with new entry rules, accounting formats, governance requirements, prudential buffers, etc. Even conditional on bank entry, differential capital and liquidity requirements across jurisdictions may generate dispersion in marginal costs within-banks across space, thereby distorting pricing and quantities on the intensive margin. Quantifying how much of this regulatory heterogeneity translates into cross-border banking frictions is a central contribution of our paper.

3 Measuring Cross-Border Frictions in the Microdata

The three stylized facts presented above point to substantial cross-border barriers in bank lending. In this section, we develop a microeconometric framework that is consistent with the microfounded model of Section 5 to estimate these barriers along three margins: relationship formation (θ^L), loan pricing conditional on relationships (θ^R), and bank entry into foreign markets (θ^E). We find that barriers to cross-border relationships between banks and firms and cross-border bank entry are large while wedges on interest rates and loan quantities are comparatively small. In contrast with macro approaches in the literature, we leverage firm-bank-level data to purge our cross-border wedge estimates from compositional differences across countries.

3.1 Microeconometric Framework

We begin by modeling the probability that firm f borrows from bank b. Let $Y_{bft} \in \{0,1\}$ take a value of 1 if firm f and bank b have positive outstanding nominal amounts in period t. We model it flexibly as a function of bank and firm characteristics (α^L_b, α^L_f), bank-firm observables X^L_{bft}, cross-border frictions $\theta^L(i_f, i_b)$, and a residual υ^L_{bft}. Our estimating equation is

$$Y^L_{bft} = \underbrace{\alpha^L_b + \alpha^L_f + \alpha^L_t}_{\text{FE}} + \sum_{i_f, i_b} \underbrace{1\{i_f \neq i_b\} \times \theta^L(i_f, i_b)}_{\text{Cross-border wedges}} + \underbrace{\phi' X^L_{bft}}_{\text{Controls}} + \underbrace{\upsilon^L_{bft}}_{\text{Residual}} \tag{1}$$

The relationship wedge $\theta^L(i_f, i_b)$ depends only on firm location i_f and bank location i_b. We measure the wedges non-parametrically by including dummy variables for each country-pair combination and absorb all time-invariant bank or firm heterogeneity with fixed effects. We add time fixed effects to absorb unobserved aggregate shifters. We estimate (1) using both OLS and PPML methods (Silva and Tenreyro, 2006).[6]

Conditional on a relationship, we model the realized interest rate as

$$R_{bft} | \left(Y^L_{bft} = 1\right) = \underbrace{\gamma^L_b + \gamma^L_f + \gamma^L_t}_{\text{FE}} + \sum_{i_f, i_b} \underbrace{1\{i_f \neq i_b\} \times \theta^R(i_f, i_b)}_{\text{Cross-border wedges}} + \underbrace{\phi' X^R_{bft}}_{\text{Controls}} + \underbrace{\upsilon^R_{bft}}_{\text{Residual}} \tag{2}$$

Cross-border wedges $\theta^R(i_f, i_b)$ are estimated via country pair dummies. We estimate the interest rate equation by OLS.

Identification. Our microeconometric wedge accounting framework identifies wedges from within-bank and within-firm comparisons. The estimator asks whether a given firm is more likely to match with a domestic than a foreign bank, and whether a given bank is more likely to match with a domestic than a foreign firm; it then aggregates these local, difference-in-differences-like comparisons over the bank–firm network (Kline, 2024). The same logic applies to the interest-rate regressions. Appendix A provides a simple example and more formal econometrics. We discuss residual threat to identification after we present the main results.

The estimates should be interpreted as bilateral lending frictions purged of bank and firm heterogeneity. The ability to remove compositional differences better isolates the role of bilateral country-level forces rather than technological primitives of banks and firms. Our use of microdata thus improves upon an extensive

[6]We use the tools developed by Correia et al. (2020). There are three additional advantages of PPML. First, non-linear models with high-dimensional fixed effects are subject to incidental parameter bias (Neyman and Scott, 1948), except for PPML (Gourieroux et al., 1984). Second, cross-border relationships are "rare events", so modeling their "arrival" as Poisson is intuitive. Third, PPML does not suffer from misspecification if the true DGP is not Poisson. It suffices that the model's conditional expectation function be correctly specified (Gourieroux et al., 1984).

literature relying on aggregate data (Portes and Rey, 2005; Head and Mayer, 2014).

Sampling Strategy. Estimating non-parametrically the full set of bilateral wedges on the full population of firm-bank links is computationally infeasible. We thus design a sampling strategy that balances identification and computational feasibility. Appendix A provides further details.

We start with the interest rate wedges. We sample all cross-border bank-firm relationships plus at least two domestic relationships for firms borrowing cross-border. Within each country, we then sample a set percentage of domestic bank-firm relationships, which account for most of the data (e.g., over 30% of relationships in the whole data are just French domestic lending relationships).

The relationship wedges are more complicated due to the combinatorial nature of the problem. To estimate (1), we need information on bank-firm relationships that were not realized. Considering the full choice set of banks for each firm is computationally infeasible. For example, with 3000 banks and about 6 million firms as we see in the data, the dataset would include 18 billion observations. Estimation of a model with high-dimensional fixed effects would be impossible.

To address these issues, we use stratified sampling and estimate the relationship wedges with inverse probability weights (Horvitz and Thompson, 1952; Manski and Lerman, 1977). We start with the intensive margin sample and associated sampling weights. For this "certainty stratum", the dyad sampling probability for the extensive margin is 1. We then sample "zeros" within firm by randomly sampling banks with whom the firm did not have a relationship with. To keep the dataset size manageable, we sample enough zeros to get to approx. 50 observations per firm-time period after we combine both existing and non-existing relationships stratifying by country. For relationships that never happened, the dyad sampling probability is the number of sampled "zeros" divided by the total number of banks within country from which we sampled with whom the firm did not have a relationship. The final sampling weights are then given by the firm sampling probability from the intensive margin times the dyad sampling probability in the extensive margin. All subsequent estimation using this sample is weighted by the inverse sampling probability, allowing us to recover parameters from the population of interest in a wide class of M-estimation methods (Pfeffermann, 1993; Wooldridge, 1999; Solon et al., 2015).

3.2 Results: Relationships, Loan Pricing and Sizes

Relationship Formation and the Extensive Margin. We find sizable frictions to establishing cross-border relationships. Before presenting the full matrix of bilateral wedges, we summarize the country-pair dummies into a single cross-border dummy that takes a value of 1 if creditor and debtor countries differ. Hence, we first estimate the relative likelihood of cross-border relationships relative to domestic relationships, averaging across all country pairs. Cross-border relationships are 3 log points (or, 95%) less likely than domestic relationships (Table 2, Column 2). In levels, the gap amounts to a 70 percentage points (pp) lower probability of cross-border relationships (Column 4).

Notably, the included firm and bank fixed effects do not materially change the wedges relative to a specification with only bank country and firm country fixed effects. The similarity indicates that the relationship wedge is not primarily driven by compositional selection. This is an informative comparison since larger banks and larger firms are unconditionally more likely to form cross-border lending relationships (Table 7). Cross-border barriers appear to shift relationship probabilities downward broadly, rather than being an artifact of large banks and large firms selecting into cross-border credit.

Despite substantial heterogeneity across country pairs, barriers to cross-border relationships are a euro area wide phenomenon. We report the estimated wedges (Column 4 specification) at the country-pair level relative to the domestic wedges in Appendix Figure 9. We find substantial dispersion in our estimated wedges across country pairs, with a standard deviation of 24 pp for an unweighted mean of 65 pp. Yet, the wedges are overwhelmingly negative across all country pairs.

Loan Pricing and Interest Rate. In contrast with relationship wedges, pricing wedges appear small. In our preferred specifications with bank and firm fixed effects (column 2), cross-border relationships within the EA feature on average 28 basis points lower interest rates (8.5% of the sample mean) relative to domestic relationship (Table 3). This suggests that cross-border loans may indeed benefit firms by promoting access to cheaper credit. Notably, specifications that include only origin and destination fixed effects find cross-border loans to be even cheaper (column 1), underscoring the importance of exploiting within-bank and within-firm variation to isolate bilateral frictions from compositional differences.

Table 2: Cross-Border Frictions to Relationship Formation

	(1)	(2)	(3)	(4)
Cross-Border	-3.011***	-2.993***	-0.789***	-0.692***
	(0.005)	(0.004)	(0.000)	(0.000)
N	106,584,064	106,584,064	106,584,064	106,584,064
Specification	PPML	PPML	OLS	OLS
Banks	2,673	2,673	2,673	2,673
Firms	574,412	574,412	574,412	574,412
Time FE	✓	✓	✓	✓
Bank Country FE	✓		✓	
Firm Country FE	✓		✓	
Bank FE		✓		✓
Firm FE		✓		✓

Notes: The table presents PPML and OLS estimates of (1). The dependent variable takes a value of 1 if the firm and the bank have outstanding credit, and 0 otherwise. The independent variable is a dummy for firm and banks being located in different countries. Inverse probability sampling weights are used throughout. Clustered standard errors at the bank, firm, and country-pair reported in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

There is sizable heterogeneity in pricing frictions across pairs (Appendix Figure 12), with wedges taking small positive or negative values relative to domestic borrowers. This stands in sharp contrast to the relationship wedges, which are large and negative for nearly all country pairs.

Loan Size and the Intensive Margin. Cross-border barriers on loan size, conditional on an existing relationship, are modest. We estimate a variant of equation (1) replacing the left-hand side dummy with the bank's log share of firm borrowing and restricting the sample to existing relationships (Appendix Table 8).We find that cross-border loan shares are 14% lower than domestic shares (Column 2), suggesting that firms do borrow less from foreign banks even conditional on having a relationship with both. This gap, however, is small compared to the frictions to relationship formation. As with loan pricing, controlling for within-country bank and firm heterogeneity substantially reduces the estimated cross-border distortion (Column 1). Appendix Figure 12 shows some heterogeneity in quantity frictions across pairs, though wedges tilt toward lower cross-border credit across most country pairs.

Table 3: Cross-Border Wedges in Interest Rates

	(1)	(2)	(3)	(4)	(5)
Cross-Border	-0.0083***	-0.0028***	-0.0027***	-0.0026***	-0.0028***
	(0.0018)	(0.0007)	(0.0007)	(0.0007)	(0.0007)
N	13,303,423	13,270,167	13,215,479	13,268,649	10,797,038
Banks	3,000	2,972	2,799	2,968	2,568
Firms	683,717	650,482	646,975	650,406	505,965
Mean Interest Rate	0.033	0.033	0.033	0.033	0.033
Time FE	✓	✓		✓	✓
Bank Country FE	✓				
Firm Country FE	✓				
Firm FE		✓	✓	✓	✓
ILST FE			✓		
Bank FE		✓			✓
Bank x Time FE			✓		
Bank x NACE2 FE				✓	
Firm-Bank Size Bins					✓

Notes: The table presents OLS estimates of a regression of the (log) gross interest rate on a cross-border indicator for firm and banks being located in different countries. Time is a quarter. ILST FE refers to industry x location x size x time fixed effects. Firm-bank size bins are defined by the interaction of firm and bank size deciles. Clustered standard errors at the bank, firm, and country-pair reported in parentheses. The number of observations, banks and firms changes due to standard connectedness requirements imposed by the set of fixed effects.

Risks to Identification and Robustness Checks. Unobservables correlated with cross-border status and credit decisions could bias our bilateral wedges.

First, relationship formation may depend on latent interest rates (i.e., offered by banks, but rejected by firms). These are unobserved in AnaCredit. Our relationship wedges may thus suffer from omitted variable bias à la Heckman (1979). However, if interest costs reflect primarily bank-specific (e.g., funding costs, risk appetite, balance sheet strength) or firm-specific factors (e.g., productivity, default risk), then bank and firm fixed effects may suffice to absorb the relevant variation.

Second, the interest rate wedges we estimate are conditional on an observed relationship. To the extent that cross-border rates differ for latent relationships — our interest rate estimates would not capture those differences. We do not view this as a major limitation, since the wedges still meaningfully measure frictions conditional on relationship formation.

Third, residual bank-firm observables may differentially drive cross-border versus domestic credit. On the relationship margin, these concerns are subdued given how stable wedges are to controlling for granular firm and bank effects.[7] On the intensive margin, we attempt to mitigate these concerns directly (Tables 3 and 8). Results are robust to controlling for time-varying shocks (bank by time and industry by location by size by time fixed effects), bank-industry specialization (bank by firm sector fixed effects), and size-based assortative matching (bank size decile by firm size decile bins).[8]

3.3 Bank Entry Wedges

Econometric Framework. We next estimate the barriers faced by banking groups when opening branches or subsidiaries in foreign markets. We specify a model for the probability that a banking group g originated in country o_g enters a destination country i:

$$Y^E_{git} = \underbrace{\alpha^E_{o_g} + \alpha^E_i + \alpha^E_t}_{\text{FE}} + \sum_{i,o_g} \underbrace{1\{i \neq o_g\} \times \theta^E(o_g, i)}_{\text{Cross-border wedges}} + \underbrace{\phi' X^E_{gi}}_{\text{Controls}} + \underbrace{\upsilon^E_{gi}}_{\text{Residual}} \qquad (3)$$

where $Y_{git} \in \{0, 1\}$ is 1 if banking group g has entered country i by time t.

A key identification challenge is that entry depends on profits in foreign markets, which are only observed for countries where the group actually operates. We propose two approaches. First, we assume that counterfactual profits are multiplicatively separable into a group-specific push factor, a destination-specific pull factor (both absorbed by fixed effects), and a residual, which we assume is uncorrelated with outcomes conditional on the included controls. Second, we use the structure of the model in Section 5 to construct both realized profits — for markets where groups have a branch or subsidiary — and counterfactual profits they would earn in markets where they are not currently present.

[7] Time-varying fixed effects would cause us to lose too many observations, a well-known problem in bipartite settings where the time dimension helps complete the network and avoid connectedness issues (Abowd et al., 2002). Our estimation attempts faced large computational challenges.

[8] Our cross-border wedges are thus not driven by large firms with higher financing needs (e.g., those with higher productivity, lower default risk, or multinational status) sorting into relationships with larger banks (e.g., global banks with greater balance sheet capacity or lower funding costs).

Results. We find sizable barriers to cross-border bank entry. Table 4 presents OLS estimates, summarizing the heterogeneity into a single cross-border indicator. Since banking groups always operate in their home market, all variation comes from entry decisions across foreign markets; the coefficient is therefore best interpreted as an average implicit tax on foreign relative to domestic banking. Across all specifications — controlling for destination and group fixed effects, model-implied profits, or both — we find a robustly negative entry gap of 99 percentage points. While there is some heterogeneity in bilateral barriers across country pairs, the key finding is that entry barriers are large throughout (Appendix Figure 9).

Table 4: Cross-Border Wedges in Bank Entry

	(1)	(2)	(3)	(4)	(5)
Cross-Border	-0.988***	-0.990***	-0.990***	-0.988***	-0.991***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
N	748,014	748,014	748,014	748,014	748,014
Time FE	✓	✓	✓	✓	✓
Entry Country FE	✓	✓	✓	✓	✓
Group Country FE	✓			✓	
Group FE		✓			✓
Group x Time FE			✓		
Model Profits				✓	✓

Notes: The table presents OLS estimates of a regression of an entry indicator on a cross-border indicator for banking group being present in a country other than its origin country. Standard errors are clustered at the parent-country, entry-country, country-pair-level .

4 The Role of Regulatory Fragmentation

We now show that our estimated cross-border barriers are strongly related to policy barriers, even after accounting for non-policy determinants. Our results are descriptive and do not claim to identify causal effects. They nevertheless provide strong validation that our estimated wedges reflect the costs of regulatory fragmentation. While measures of non-policy barriers are available for a large sample of countries (Pellegrino et al., 2025), measures of policy distances for banking regulations are not. We thus build a new dataset of banking policy distances across the euro area.

4.1 Data Sources on Banking Regulations

We collect and harmonize data on multiple dimensions of banking regulation from dispersed sources. Appendix B provides extensive details.

Macroprudential Regulation. Macroprudential policies in the EU are governed by the Capital Requirements Directive (CRD) IV. Prudential buffers include the capital conservation buffer, the countercyclical capital buffer, the systemic risk buffer, over which countries retain discretion; and additional buffers imposed on systemically important banks, for which eligibility criteria and buffer values are set by the Single Supervisory Mechanism. In addition, national regulators can impose borrower-based measures (BoBMs) such as loan-to-value or debt-to-income constraints for certain lending (e.g., residential mortgages).

We collect tabular and textual data from the ESRB website on all measures since 2014, when reporting started. Per the CRD IV, all macroprudential policies must be reported to the European Systemic Risk Board (ESRB). We extract statutory data on buffer values, keeping track of temporary exemptions, recommended versus required levels, transitional periods, and asset- or borrower-specific qualifications. The resulting dataset is a yearly country panel. Finally, we obtain yearly bank-level data on realized values of individual buffers for all systemic institutions.[9]

Microprudential Regulation. Microprudential policies in the EU are governed both by the CRD IV and the Capital Requirements Regulation (CRR) IV. The latter specifies liquidity requirements, computations of risk-weights, classifications of risk exposures, provisioning rules, and a plethora of other regulations. In principle, national authorities cannot deviate from these regulations. However, the presence of Options and Discretions (O&Ds), “escape clauses” by which national authorities can deviate from the Single Rulebook is enshrined in the CRD IV. Take-up of these O&Ds must be reported to the European Banking Authority (EBA). We obtain data on take-up of each O&D in the Single Rulebook from EBA disclosures for 2020 and 2024. We then classify each O&D as a macro or microprudential policy lever.[10]

We also collect data on liquidity and prudential waivers, another distinctive

[9]We are very grateful to the ESRB Secretariat for sharing these data.

[10]We could not find information for earlier years or intermediate periods. Requests to the EBA did not yield further data.

feature of the EU regulatory ecosystem. The Single Rulebook requires financial institutions to satisfy liquidity and prudential requirements on both a solo and a consolidated basis.[11] As a result, large banking groups may have subsidiaries facing different regulatory requirements across countries, generating frictions to internal capital markets and creating scope for national authorities to ring-fence resources within subsidiaries. Waivers allow banking groups to request that regulatory requirements be assessed only at the consolidated level, thereby relieving solo-level obligations. Data on waivers are available for 2022 and 2023.

Deposit Guarantee Systems (DGS). Data on deposit insurance come from the EBA, the International Association of Deposit Insurers (IADI), and the World Bank Bank Regulation and Supervision Survey (BRSS). Across these sources, we collect variables on capitalization, coverage limits per depositor, system type (e.g., paybox or paybox-plus), funding structure, and administration (e.g., by the central bank or an independent agency), among other dimensions.

Although the BRSS provides the most comprehensive cross-country overview of deposit guarantee systems, its data extend only through end-2016. In 2014, the European Commission's DGS Directive legislated substantial harmonization of deposit insurance schemes across EU countries as a precondition for the European Deposit Insurance System. However, the transitional period lasted until July 2024 — an exception among the Banking Union reform packages. To capture changes since 2016, we supplement the BRSS data with information from the IADI survey, manually recoding any reporting inconsistencies over time by cross-checking against national legislation.

Supervision and Resolution. We obtain granular data on supervision and resolution practices at the country level from the most recent wave of the BRSS, which covers end-2016. By that point, the new institutional architecture of the Single Supervisory Mechanism and the Single Resolution Mechanism was in place, and subsequent reforms have consisted primarily of refinements to the Single Rulebook (e.g., CRR2/CRD5).[12] The BRSS includes the euro area as a separate responding

[11] These waivers also circumvent the reporting requirements at the solo and consolidated levels. On the flipside, certain O&Ds give national authorities the power to impose additional reporting requirements.

[12] Following the 2014 euro area crisis, banking supervision and resolution were fundamentally transformed by the Single Supervisory Mechanism and the Single Resolution Mechanism, respec-

entity to capture the SSM and the SRM, so distances in supervision and resolution should be interpreted as applying mostly to non-significant institutions.[13]

Entry, Governance and Accounting. We collect BRSS data on two additional dimensions of banking policy. First, we collect policies related to bank entry. In the European context, banking licenses are granted jointly by national bodies and the ECB, though some levers remain under national discretion. Second, we collect policies on accounting, auditing, and governance requirements, including rules on board composition and compensation, and whether financial statements must be prepared according to international standards.

Corporate Bankruptcy Laws and Practices. We collect data on corporate bankruptcy laws and outcomes for 2010, 2016, and 2022 from the OECD. Corporate bankruptcy regimes are a key determinant of recovery rates, losses given default, and the time required to resolve a failing firm — and thus of credit risk more broadly. Differences in bankruptcy regimes across jurisdictions are therefore an important consideration for banks contemplating cross-border lending.

4.2 Measuring Regulatory Fragmentation

Policy Distances. To quantify the differences in regulations across country pairs, we use Gower (1971) distance metrics. This metric has the appealing property that it can be applied to binary, ordinal, and continuous variables alike, and aggregated across regulatory variables.

Suppose we observe a vector of regulatory variables $\mathbf{r}_c = (r_c^1, \cdots, r_c^k)$ where c indexes countries and k indexes regulatory dimensions. The regulatory distance across countries c and c' is $d(r_c, r_{c'}) = \sum_k d(r_c^k, r_{c'}^k)$, where

$$d(r_c^k, r_{c'}^k) = \frac{|r_c^k - r_{c'}^k|}{\max_i r_i^k - \min_i r_i^k}$$

For binary or categorical variables, the distance is 1 if the countries do not share

tively. The former was fully operational by November 2014, while the latter was fully applicable by January 2016.

[13]Although there could be time-series variation in the stringency of supervisory practices and leniency in resolution practices for non-significant institutions under the competency of national bodies since 2016, it is unclear in which direction this would bias our measurement.

the policy, and 0 otherwise. For continuous variables, the distance normalizes the difference in policies by the range across countries.

We find significant differences in banking regulations across countries. We start with aggregating all variables into a single index of policy distance for each country pair. To do so, we first compute bilateral distances for over 500 variables; and then average across variables. Given each regulatory distance lies between 0 and 1, the aggregate distance index can be interpreted as the share of policies that differ between the two countries. This interpretation is exact if all regulatory dimensions are discrete, and approximate when continuous variables are also used. Figure 3 plots the regulatory distances across all dimensions of our dataset. The average distance across country pairs in the euro area is 0.24 excluding the diagonal, with a standard deviation of 0.06.

Cross-country differences are more pronounced in bankruptcy and governance and less pronounced in DGS and microprudential policies. We next group variables into eight categories: corporate bankruptcy, DGS, entry, governance, macroprudential, microprudential, resolution, and supervision. The full mapping between individual variables and groupings is available in Appendix B, where we also plot heatmaps and tabulate summary statistics by policy group. We find the largest differences in bankruptcy and governance. Meanwhile, DGS and microprudential policies are closer across countries, consistent with the binding nature of the CRRs and the harmonization push induced by the DGSD.

Validation of Wedges We are now ready to correlate our estimated wedges with measures of policy distances and non-policy barriers using OLS:

$$\tau_{ij}^{k} = a_i + a_j + \beta \times \text{Policy Distances}_{ij} + \gamma \times \text{Non-Policy Distances}_{ij} + \upsilon_{ij}, \qquad (4)$$

where τ_{ij}^{k} is the cross-border wedge, with $k = L, R, E$, estimated in the previous section, a_i and a_j are origin and destination fixed effects and υ_{ij} is a residual.

Regulatory distances strongly correlate with the cross-border relationship wedges (Figure 4, panel a). The plot specifications control for origin and destination fixed effects and non-policy barriers emphasized in the previous literature on barriers to cross-border flows (Pellegrino et al., 2025). We find significant effects for all regulatory buckets except microprudential and bank entry policies. The largest correlations are for macroprudential, deposit insurance, and bankruptcy

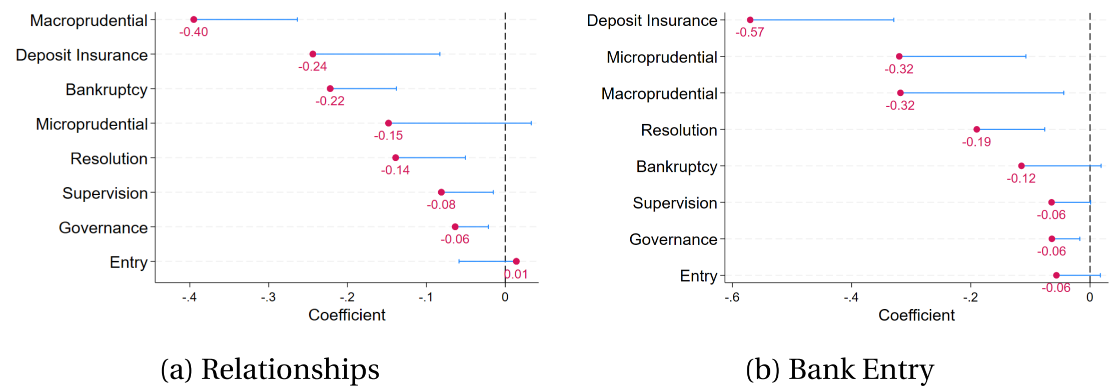


Figure 4: Correlations of Cross-Border Barriers with Policy Distances

Notes: The coefficient plots report OLS estimates for the policy variables on equation (4) with one-sided confidence bands based on heteroskedasticity-robust standard errors. Panel (a) reports the results for the relationship wedges and panel (b) reports outstanding amounts. All policy variables are jointly included in the regression. The specifications include origin and destination fixed effects and non-policy controls for Pellegrino et al. (2025) (measures of geographical, cultural, and linguistic distances; indicators for shared border, languages, or legal origin; and statutory bilateral capital tax rates). The relationship wedges are estimated from microdata with bank and firm fixed effects via OLS, as in Table 2, column 4. The bank entry wedges are estimated with banking group and destination country effects and controlling for model-implied profits via OLS, as in Table 4, column 4.

fragmentation.

Regulatory distances also strongly correlate with the cross-border bank entry wedges (Figure 4, panel b). Differences in deposit insurance schemes, microprudential and macroprudential policies, and national resolution policies have the largest correlations, all of which are significant at conventional levels. Corporate bankruptcy, domestic supervision practices and bank governance rules, and other policies regarding bank entry also correlate negatively, but are less sizable and statistically significant.[14]

The strong correlations between both relationship wedges and entry wedges with regulatory distance measures suggest that multiple policy levers could generate gains in cross-border banking integration through extensive-margin channels. By contrast, we find little evidence that frictions on loan pricing or loan quantities

[14] When correlating the estimated branching wedges with bilateral distance measures, the LPM-based estimates exploit the fact that some bilateral environments are associated with no observed entry at all. Thus, the exercise should be interpreted as asking whether policy and non-policy distances predict entry shortfalls over the full bilateral matrix. Because no-entry cells provide limited information about heterogeneity among themselves, we also assess robustness to excluding zero-entry pairs and using PPML estimates on the non-separated subset. Conditional on some cross-border bank entry, we find PPML wedge estimates are significantly correlated with regulatory distances in deposit insurance schemes and microprudential policies at the 5% level, and macroprudential policies 0.5% level. Results are available upon request.

— conditional on existing relationships — correlate with policy distances (Figure 13). This muted role of intensive margin barriers reinforces the view that harmonization gains may come primarily by spurring cross-border bank entry and relationship formation.

5 A Spatial Model of Banking

To quantify the macroeconomic gains from lifting regulatory barriers, we next build a quantitative spatial general equilibrium model of the euro area with heterogeneous banks and firms. The model incorporates frictions to bank entry, loan demand, and interest rate setting, which map directly to the wedges estimated in Section 3. We then use this model to run counterfactuals that quantify the effect of cross-border wedges on the allocation of credit and output in the euro area.

Environment. The euro area economy is populated by a set of households $\mathcal{H}$, firms $\mathcal{F}$ and banks $\mathcal{B}$. It is composed of a finite set of countries indexed by $i \in \mathcal{I}$. Each country is populated by a continuum of households $h \in \mathcal{H}_i$ and firms $f \in \mathcal{F}_i$, and a finite set of banks $b \in \mathcal{B}_i$. The set of households, firms, and banks throughout Europe can be partitioned by countries: $\mathcal{H} = \bigcup_{i\in\mathcal{I}} \mathcal{H}_i$, $\mathcal{F} = \bigcup_{i\in\mathcal{I}} \mathcal{F}_i$, and $\mathcal{B} = \bigcup_{i\in\mathcal{I}} \mathcal{B}_i$. In addition, banks are part of banking groups which are indexed by $g \in \mathcal{G}$ with $\mathcal{B}_g$ denoting the set of banks in group g. The full set of banks can likewise be partitioned across groups, $\mathcal{B} = \bigcup_{g\in\mathcal{G}} \mathcal{B}_g$. Banking groups are attached to an origin country o_g.

5.1 Households and Deposits

Preferences and Problem. Households choose consumption c_h and their labor supply n_h to maximize GHH preferences (Greenwood et al., 1988) with a unitary risk aversion parameter. This specification abstracts from wealth effects on labor supply. Households start the period with liquid wealth d_h and decide at which banks to deposit it. Each bank offers a gross deposit rate $R_b^D = 1 + r_b^D$. Household income is labor earnings $w \times n_h$, where w denotes the real hourly wage rate, plus returns on deposits $(1 + r_b^D) \times d_h$. When investing their deposits, households take into account deposit rates r_b^D and non-pecuniary costs and amenities provided by the bank ω_{bh}. The problem of household h is given by,

$$\max_{c_h, n_h, b \in \mathcal{B}} \quad \ln\left(c_h - \psi_0 \frac{n_h^{1+\psi_1}}{1+\psi_1}\right) \quad \text{s.t.} \quad c_h = (1 + r_b^D) d_h + w n_h + T \tag{5}$$

$$b^* = \text{argmax}_{b \in \mathcal{B}} \left\{ \frac{r_b^D}{\omega_{bh}^D} \right\} \tag{6}$$

where $\psi_1 > 0$ is the inverse Frisch elasticity of labor supply, $\psi_0 > 0$ is the weight on labor disutility, T is a lump-sum rebate of bank and firm profits and b^* is the household's optimal bank choice.

Demand for Deposits and Labor Supply. The optimal intratemporal decision yields the household labor supply schedule

$$n_h = \left(\frac{w}{\psi_0}\right)^{\frac{1}{\psi_1}}. \tag{7}$$

We assume that the vector $\{\omega_{bh}^D\}$ follows an Extreme Value type II distribution, and is identically and independently distributed across banks for households living in the same country i. We denote $\mathcal{A}_{bi}^D$ its location parameter, and $\sigma^D > 0$ its scale parameter. Under this distributional assumption, the probability that a household in country i chooses bank b is

$$p_{bi}^D = \frac{\mathcal{A}_{bi}^D \left(r_b^D\right)^{\sigma^D}}{\sum_{b'} \mathcal{A}_{b'i}^D \left(r_{b'}^D\right)^{\sigma^D}}. \tag{8}$$

Proof. Appendix C.1 □

5.2 Firms and the Demand for Loans

Firms are located across countries; we denote i_f the country where firm f operates. Firms choose factor inputs, select which banks to borrow from, and decide whether to default after production takes place and after observing an idiosyncratic default cost.

Technology. Production combines capital k and labor n according to

$$y = z_f k^\kappa n^\lambda \tag{9}$$

where z_f denotes firm-specific Hicks-neutral productivity. We assume diminishing returns to scale, $\kappa + \lambda < 1$, to ensure firms have an optimal finite size.

Firms finance capital expenditures with bank credit, which they obtain from potentially several banks. Denoting q the unit cost of capital goods, the total value of bank loans equals total capital spending

$$\sum_b \ell_{bf} = q k_f \tag{10}$$

Firms choose labor n, capital k and loans ℓ_{bf}, taking as given the wage w, the unit cost of capital goods q and the cost of borrowing R^L_{bf} offered by banks and which is specific to the firm-bank pair. The choice of banks and the resulting borrowing costs are described below. Firm f's profit in the absence of default ("ND") is

$$\pi^{ND}_f = y_f - w n_f - \sum_b R^L_{bf} \ell_{bf} + q(1-\delta)k \tag{11}$$

where $\delta \in (0,1)$ is the depreciation rate.[15]

Default. Ex post, firms may default on their debt, $\sum_b R^L_{bf}\ell_{bf}$. If a firm defaults, it only repays $(1-\alpha)$ of the loan value. To generate heterogeneity in the default decisions, we allow for idiosyncratic cost of default shocks ψ_f where $\psi_f \in \{0, \bar{\psi}\}$ and $\bar{\psi} > \alpha$. The cdf of the cost of default's distribution is denoted $G_f(\psi)$. Cost of default shocks are realized after production and sales. When deciding whether to default, a firm trades off savings from not repaying the bank a fraction α of the loan and the cost of default ψ. Ex post profits are given by

$$\pi^{ND}_f + (\alpha - \psi_f) \sum_b R^L_{bf} \ell_{bf} \mathbb{1}_{\text{Default}=1}. \tag{12}$$

[15] In many static models, capital is assumed to be worthless at the end of the period. In our case, we assume it can be frictionlessly converted back into consumption goods. This is just a shift in the resource constraint at the end of the period and does not affect our results.

A firm defaults if and only if $\alpha > \psi_f$. This implies that the firm defaults if and only if $\psi = 0$. In what follows, we denote the probability of default $G_f = G_f(\alpha)$.

Profit Maximization and Optimal Input Decision. When choosing the mix of inputs and loans, firms face a static profit maximization problem

$$\pi_f = \max_{n_f, k_f, \ell_f} \left\{ y_f - wn_f - \sum_b R^L_{bf} \ell_{bf} + q(1-\delta)k_f + G_f \alpha \sum_b R^L_{bf} \ell_{bf} \right\} \tag{13}$$

subject to the technological constraint (9) and the financing constraint (10). The interest rate proposed by bank b to firm f, R^L_{bf}, incorporates a credit risk premium. From the firms' perspective, the product $R^L_{bf}(1-\alpha G_f)$ can be interpreted as a risk-free equivalent cost of borrowing since the higher cost of funds implied by the credit risk premium is offset by the expected gains from default αG_f.

We next denote

$$u_{bf} \equiv q\left(R^L_{bf}(1-\alpha G_f) + \delta - 1\right) \tag{14}$$

as the bank-firm specific user cost of capital and u_f the effective user cost of capital for firm f, which we define formally below. The optimality conditions yield capital demand (15) and profits (16):

$$k_f = z_f^{\frac{1}{1-\kappa-\lambda}} \left(\frac{\kappa}{u_f}\right)^{\frac{1-\lambda}{1-\kappa-\lambda}} \left(\frac{\lambda}{w}\right)^{\frac{\lambda}{1-\kappa-\lambda}} \tag{15}$$

$$\pi_f = (1-\kappa-\lambda) z_f^{\frac{1}{1-\kappa-\lambda}} \left(\frac{\kappa}{u_f}\right)^{\frac{\kappa}{1-\kappa-\lambda}} \left(\frac{\lambda}{w}\right)^{\frac{\lambda}{1-\kappa-\lambda}} \tag{16}$$

Optimal Demand for Credit. A firm then decides on the set of banks from which to borrow. We partition the firm's capital stock into P equally-sized pieces or projects, and we assume that each piece is funded through a loan, which gives $\ell_{bf} = \ell_f / P$ for all b, where $\ell_f = qk_f$ is the total amount of loans by firm f. Each bank offers a gross interest rate R^L_{bf}. In addition, a bank offers services that are specific to the bank-firm-project pair, ω^L_{bfp}, and that decrease its effective user cost. For example, some banks may specialize in certain sectors (Paravisini et al., 2023) and monitoring or screening costs are specific to lenders and projects (Townsend, 1979).

For each project $p = 1, \ldots, P$, the firm chooses the bank that maximizes profits, or equivalently the bank that provides the lowest user cost of capital:

$$\min_{b \in \mathcal{B}} \left\{ \frac{u_{bf}}{\omega^L_{bfp}} \right\}. \tag{17}$$

We assume that shocks $\{\omega_{bfp}\}$ are independently drawn from a Fréchet distribution with bank-firm specific location parameters $\mathcal{A}^L_{bf}$ and common scale parameter σ^L. The probability that firm f borrows from bank b is then

$$p^L_{bf} = \frac{\mathcal{A}^L_{bf} \left(u_{bf}\right)^{-\sigma^L}}{\sum_{b'} \mathcal{A}^L_{b'f} \left(u_{b'f}\right)^{-\sigma^L}}. \tag{18}$$

Letting $P \to +\infty$, we can define the composite user cost for firm f:

$$u_f = \Gamma\left(1 + \frac{1}{\sigma^L}\right) \left(\sum_{b \in \mathcal{B}} \mathcal{A}^L_{bf} \left(u_{bf}\right)^{-\sigma^L} \right)^{-1/\sigma^L} \tag{19}$$

where $\Gamma(.)$ is the gamma function.

Cross-border Relationship Wedges. The shifter $\mathcal{A}^L_{bf}$ captures all perceived amenities and frictions firm f faces when borrowing from bank b beyond differentials in interest rates. When firms borrow cross-border, they face additional barriers. We define the cross-border relationship wedge $\tau^L(i_f, i_b)$ as implicit taxes that banks and firms face when located in different jurisdictions:

$$\mathcal{A}^L_{bf} = (1 - \tau^L(i_f, i_b))\tilde{\mathcal{A}}^L_{bf} \tag{20}$$

where $\tau^L(i_f, i_b)$ depends on the country where the firm and the bank are located and $\tilde{\mathcal{A}}^L_{bf}$ is a residual term. Section 3 estimated these wedges and Section 4 correlated them with measures of regulatory distances.

5.3 Banks, Interest Rates and Branching Decisions

Each bank belongs to a banking group, which we index by $g \in \mathcal{G}$. We denote g_b the group to which bank b belongs and $\mathcal{B}_g$ the set of banks in group g. Groups encompass different ownership and legal structures, such as branches and subsidiaries, and result from various histories, from the direct opening of new establishments abroad to mergers with and acquisitions of existing foreign institutions. We denote o_g the country of origin of group g.

The timing of the banking groups' and banks' decisions is as follows. First, the group decides the set of countries in which to establish branches. Then each bank sets the gross rate on its deposits R_b^D and on the gross rates on loans R_{bf}^L taking the location of other banks and their pricing decisions as given.

Technology Banks intermediate funds between firms and households. Aggregating across households and firms, the demand for loans and deposits at bank b are respectively given by

$$L_b = \int_f \ell_{bf} df \tag{21}$$

$$D_b = \int_h d_h \times p_{bh}^D dh. \tag{22}$$

Banks can access a wholesale market to raise additional funds W_b, or to invest excess liquidity $(-W_b)$. The balance sheet accounting identity relates wholesale funding to deposits and loans for each bank:

$$L_b \equiv W_b + D_b. \tag{23}$$

All banks take as given the wholesale gross interest rate R_W.

Payoffs. Denote $\mathbb{1}_f$ the indicator function equal to 1 if firm f repays fully. The payoff of bank b at the end of the period is

$$\pi_b^B = \int \frac{R_{bf}^L}{\mathcal{A}_{bf}^R} \times (\mathbb{1}_f + (1-\alpha)(1-\mathbb{1}_f)) \times \ell_{bf} df - \int R_b^D \times d_h \times p_{bh}^D dh - R_W W_b$$

where $\mathcal{A}_{bf}^R$ captures additional costs banks face when lending to firms beyond the marginal cost of funds R_W and the risk of default G_f. We assume that banks can perfectly price-discriminate ex post based on realized shifters $\mathcal{A}_{bf}^R$ and default probabilities G_f, so the interest rate offered by bank b to firm f is

$$R_{bf}^L = R_b^L \times \frac{\mathcal{A}_{bf}^R}{1-\alpha G_f} \tag{24}$$

where R_b^L is the base rate.

Proof. Appendix C.3 □

Expected profits are then

$$\pi_b^B = \max_{R_b^L, R_b^D} \int R_b^L \times \ell_{bf} df - \int R_b^D \times d_h \times p_{bh}^D dh - R_W W_b \tag{25}$$

Optimal Interest Rate. At the optimum, banks set the deposit rate to a markdown applied to the marginal cost of funds R_W, where the markdown depends on the elasticity of households' deposit supply $\varepsilon_{D/R_b^D} > 0$. Lending rates are set as a markup over marginal cost, where the markup depends on the elasticity of firms' loan demand $\varepsilon_{L/R_b^L} < 0$:

$$R_b^L = \frac{1}{1 + \varepsilon_{L/R_b^L}^{-1}} R^W \tag{26}$$

$$R_b^D = \frac{1}{1 + \varepsilon_{D/R_b^D}^{-1}} R^W \tag{27}$$

Proof. Appendix C.2 □

Our model features variable mark-ups and mark-downs. Given optimal rates, the firm-bank-specific loan rate is given by (24) and total bank profits are

$$\pi_{bi}^B = R^W \left(\frac{1}{-1 - \varepsilon_{L/R_b^L}} L_b + \frac{1}{1 + \varepsilon_{D/R_b^D}} D_b \right) \tag{28}$$

Cross-border Interest Rate Wedge. We define the interest rate cross-border wedge $\tau^R(i_f, i_b)$ and decompose the shifters $\mathcal{A}_{bf}^R$ into this wedge and a residual $\tilde{\mathcal{A}}_{bf}^R$:

$$\mathcal{A}_{bf}^R = (1 + \tau^R(i_f, i_b)) \tilde{\mathcal{A}}_{bf}^R. \tag{29}$$

The interest rate wedges capture policy and non-policy barriers. Policy barriers may arise from country differences in prudential buffers, deposit insurance funding schemes, corporate bankruptcy laws, which create differences in the marginal costs or expected profits banks face when lending to firms in foreign jurisdictions.[16] Non-policy barriers include geographic, language and cultural barriers which increase the cost for banks to lend to and monitor firms in foreign jurisdictions.

Branching Decision and Cross-border Branching Wedge. A banking group g located in origin country o decides whether and where to branch out. A group enters if the groups' additional profits from doing so exceed the entry cost κ^E_{gi}, which depends on the destination country i and the banking group g. Denote $\pi^B_{gi} = \pi^B_b$ the profit of the bank belonging to group g operating in country i, i.e. for $b = \mathcal{B}_g \cap \mathcal{B}_i$, the groups' total profits across destinations are

$$\sum_{i \in \mathcal{I}} \left(\pi^B_{gi} - \kappa^E_{gi}\right) \times \mathbb{1}_{gi}. \tag{30}$$

where $\mathbb{1}_{gi}$ indicates if the group operates in destination country i.

Entry costs capture both regulatory and non-regulatory barriers to cross-border banking. Regulatory barriers include differences in licensing requirements, governance rules, supervisory practices, and resolution regimes. Non-regulatory barriers include geographic distance, language differences, and informational frictions. We assume that entry costs are additively separable between four terms:

$$\kappa^E_{gi} = \tau^E(i, o_g) + \nu_i + \mu_g + \varepsilon^E_{gi}. \tag{31}$$

where $\tau^E(i, o_g)$ is the branching wedge which captures policy and non-policy differences across country-pairs, ν_i is a destination-specific component and μ_g is the group-specific component of the fixed cost.

We assume that ε^E_{gi} is independently distributed across group-destination pairs according to a uniform distribution and that entering a destination country leaves the profits of branches located in other countries and in the origin country unchanged. Under these two assumptions, the probability of entry is linear in ex-

[16] Since the euro crisis, bank spreads became tightly linked to sovereign spreads due to the bank-sovereign nexus (Acharya et al., 2014). The ensuing market segmentation has been partly attributed to a lack of regulatory harmonization, such as a common fiscal backing for a European deposit insurance scheme. To the extent the bank-sovereign nexus is driven by the lack of regulatory convergence on this front, differences in funding costs across countries can be mapped into the wedge τ^R.

pected profits and bilateral barriers, which provides a structural foundation for the linear probability specification estimated in Section 3:

$$P(\mathbf{1}_{gi} = 1) \;=\; F_{\varepsilon}\big(\pi_{gi}^{B} - \tau^{E}(i, o_g) - \nu_i - \mu_g\big)\,, \tag{32}$$

where F_ε is the CDF of ε_{gi}^{E}.

The assumption that entry decisions are independent across destinations may seem strong, but is supported by the data. In principle, opening new branches could cannibalize existing ones. Independence would hold exactly when cross-border barriers are prohibitively large — so that branches do not compete with each other — or when individual banks are atomistic. In Section 6 we use the calibrated model to provide quantitative evidence that this assumption is approximately satisfied. This result reflects the strong home bias of banking relationships and the large number of banks operating in each country, implying that a single bank remains small relative to the national market.

5.4 Market Clearing and Equilibrium

Capital Producers. A set of competitive firms produce capital goods using final goods with linear technology $k = a_k y$, where $a_k > 0$ is the productivity parameter. Linear technology and perfect competition pin down the equilibrium price of capital goods $q = a_k^{-1}$.

Large Open Economy. The euro area is a large open economy with respect to the rest of the world. Following Schmitt-Grohe and Uribe (2003), we model the wholesale interest rate faced by banks R^W as a function of the aggregate level of net borrowing from the rest of the world $B = \int W_b db / \int D_b db$:

$$\ln R^{W} = \ln R^{*} + \chi_1 \ln(1 + B) + \ln \chi_0 \tag{33}$$

where R^* is the world risk-free rate and $\chi_0, \chi_1 > 0$ are the intercept and the slope of the interest rate function.

Market Clearing. Labor market clearing is given by

$$\int_f n_f df = \int_h n_h dh. \tag{34}$$

The $2\times\mathcal{B}$ loan and deposit markets clear according to (21) and (22), respectively. The wholesale funding market clears according to Equation (33). By Walras' Law, the final goods market clears

$$\int_f y_f + \frac{(1-\delta)k_f}{a_k} df = \int_h c_h dh + \int_g \int_i \kappa_{gi}^E \mathbb{1}_{gi} dg di. \tag{35}$$

Equilibrium Definition. An equilibrium is a set of household policy rules (n_h, b_h), firms' policy rules $(n_f, k_f, \{p_{bf}\}_b, \mathbb{1}_{f\text{Default}})$, and banks' policy rules $\left(R_b^L, R_b^D\right)$ and banking groups' branching decisions $(\mathbb{1}_{gi})$ and prices (w, R^W) such that (i) given the wage rate and the set of deposit rates, households maximize their utility (5), (ii) given the wage rate and the set of loan rates, firms maximize their profits given by (13), (iii) given the wholesale funds rate banks set their rates to maximize their profits (25) and banking groups make their branching decisions to maximize profits, and (iv) all markets clear.

6 The Macroeconomic Gains from Lifting Barriers

We now calibrate the model introduced in the previous section to the euro area and use it to quantify the general equilibrium effects of partially lifting the cross-border barriers to banking estimated in Sections 3 and 4. The calibrated model predicts sizable and heterogeneous output gains across euro area countries. These gains are primarily driven by increases in capital and labor rather than improvements in allocative efficiency.

6.1 Calibration

The calibration strategy combines external calibration of a small set of parameters with internal estimation of firm fundamentals, bank-firm shifters and group-destination fixed costs. The model matches important moments of the micro-data, including the distribution of output, default risks and capital intensity on the firm side, as well bank-level loan portfolios and pricing, bank deposits and banking groups' branching propensities on the bank side.

6.1.1 External Calibration

We begin by calibrating a subset of parameters externally. Table 5 summarizes the externally calibrated parameters. For the output elasticities with respect to labor and capital, we follow Ottonello and Winberry (2024) and set the former to $\lambda = 0.64$, which is also consistent with the labor share in the European Union, and the latter to $\kappa = 0.21$, which implies that the total returns to scale are 0.85. The depreciation rate is fixed at the conventional value of $\delta = 0.05$. Labor supply is governed by a Frisch elasticity parameter, which is set to $\psi_1 = 2.5$, within the range used in the literature (Keane and Rogerson, 2012; Mui and Schoefer, 2025). Finally, the parameter α is set to 4% to match the median estimated loss given default in the euro area (Georgescu et al., 2024).

We set the elasticity of substitution across lenders (σ_L) to one, based on Altavilla et al. (2022), who estimate elasticities to gross interest rates in the range of 7 to 22. Using the median user cost in the data of 0.08 and the formula relating the elasticity to the gross interest rate and to the user cost $\epsilon_{\text{R}} = \epsilon_{\text{u}} \times \frac{u}{u+1-\delta}$, we obtain a range of 0.4 to 1.3. We use the midpoint value of 1. Finally, the elasticity of substitution of deposits to interest rate is also set to 1, within the range of values estimated in the banking literature (Tanner et al., 2021).

Table 5: Externally Calibrated Parameters

Parameter	Description	Value
κ, λ	Production elasticities	(0.22,0.64)
δ	Depreciation rate	0.05
R^*	Baseline real interest rate	1.02
σ_L	Substitution across lenders	1
σ_D	Substitution across deposit providers	1
ψ_1	Frisch elasticity parameter	2.5
α	Loss given default parameter	0.04
χ_1	Net borrowing cost elasticity	0.01

We set the elasticity of the interest rate faced by banks in Equation (33) to 0.01, which is small but higher than the value used in Schmitt-Grohe and Uribe (2003) since the euro area is not a small open economy. This corresponds to an increase of the wholesale rate by 10 basis points for a 10% of total deposits additional lending ($\chi_1 \simeq \frac{\Delta R^W}{R^* \Delta B} = \frac{.001}{1.02 \times .10} \simeq .01$).

6.1.2 Internal Calibration and Estimation

The remaining parameters are estimated by inverting the model and matching micro-level moments.

Firm Fundamentals (z_f, G_f). We start with firm-level measures of output (y_f), capital (k_f) and default risk (G_f) using balance sheet information available in AnaCredit.[17] Given the production function and externally calibrated elasticities, we recover firm-level productivity by inverting the firm's optimal capital demand condition, $Cz_f = k_f^{-\kappa} (\kappa y_f)^{1-\lambda}$, which is identified up to a constant $C = \kappa^{\lambda-1} \left(\frac{w}{\lambda}\right)^{\lambda}$.

To reduce the dimension of the dataset, we partition firms into bins based on deciles of productivity and default risk in each country i. We denote $\mathcal{F}_i(n_z, n_G)$ the set of firms with the n_zth element of the productivity grid and n_Gth element of the default probability grid in country i. Within each bin, we construct a representative firm by taking geometric averages of firm-level variables $X = z, k, y, u, G$:

$$X_{\mathcal{F}_i(n_z,n_G)} = \exp\left(\sum_{f \in \mathcal{F}_i(n_z,n_G)} g_f \ln X_f\right) \quad \text{with} \quad g_f = \frac{\sum_b \ell_{bf}}{\sum_{f \in \mathcal{F}_i(n_z,n_G)} \sum_b \ell_{bf}}$$

This aggregation preserves consistency with firms' optimality conditions and limits the influence of outliers. We also aggregate the bank-firm-specific costs of funding R_{bf}, which we use to compute the bank-firm user costs u_{bf} .

Loan Demand and Bank Pricing Shifters $\left(\mathcal{A}^L_{b\mathcal{F}_i(n_z,n_G)}, \mathcal{A}^R_{b\mathcal{F}_i(n_z,n_G)}\right)$. We then compute average loan shares, $p^L_{b\mathcal{F}_i(n_z,n_G)} = \sum_{f \in \mathcal{F}_i(n_z,n_G)} g_f p_{bf}$. These moments are used to recover bilateral loan demand shifters by inverting the equation for loan de-

[17] When missing, default risk is imputed using observable firm characteristics (output and asset).

mand (18):

$$\mathcal{A}^L_{b\mathcal{F}_i(n_z,n_G)} = p^L_{\mathcal{F}_i(n_z,n_G)} \left(\frac{u_{b\mathcal{F}_i(n_z,n_G)}}{u_{\mathcal{F}_i(n_z,n_G)}} \right)^{\sigma_L} \tag{36}$$

Given these demand shifters, we compute bank-level elasticities of loan demand with respect to interest rates by aggregating across bins using the expression (C.37). We then use observed interest rates together with the model's optimal pricing condition to recover bank-specific pricing shifters

$$\mathcal{A}^R_{b\mathcal{F}_i(n_z,n_G)} = \frac{1+\varepsilon^{-1}_{L/R^L_b}}{R_W} R^L_{b\mathcal{F}_i(n_z,n_G)} (1-\alpha G_{\mathcal{F}_i(n_z,n_G)}) \tag{37}$$

This procedure ensures that the model jointly matches observed loan shares and the cross-sectional dispersion in lending rates.

Deposits Shifters $\left(\mathcal{A}^D_b\right)$**.** On the funding side, we construct bank-level deposits using balance sheet data and ensure consistency with country-level aggregates. Given the elasticity of substitution across deposit providers, observed deposit shares are used to recover bank-specific deposit shifters. These shifters rationalize the cross-sectional distribution of deposits across banks within each country.

Labor Supply (ψ_0) **and Capital Inflows** (χ_0)**.** Given the Frisch elasticity parameter, we calibrate the labor supply preference parameter (ψ_0) so that aggregate labor supply given by Equation (7) equals aggregate labor demand from firms in the baseline equilibrium at the wage defined above,

$$\psi_0 = w \times \left(\int n_f df \right)^{-\psi_1}. \tag{38}$$

We set the intercept of the interest rate schedule to $\ln \chi_0 = \chi \ln \left(\int D_b db / \int L^*_b db \right)$ where $\int L^*_b$ is the total level of lending, so that $R^W = R^*$ in the baseline steady state of the economy.

Branching Wedges and Entry Costs $(\tau^E_{io_g})$**.** We estimate origin- and destination-specific fixed costs of bank entry using observed branching patterns. We assume that the branching wedge depends on observable bilateral characteristics:

$$\tau^E_{io_g} = X'_{o(g)i}\gamma, \tag{39}$$

where $X_{o(g)i}$ includes measures of regulatory distance, geographic distance, language similarity, and other bilateral frictions. We then replace the branching wedge τ^E in Equation (32) which we estimate using a linear probability model, where μ_g captures unobserved group-level heterogeneity, and ν_i captures unobserved destination-level heterogeneity.

6.2 Counterfactual Analysis with Fixed Bank Network

We now use the calibrated model to quantify the aggregate impacts of barriers in general equilibrium in the euro area. Our main exercise considers a counterfactual reduction in cross-border relationship wedges (τ^L) across all pairs by 10%, which is equivalent to a 10% increase in $\mathcal{A}^L_{bf}$ when a firm f and a bank b are not in the same country. This counterfactual holds the network of branches and subsidiaries of banking groups fixed.

Aggregate Output Gains. A 10% reduction in cross-border barriers generates a 1.6% increase in euro area GDP. To understand the sources of this gain, we decompose aggregate output growth into contributions from capital, labor, and total factor productivity.

The vast majority of the gains—96%—are driven by increases in factor inputs rather than improvements in allocative efficiency. Capital increases by 2.4% and labor by 1.6% (see Table 6, and Appendix Figure D.1). The mechanism is as follows: lower cross-border frictions broaden firms' access to foreign financial intermediaries, which raises the foreign share of bank credit in the euro area by 1.2 percentage points (Figure 5b). This in turn decreases the firms' effective user costs (u_f), incentivizing them to scale up their capital investment (K), as well as labor (L) due to technological complementarities.

TFP rises by less than 0.1%, accounting for only 3.8% of the total GDP gain. In principle, reducing cross-border barriers could improve credit allocation by directing capital toward firms with the highest marginal product, thereby raising aggregate TFP. Formally, near an efficient allocation, output decreases in the weighted dispersion of user costs around the efficient level u^*:

$$Y \;\approx\; Y^* \;-\; \frac{\rho\, K}{\kappa\, u^*}\; \mathrm{Var}_{w^*}(u_f).$$

In practice, however, the reforms generate only modest reallocation. We investigate this point further below.

Table 6: Aggregate effects of a 10% reduction in cross-border barriers

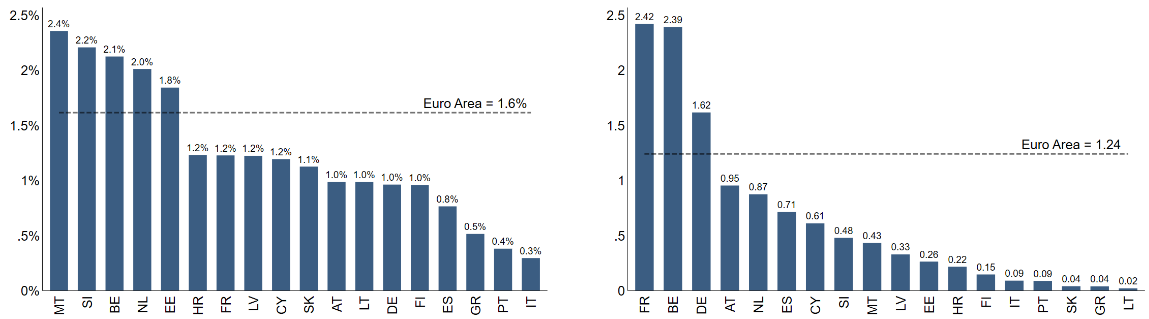
	Y	K	N	TFP	Var(Y/N)
$\Delta \log$ (*100)	$+1.61$	$+2.36$	$+1.61$	$+0.06$	-2.71
Contribution (%)	100	32.2	64.0	3.8	—

Heterogeneous Gains and Weak Convergence. The modest TFP gains are closely related to the absence of convergence in marginal products of capital across countries. Appendix Figure D.4a shows that following further financial integration, countries with initially higher user costs do not experience a greater decline in their average cost of capital. Perhaps surprisingly, no clear convergence across countries is happening in our counterfactual.

Similarly output gains across countries are uneven and unrelated to initial level of output per capita (Figure 5a). While smaller and poorer countries like Malta, Slovenia and Estonia gain more than the average country, financial centers like the Netherlands, Luxembourg, Ireland and to some extent Belgium, which are among the richest countries in the euro area, show the greatest gains. Spain, Greece, Portugal and Italy gain the least. While we fail to find substantial improvement in capital allocation, inequality across countries decrease overall, as indicated by the 2.7% reduction in the variance of output per hours worked Y/L.

Country size and the initial exposure to bank credit from the rest of the euro seems plays a bigger role in explaining our results. Indeed the heterogeneity we uncover across countries reflects that smaller economies see greater increases in cross-border flows from their larger neighbors.

The modest TFP gains also reflect an absence of convergence within countries across firms. Appendix Figure D.4b shows that the variance of log user costs across firms increases in almost all countries, running counter to the prior that banking integration should equalize marginal products of capital across firms. This result arises because firms are unequally exposed to the reform: those that benefit most are those that already enjoy better access to finance and, consequently, already face a lower marginal product of capital. This finding suggests that cross-border integration reforms may not reach the firms that need them most.



(a) Output Gains from Banking Integration

(b) Increase in Foreign Share

Figure 5: Financial and Real Effects of Banking Integration

Notes: The figure reports the general equilibrium effects of a 10% reduction in cross-border relationship wedges (τ^L) across all country pairs. Panel (a) shows the implied percent change in output (GDP) for each euro area country, relative to the baseline calibration. The dashed line marks the euro-area aggregate gain of 1.6%. Panel (b) shows the change in each country's foreign borrowing share (the fraction of credit supplied by foreign banks) expressed in percentage points. Ireland and Luxembourg are omitted for visualization, and show the largest gains of about 8-12% in output. The dashed line marks the euro-area average increase of 1.24 percentage points.

6.3 Counterfactuals with Endogenous Bank Network

Fundamentals of Unobserved Branches. With endogenous bank networks, we need to construct fundamentals for banks that are not observed in the baseline equilibrium. Consider a banking group g with origin country o_g and let $\mathcal{I}_g$ denote the set of countries in which the group operates in the data. For a counterfactual branch of group g in destination country $i \notin \mathcal{I}_g$, we impute the unobserved loan-demand and pricing shifters for each firm bin $\mathcal{F}_j(n_z, n_G)$ by taking the average of the the group fundamentals in its origin country and the fundamentals of banks already operating in country i. Specifically, for $X \in \{L, R\}$, we set

$$\mathcal{A}^X_{gi,\mathcal{F}_j(n_z,n_G)} = \left(\mathcal{A}^X_{go_g,\mathcal{F}_j(n_z,n_G)} \, \overline{\mathcal{A}}^X_{i,\mathcal{F}_j(n_z,n_G)} \right)^{1/2}, \tag{40}$$

where $\mathcal{A}^X_{go_g,\mathcal{F}_j(n_z,n_G)}$ is the shifter of group g in its origin country, and $\overline{\mathcal{A}}^X_{i,\mathcal{F}_j(n_z,n_G)}$ is the average shifter among banks operating in destination country i for firms in bin $\mathcal{F}_j(n_z,n_G)$. We compute the latter as the geometric average

$$\overline{\mathcal{A}}^X_{i,\mathcal{F}_j(n_z,n_G)} = \exp\left[\frac{1}{|\mathcal{B}_i|}\sum_{b\in\mathcal{B}_i}\log \mathcal{A}^X_{b,\mathcal{F}_j(n_z,n_G)}\right]. \tag{41}$$

This imputation allows counterfactual branches to inherit group-specific comparative advantages while also reflecting destination-specific operating conditions.

Cannibalization Test. Before turning to the full endogenous-network counterfactuals, we assess whether the entry decisions of banking groups across destinations can be treated as approximately independent, as assumed in the empirical approach (3) and in the structural model (32). The concern is that when a group opens a new foreign bank, this bank may partly cannibalize the loan and deposit business of the group's existing banks, so that the profitability of entry in one destination depends on the group's full network.

To quantify the degree of cannibalization, we use the calibrated model to compute, for each banking group g, the profits of its existing banks under two network configurations. First, we compute baseline group profits, $\pi_g(\mathcal{I}_g)$, using the observed set of countries in which the group operates. Second, we construct a counterfactual in which the group completes its euro-area network by opening banks in every country where it is absent, assigning fundamentals to these unobserved banks using (40). By expanding simultaneously into all missing destinations, this exercise should provide an upper bound on within-group cannibalization.

For all banking groups, we find that within-group cannibalization is negligible. Appendix Figure D.5 plots the change in the sum of profits of the group's pre-existing branches, excluding profits earned by the newly created branches. The very small changes in these profits indicate limited within-group cannibalization and support the assumption that branching choices can be modeled as independent across destinations.

7 Conclusion

This paper studies barriers to cross-border bank lending to firms in the euro area and their implications for credit allocation and aggregate output. Using granular credit registry data, we develop a microeconometric framework to estimate cross-border wedges in relationship formation, loan pricing, and bank entry, and embed these estimates in a quantitative general equilibrium model.

Empirically, barriers to cross-border bank entry and to cross-border lending relationships are the dominant friction, far exceeding distortions in interest rates or loan quantities conditional on existing relationships. We further show that these extensive-margin barriers are strongly associated with differences in national regulatory frameworks, based on a novel dataset of policy distances across euro area countries. Together, these findings point to regulatory fragmentation as a key impediment to financial integration.

By combining micro-level identification with a structural model, the paper finds that reducing regulatory barriers and advancing the European Banking Union could generate meaningful aggregate gains for the euro area, though with considerable heterogeneity across member states. Importantly, the first-order gains arise not from improved credit allocation across firms or intensified competition, but from broader access to foreign financial intermediaries and the resulting economy-wide decline in firms' effective cost of capital.

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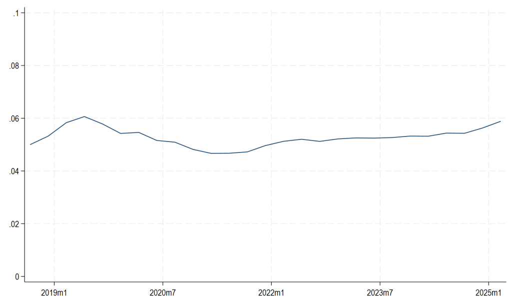
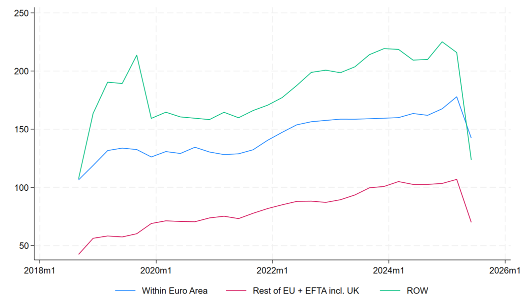
A Empirical Appendix

This appendix collects additional details and results on the measurement and econometric strategies.

A.1 Additional Measurement: Operational Geography



(a) Cross-Border Lending Share



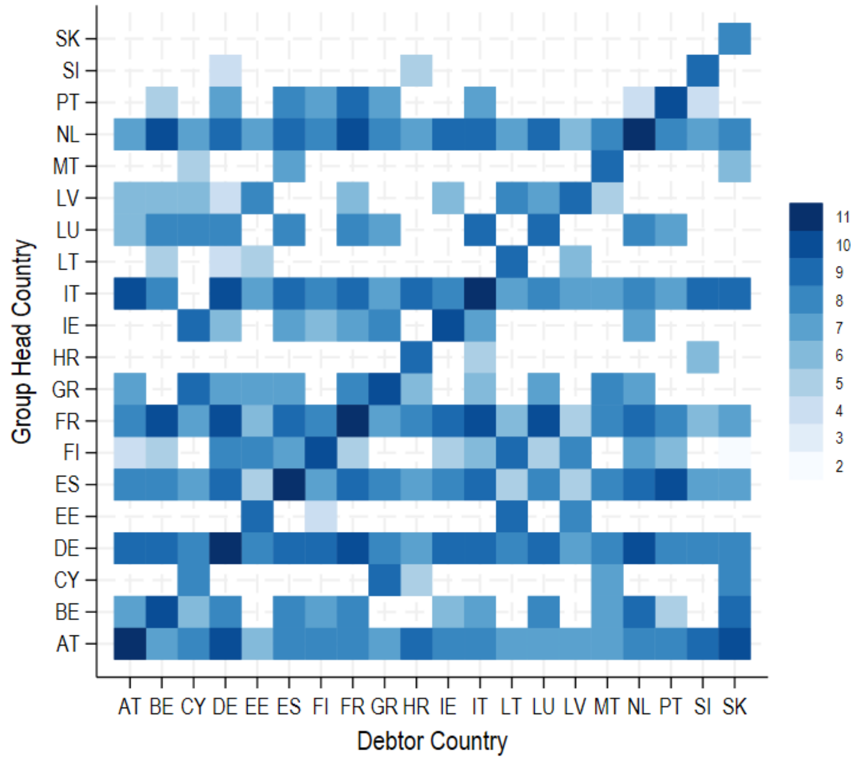
(b) Cross-Border Lending in Billions

Figure 6: Cross-Border Lending Patterns by Operational Geography

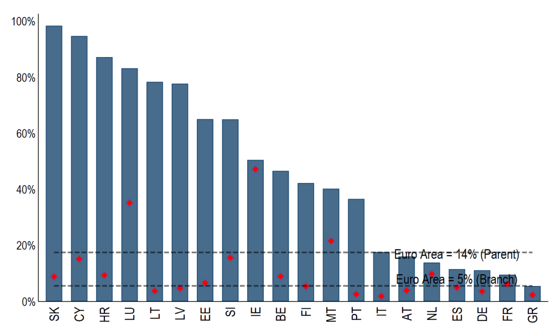
A.2 Remapping Banking Flows with Group Structures

Fact 1 of the main text described cross-border positions based on an operational geography concept of cross-border relationships. We argued that such a concept was most appropriate given the local nature of lending technologies. An alternative approach is to describe cross-border positions in terms of the nationality of the ultimate owners of bank branches. For such, we use the group structure described in B and used to demonstrate Fact 2 (limited cross-border branching). In the spirit of Beck et al. (2024), we remap banking claims based on this nationality concept. Figure 7 shows the results.

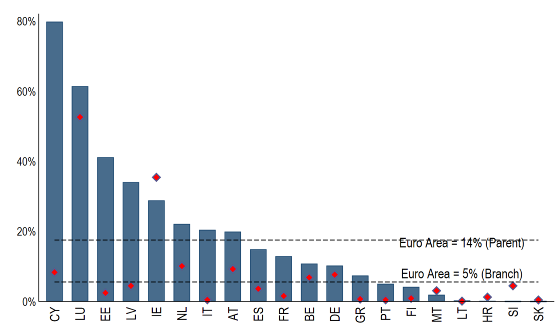
The remapping tends to increase the degree of banking integration, especially for smaller economies. The cross-border share of lending rises from 5% to 14%. Two noteworthy patterns emerge from the restated matrix of bilateral positions. First, the diagonal remains overwhelmingly larger than the off-diagonal terms, confirming that the strong domestic concentration of banking portfolios remains. In other words, nationality-based accounting does not suffice to overturn the



(a) Bilateral positions (Log 10) - Group Structure



(b) Cross-Border Loan Shares by Debtor Country



(c) Cross-Border Loan Shares by Creditor Country

Figure 7: Geography of Cross-Border Lending in the EA - Group Structure

Notes: Panel (a) plots bilateral cross-border lending positions on a log-10 scale, aggregated at the banking group level. Panel (b) shows the share of cross-border loans as a fraction of total lending received, by debtor country. Panel (c) shows the share of cross-border loans as a fraction of total lending extended, by creditor country. All panels are constructed using the group-structure definition of cross-border lending described in subsection B.2.

strong home bias documented in the main text. Second, the matrix of bilateral positions becomes sparser. For example, Slovakia lends to most euro area countries in 1, but does not lend to any other country but itself in the restated matrix. Most bank branches geographically located in Slovakia that appeared as cross-border lenders before turned out to be owned by parent banking groups domiciled outside of Slovakia. This pattern is not unique to Slovakia: many other smaller countries no longer lend abroad to as many destinations, reflecting foreign ownership by larger banking groups. This pattern is then reflected in the cross-border loan shares as debtors. Most such countries now borrow over 50% from foreign banking groups.

Larger economies remain domestically concentrated after the remapping. Countries such as France, Germany, and Spain remain below the euro area average. Among the EA4, only Italy stands out as showcasing cross-border shares around 20%, a sizable increase relative to the geography-based definition (red dots). The effects also differ across debtor vs creditor positions. The larger economies showcase a large increase in their cross-border share as lenders, but little movement in their cross-border share as borrowers. This reflects that the largest banking groups are originally from and domiciled at these largest economies.

Restating bilateral positions based on nationality rather than residency does not overturn the large degree of domestic concentration and the low degree of cross-border branching we documented in the main text. However, it does highlight that the actions of large banking groups can reshape the geography of capital flows, so that frictions to cross-border branching can play a large role in constraining the banking union.

A.3 Cross-Border Entry: Branches versus Subsidiaries

In the main text, we use "bank entry" to refer to any foreign establishment of a banking group. In this appendix, we split cross-border bank entry into foreign branches and foreign subsidiaries. Both represent foreign group entry into a host market, but branches and subsidiaries differ in legal personality, licensing, supervision, prudential treatment, resolution, and deposit protection.

The foundational distinction is legal: a branch is part of the parent bank, while a subsidiary is a host-country legal entity. Branching often leverages EU passporting rules, by which authorization in a single country allows a multinational bank to more easily expand abroad. Subsidiaries, on the other end, must obtain the banking license directly from the national regulator and the ECB.

Economically, there are three key differences. First, subsidiaries place deposit protection and much of resolution planning at the hands of the host state (or the SRM if the subsidiary is sufficiently large); whereas branch deposits remain protected by the home DGS, with the host DGS ordinarily acting as payout agent. Second, subsidiaries give the host state more direct control over governance, reporting, resolvability, and supervision. Third, subsidiaries lock more resources into the host country, as capital and liquidity requirements are binding at the subsidiary-level (subject to waivers); meanwhile, branches do not face individual capital or liquidity requirements and preserve group-wide balance-sheet mobility.

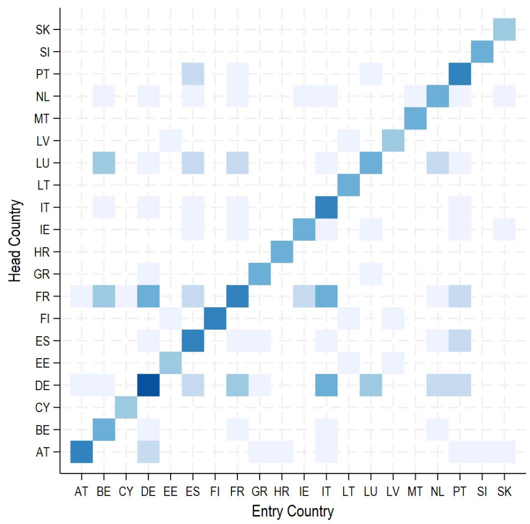
The pooled patterns documented in Figure 2 continue to hold once we split entry via branches and subsidiaries (Figure 8). There is cross-country heterogeneity in the choice of organizational structure. Banking groups from Austria, France, Germany, Luxembourg and the Netherlands primarily expand through branching. Banking groups from Belgium and Spain display enter across both legal structures evenly. Last, banking groups from Italy tend to favor subsidiaries.

In the main text, we have focused on barriers to any form of cross-border entry. The empirical decomposition in this appendix does not invalidate our pooled estimates of entry wedges. Rather, it clarifies their interpretation. The estimated entry wedge should be read as an average over the legal forms through which groups actually enter. A richer model could add a second-stage organizational choice in which a group first decides whether to enter host market, then chooses branch versus subsidiary conditional on entry. Understanding how regulatory differences shape entry mode and implications for credit and real activity in the euro area is a fruitful avenue for future research.

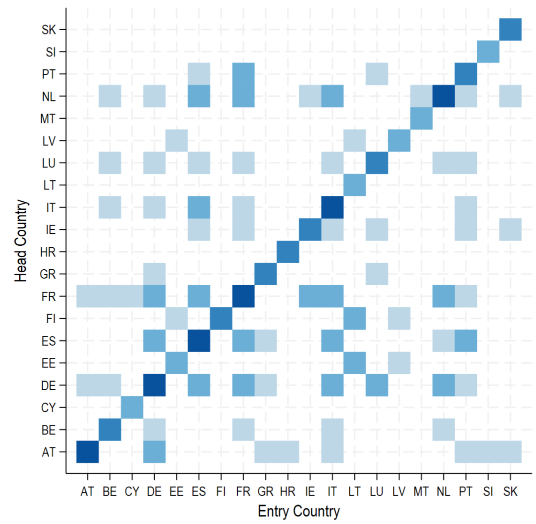
A.4 Sampling

A.4.1 Interest Rate Regressions

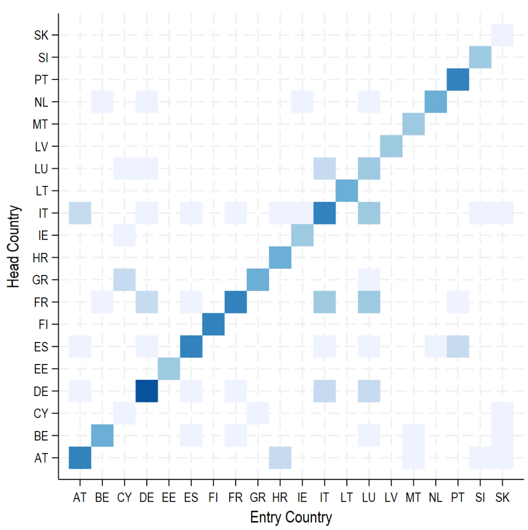
The interest rate regressions condition on the existence of an active lending relationships. Even after restricting attention to positive relationships, however, the underlying firm-bank panel remains too large to estimate on the full universe. We



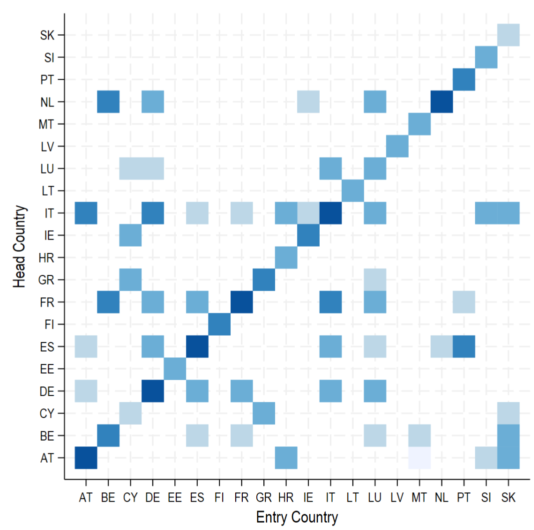
(a) Number of Branches



(b) Branches' ONA



(c) Number of Subsidiaries



(d) Subsidiaries' ONA

Figure 8: Cross-Border Entry Patterns

Notes: Panel (a) reports the number of branches and panel (b) reports outstanding amounts of branches. Panel (c) reports the number of subsidiaries and panel (d) reports outstanding nominal amounts of subsidiaries. See 2 for the combined entry patterns. Values are shown by country of the group head (rows) by country of entry (columns). The diagonal corresponds to domestic positions, and includes (i) entry of group head into its origin country (by definition), and (ii) standalone banks that do not have cross-border operations or are not owned by any major banking groups. For disclosure purposes, numbers are omitted. Empty cells correspond to zero. For panels (a) and (c), the color cutoffs correspond to $(< 5, < 10, < 50, < 100, < 500, \geq 500)$ branches or subsidiaries. For panels (b) and (d), color cutoffs correspond to $(< 1000, < 1\text{mn}, < 1\text{bn}, < 10\text{bn}, < 100\text{bn})$ EUR.

therefore implement a sampling design that operates at the firm-bank dyad level and then expands the sample along the time and firm dimensions.

Step 1: seed sampling of positive dyads. Let $\mathcal{D}_{bc}^{+}$ denote the set of firm-bank dyads with at least one positive lending observation and with bank-country i_b and firm-country i_f. For each country pair where bank and firm are not in the same country ($i_b \neq i_f$) we sample the universe of relationships. For each domestic country-pair ($i_b = i_f$) we draw a 5% simple random sample of bank-firm pairs (b, f) without replacement of dyads from $\mathcal{D}_{bc}^{+}$. For some smaller countries, in addition to sampling the universe of cross-border relationships, we also sample the universe of domestic relationships to increase the statistical efficiency of our estimates.

Step 2: time expansion. For every sampled dyad (b, f), we recover the full time series of that relationship. That is, once a dyad is selected, all periods t for which the dyad is observed in the underlying panel are retained. This step is deterministic and therefore does not introduce additional sampling uncertainty at the time dimension. The effective sampling unit is thus the firm-bank relationship rather than the firm-bank-time observation.

Step 3: firm-level snowballing. To preserve the within-firm comparisons needed to identify country-pair wedges net of firm heterogeneity, we augment the sample by including the other observed positive bank relationships of sampled firms. Formally, if firm f appears in at least one sampled dyad, we add all other banks $b' \neq b$ such that the dyad (f, b') is observed with positive lending in at least one period. We then retain the full time series for these additional dyads as well.

The purpose of snowballing is not to change the estimand. Rather, it is to preserve the comparison structure required by the fixed-effects design. If one were to keep only isolated seed dyads, many firms would be observed with a single banking partner, in which case firm fixed effects would absorb nearly all of the cross-sectional variation of interest. By expanding around sampled firms, the resulting sample contains richer firm-specific choice sets and better preserves the connectedness of the observed lending network.

A.4.2 Relationship Regressions

The extensive-margin specification requires us to work with a dyad-level outcome that is highly sparse: for any given firm f and period t, only a small subset of banks b is observed to lend, while the set of feasible zero dyads is extremely large. Estimating the model on the full universe of firm-bank-time observations is therefore computationally infeasible. At the same time, dropping zero observations would alter the estimand by conditioning on relationship formation and would prevent us from recovering the relationship wedge. For this reason, we combine a Poisson pseudo-maximum-likelihood estimator with a case-control sampling design that retains all observed links and randomly subsamples zero dyads. In our setting, the motivation for case-control or choice-based sampling is purely computational: zeros vastly outnumber positives, so we keep all positives and sample only a small subset of zeros. For classic results on endogenous or response-based sampling and inverse-probability weighting in generalized linear models and related M-estimation problems, see Horvitz and Thompson (1952), Manski and Lerman (1977), Pfeffermann (1993), Wooldridge (1999), and Solon et al. (2015).

Step 1: firm sampling. We first draw a country-stratified sample of firms. Let p_f denote the inclusion probability of firm f. Conditional on firm f being selected, we recover the full set of realized lending relationships for that firm over time. Hence, all positive observations associated with sampled firms are retained in the estimation sample. To ensure representativeness across countries, we cluster the sampling of firms at the country level. We set $p_f = 1\%$.

Step 2: zero subsampling within firm-time risk sets. For each sampled firm-period pair (f, t), let

$$\mathcal{J}^0_{ft} = \{j : Y_{bft} = 0\}$$

denote the set of feasible banks with no observed lending relationship. Rather than keeping the full set $\mathcal{J}^0_{ft}$, we draw a random subset of zeros. Pragmatically, we draw enough zeros to reach 50 observations per firm. Let π_{bft} denote the conditional inclusion probability of zero dyad (b, f, t) given that firm f has been sampled. This is computationally obtained from simply dividing the number of sampled zeros by the size of all possible banks that the firm could have banked with. Thus, each retained zero observation has overall inclusion probability

$$\Pr\{(b, f, t) \text{ is observed in the estimation sample}\} = p_f \pi_{bft}.$$

This design is a standard case-control or choice-based sampling scheme: all positive dyads for sampled firms are retained, while zero dyads are sampled at a lower rate. Under known positive sampling probabilities and standard integrability conditions, inverse-probability-weighted moments have expectation equal to the corresponding target-population moments; hence, the weighted estimating equations target the population moment conditions for the estimator of interest.

Inverse-probability weights. The resulting estimation weights are

$$w_{ijt} = \begin{cases} \dfrac{1}{p_f}, & \text{if } Y_{bft} > 0, \\[2ex] \dfrac{1}{p_f \pi_{bft}}, & \text{if } Y_{bft} = 0 \text{ and } (b, f, t) \text{ is sampled.} \end{cases} \tag{42}$$

We then estimate (1) by weighted PPML on the sampled data. Because all positives are retained and zeros are reweighted by the inverse of their sampling probability, the weighted estimator targets the same population conditional mean that would be obtained from the full universe of dyads.

A.5 Estimation Details

This appendix elaborates on the comparisons leveraged by the two-way fixed-effects estimator in our setting. The estimator exploits relative comparisons that difference out persistent bank and firm heterogeneity. In that sense, the estimator is best understood as aggregating many local difference-in-difference comparisons. The estimator requires overlap in a connected network (as in matched worker–firm datasets, e.g. Abowd et al. (1999); Kline (2024)): banks that lend to multiple firms, firms that borrow from multiple banks, and chains of such relationships that connect domestic and cross-border lending.

For exposition, suppress time subscripts and additional controls, and write the outcome for an observed bank–firm edge (b, f) as

$$y_{bf} = \alpha_b + \delta_f + \theta_{c(b),c(f)} + u_{bf}, \tag{43}$$

where α_b is a bank fixed effect, δ_f is a firm fixed effect, and $\theta_{c(b),c(f)}$ is the country-pair effect for the country of bank b and the country of firm f. The estimated specification in the main text is richer, but (43) is sufficient to understand the source of identification.

A four-edge case: the basic comparison. Consider two banks, b_H in country H and b_F in country F, and two firms, f_H in country H and f_F in country F. Suppose all four lending relationships are observed. Then

$$\begin{aligned}
y_{b_H f_H} &= \alpha_{b_H} + \delta_{f_H} + \theta_{HH} + u_{b_H f_H}, \\
y_{b_H f_F} &= \alpha_{b_H} + \delta_{f_F} + \theta_{HF} + u_{b_H f_F}, \\
y_{b_F f_H} &= \alpha_{b_F} + \delta_{f_H} + \theta_{FH} + u_{b_F f_H}, \\
y_{b_F f_F} &= \alpha_{b_F} + \delta_{f_F} + \theta_{FF} + u_{b_F f_F}.
\end{aligned}$$

Define, for each bank, the foreign-minus-domestic gap

$$\Delta_{b_H} \equiv y_{b_H f_F} - y_{b_H f_H}, \qquad \Delta_{b_F} \equiv y_{b_F f_F} - y_{b_F f_H}.$$

Taking the difference of these two gaps gives

$$\begin{aligned}
\Delta_{b_H} - \Delta_{b_F} &= \left[y_{b_H f_F} - y_{b_H f_H}\right] - \left[y_{b_F f_F} - y_{b_F f_H}\right] && (44) \\
&= \left[\theta_{HF} - \theta_{HH}\right] - \left[\theta_{FF} - \theta_{FH}\right] + \tilde{u}, && (45)
\end{aligned}$$

where

$$\tilde{u} \equiv u_{b_H f_F} - u_{b_H f_H} - u_{b_F f_F} + u_{b_F f_H}.$$

The bank fixed effects cancel in the first difference, and the firm fixed effects cancel in the second difference.

Equation (45) is the basic local comparison behind the estimator. It is useful to read it as a difference-in-differences. The first difference compares foreign and domestic lending for a given bank. The second difference compares that foreign-minus-domestic gap across banks from different countries. Equivalently, one can reverse the order of differencing and interpret the same expression as comparing banks within a firm and then comparing those within-firm gaps across firms. In nonlinear binary-response models (e.g., PPML), the same interpretation applies most cleanly to the latent index of match surplus rather than to link probabilities in levels, but the difference is likely to be immaterial when the match probability is small (Angrist and Pischke, 2009). In either case, the tetrad isolates a relative country-pair contrast after removing bank and firm heterogeneity. This is the sense in which the estimator resembles a multi-arm difference-in-differences design (Kline, 2024). In our setting, the treatment arms are country pairs and the primitive contrast is the tetrad in (45).

From tetrads to regression The simple tetrad example generalizes into our full regression model. Exact tetrads need not appear everywhere in the data. What matters more generally is that local within-bank and within-firm comparisons can be chained together. For the interest rate regressions, this chaining comes from observed lending links; for the relationship regressions, it comes from observed potential matches, including non-links. The least-squares estimator combines these comparisons globally. Let D_B, D_F, and D_P denote the incidence matrices for bank dummies, firm dummies, and country-pair dummies. By the Frisch–Waugh–Lovell logic, the estimated country-pair coefficients satisfy

$$\hat{\theta} = (\widetilde{D}'_P \widetilde{D}_P)^{-1} \widetilde{D}'_P \widetilde{y}, \qquad \widetilde{y} = M_{BF} y, \qquad \widetilde{D}_P = M_{BF} D_P,$$

where M_{BF} is the residual-maker that projects orthogonally off the span of bank and firm dummies.

More formally, let $\mathcal{G}$ denote the bipartite network whose nodes are banks and firms, and whose edges are observed lending relationships. A connected component of $\mathcal{G}$ is informative for the bilateral wedges only if it contains overlap linking different country pairs (Abowd et al., 2002; Bonhomme, 2020). Consider any even cycle $e_1, e_2, \ldots, e_{2m}$ where consecutive edges share a bank or a firm, and the cycle closes back on itself. Writing $p(e_\ell)$ for the country pair associated with edge e_ℓ, we have

$$\sum_{\ell=1}^{2m} (-1)^\ell y_{e_\ell} = \sum_{\ell=1}^{2m} (-1)^\ell \theta_{p(e_\ell)} + \sum_{\ell=1}^{2m} (-1)^\ell u_{e_\ell}.$$

Each bank and each firm on the cycle appears twice with opposite signs, so the fixed effects telescope out. The four-edge example above is simply the shortest nontrivial cycle. Longer cycles therefore generate the same type of identifying variation when exact tetrads are absent. In this sense, the full estimator simply stacks many local double-difference comparisons over the connected component of the network. This also clarifies the limit of the difference-in-differences analogy. A single tetrad identifies only one relative contrast among country-pair effects. The full matrix of wedges is recovered only because the network supplies many overlapping tetrads and longer cycles. Least squares then chooses the set of country-pair effects that best fits all of these local comparisons jointly.

This is the point at which the connection with modern difference-in-differences is most useful. As Kline (2024) emphasizes in the worker–firm setting, once one moves from a single clean comparison to a least-squares system that aggregates many heterogeneous local contrasts, the resulting coefficients should be interpreted as projection objects. The same logic applies here. Our estimated wedges summarize the best additive fit to the collection of local difference-in-difference comparisons implied by the observed lending network.

What is and is not identified from the country-pair effects The country-pair coefficients are not identified in levels. For any collections of country-specific constants $\{a_c\}_c$ and $\{b_c\}_c$, define

$$\alpha'_b = \alpha_b - a_{c(b)}, \qquad \delta'_f = \delta_f - b_{c(f)}, \qquad \theta'_{cd} = \theta_{cd} + a_c + b_d. \tag{46}$$

Substituting (46) into (43) leaves fitted values unchanged. Hence the bilateral effects are identified only up to additive origin- and destination-country shifts.

For this reason, the levels of θ_{cd} are not intrinsically meaningful. What is meaningful is a *normalized* version of the bilateral matrix, such as bilateral deviations after removing origin and destination means, or differences relative to domestic lending. The former is the motivation for including origin and destination fixed effects in the second-stage regressions of the wedge accounting framework. The second is the motivation for presenting the estimated wedges in differences relative to domestic lending. Under any such normalization, the resulting wedges capture the component of bilateral lending outcomes that cannot be attributed to persistent bank heterogeneity, persistent firm heterogeneity, or country-wide origin/destination shifters.

A.6 Additional Estimates

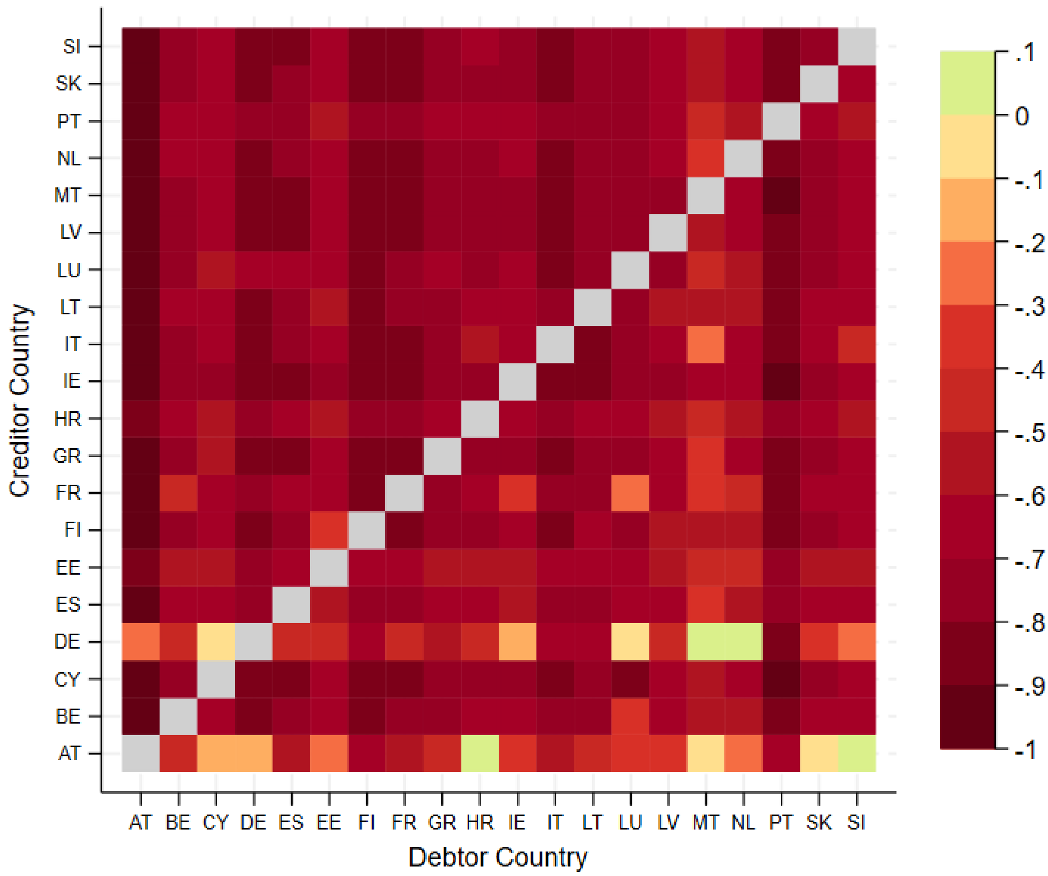


Figure 9: Relationship Wedges

Notes: This figure displays the estimated cross-border relationship wedges $\theta^L(i_f, i_b)$. Each cell represents a debtor country–creditor country pair. The regression specification includes the same controls as in our baseline estimates (2, column 2). Wedges are identified from within-bank and within-firm comparisons based on overlapping lending relationships across country pairs within connected components of the bank-firm network.

Table 7: Descriptive Statistics: Bank- and Firm-Level

	All Relationships						Cross-Border Relationships					
	N	Mean	SD	p50	p90	p99	N	Mean	SD	p50	p90	p99
Bank-Level												
Assets:												
Banking Group Size	2291	2.84	1.000	6.000	17.000	25.000	897	3.40	1.000	9.000	17.000	25.000
Total Credit in AnaCredit	2291	1.27	0.217	2.505	4.796	21.864	897	2.48	0.462	5.389	11.929	41.944
Total Asserts (billions)	2103	43.56	0.566	47.504	168.004	1184.911	831	78.66	1.880	167.204	675.439	1260.637
NFC Loans in EA (billions)	2103	4.16	0.100	6.080	21.731	103.880	831	7.71	0.272	20.458	56.648	105.168
HH Loans in EA (billions)	2103	5.47	0.094	7.619	25.511	130.307	831	9.93	0.194	22.922	81.237	136.517
HH Mortgages in EA (billions)	2103	4.56	0.030	6.048	22.786	114.689	831	8.37	0.064	19.796	66.786	115.556
Cash (millions)	2103	44.43	0.350	58.000	234.181	1152.000	831	88.02	1.200	234.181	603.381	1440.974
HH Consumption Lending in EA (millions)	2103	912.77	35.250	1755.112	5268.830	21 827.905	831	1565.97	82.000	4026.000	9063.000	23 672.000
NFC Debt Securities held (millions)	1802	60.18	0.001	48.000	151.959	1788.000	677	123.39	0.015	169.000	869.576	2989.730
Liabilities:												
NFC ON Deposits in EA	2103	2.38	0.023	2.420	10.087	63.579	831	4.45	0.058	9.676	33.067	67.552
HH ON Deposits in EA	2103	4.46	0.060	4.322	21.821	136.428	831	8.74	0.149	19.084	52.939	143.857
NFC Agreed maturity Deposits in EA	2103	1.14	0.004	1.024	5.426	34.757	831	2.09	0.023	4.196	10.094	44.596
HH Agreed maturity Deposits in EA	2103	1.34	0.045	2.869	8.129	22.383	831	2.22	0.137	7.034	13.042	23.998
NFC Redeemable at Notice Deposits in EA	2103	0.14	0.000	0.010	0.076	1.804	831	0.26	0.000	0.051	0.274	14.394
HH Redeemable at Notice Deposits in EA	2103	2.17	0.000	0.402	6.124	65.449	831	4.03	0.000	2.447	39.361	92.824
NFC Deposits Included in M3 in EA	2103	3.84	0.032	3.326	15.758	96.287	831	7.11	0.099	13.973	55.342	98.036
HH Deposits Included in M3 in EA	2103	7.36	0.133	8.619	40.950	154.008	831	14.04	0.319	36.999	115.813	201.410
Total Capital and Reserves	2103	2.76	0.071	4.228	14.933	56.423	831	5.01	0.223	13.451	35.593	81.831
Remaining Liabilities	2103	7.36	0.015	1.760	13.395	191.760	831	13.69	0.046	11.554	72.888	380.177
Firm-Level												
Total Firm Credit (millions)	3 503 981	0.83	0.122	1.031	2.274	10.945	24 628	14.07	1.182	24.986	54.884	230.960
Number of Bank Relationships	3 503 981	1.32	1.000	2.000	3.000	5.000	24 628	2.24	1.000	5.000	6.000	10.000
Balance Sheet Total (millions)	2 683 490	36.55	0.605	6.266	14.869	115.869	22 265	1478.01	11.397	359.617	1109.665	12 034.228
Annual turnover (millions)	2 706 660	21.71	0.394	5.154	13.018	105.104	21 803	785.65	6.800	282.797	816.141	6529.275
Number of Employees	2 814 125	85.79	2.000	25.000	51.000	318.000	22 443	2423.54	18.000	526.000	1244.000	9481.000
Firm age (Years)	3 503 981	15.04	10.000	33.000	41.000	68.000	24 628	19.91	11.000	42.000	62.000	123.000

Note: This table shows summary statistics for a banks and firms in our AnaCredit - iBSI - RIAD integrated dataset as of September 2024. We define cross-border based on operational geography. Banks or firms are considered cross-border if they have at least one cross-border relationship in the cross-section. All values in the bank liability panel are given in billions of Euros.

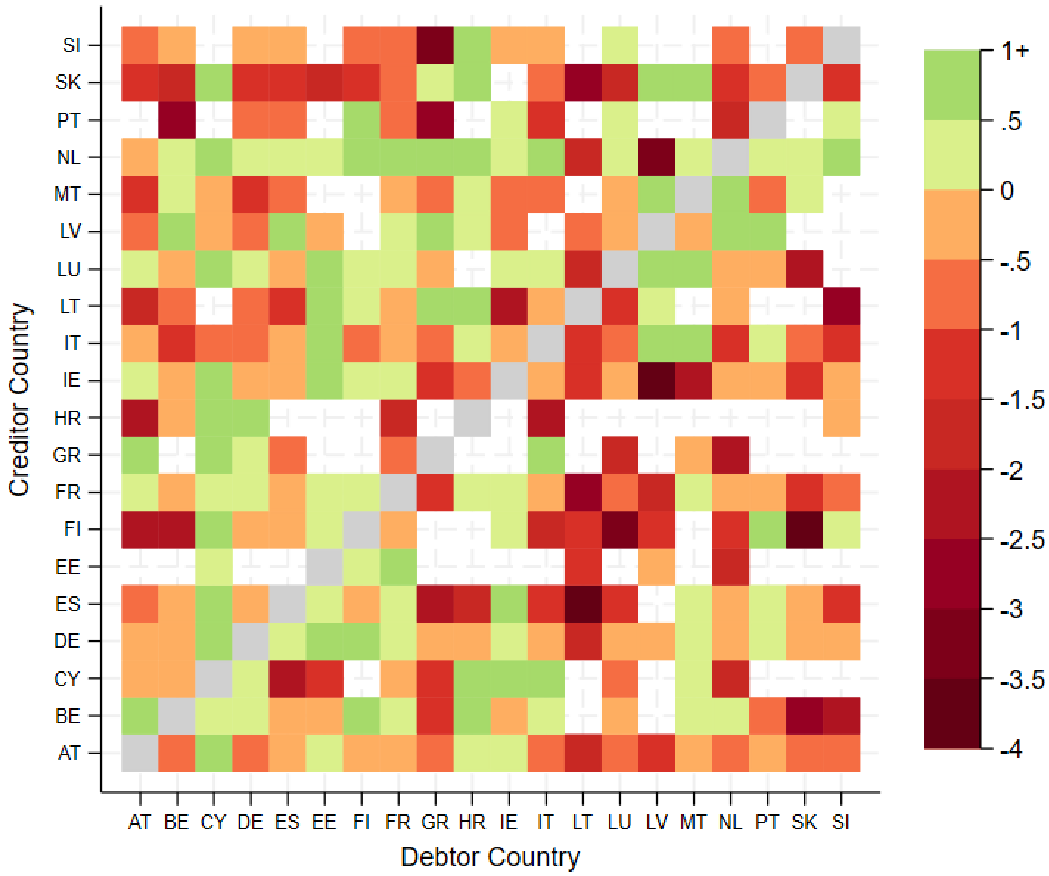


Figure 10: Quantity Wedges

Notes: This figure displays the estimated cross-border quantity wedges (loan shares conditional on relationships). Each cell represents a debtor country–creditor country pair. The regression specification includes the same controls as in our baseline estimates (8, column 2). Wedges are identified from within-bank and within-firm comparisons based on overlapping lending relationships across country pairs within connected components of the bank-firm network.

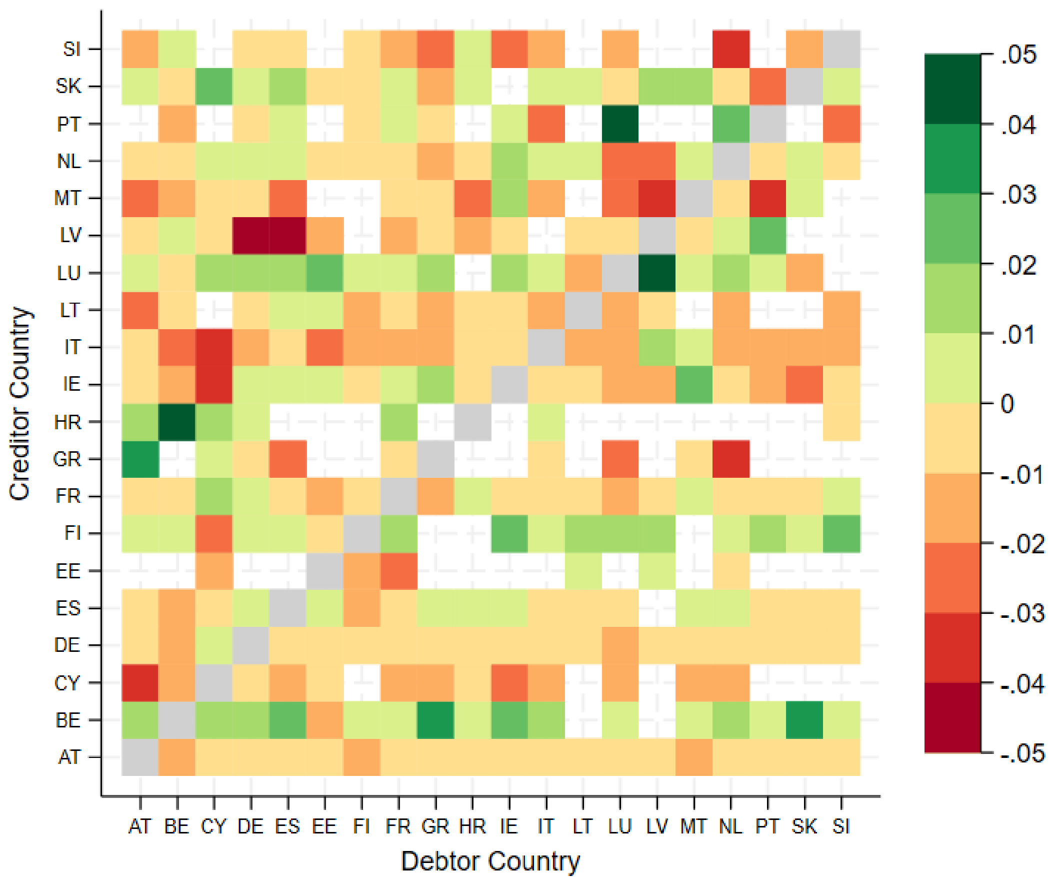


Figure 11: Interest Rate Wedges

Notes: This figure displays the estimated cross-border interest rate wedges $\theta^R(i_f, i_b)$. Each cell represents a debtor country–creditor country pair. The regression specification includes the same controls as in our baseline estimates (3, column 2). Wedges are identified from within-bank and within-firm comparisons based on overlapping lending relationships across country pairs within connected components of the bank-firm network.

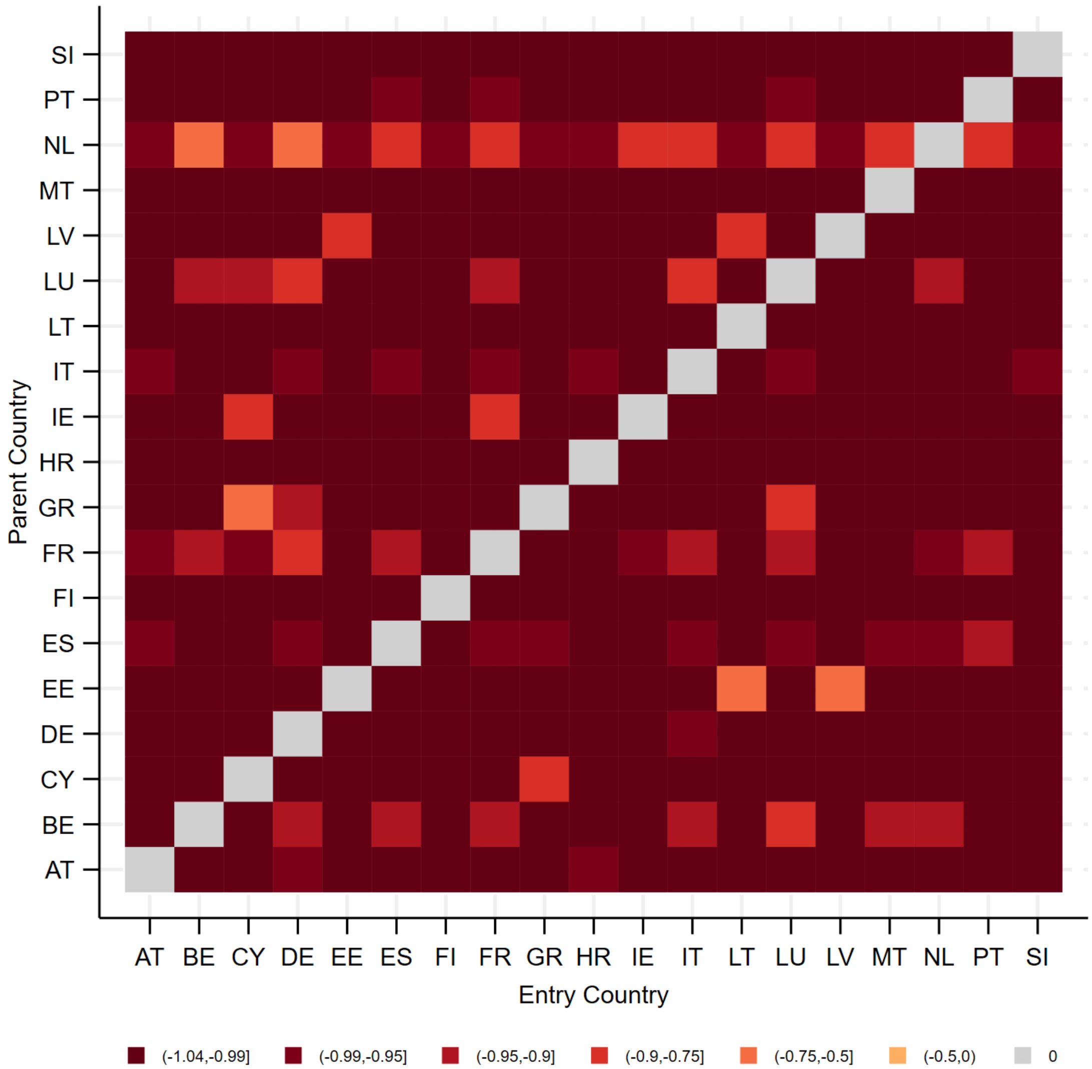


Figure 12: Bank Entry Wedges

Notes: This figure displays the estimated cross-border bank entry wedges $\theta^E(i_f, i_b)$. Each cell represents a debtor country–creditor country pair. The regression specification includes the same controls as in 4, column 4 (banking group fixed effects and destination fixed effects).

Table 8: Cross-Border Wedges in Credit Quantities

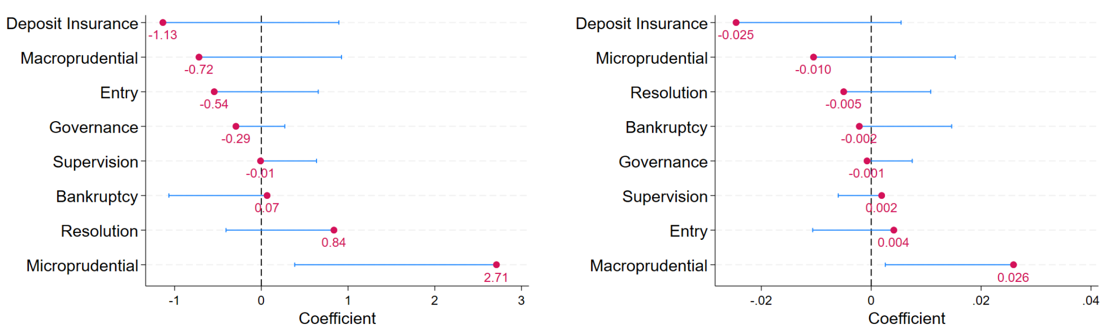
	(1)	(2)	(3)	(4)	(5)
Cross-Border	-0.3193***	-0.1408*	-0.1350*	-0.1984***	-0.1649**
	(0.0536)	(0.0719)	(0.0704)	(0.0656)	(0.0766)
Interest Rate	-1.0791***	-3.2301***	-3.708***	-2.274***	-3.188***
	(0.9820)	(0.4953)	(0.5563)	(0.2631)	(0.4272)
N	13,303,423	13,270,167	13,215,479	13,268,649	10,797,038
Banks	3,000	2,972	2,799	2,968	2,568
Firms	683,717	650,482	664,975	650,406	505,965
Average Share	0.438	0.437	0.435	0.437	0.399
Time FE	✓	✓		✓	✓
Bank Country FE	✓				
Firm Country FE	✓				
Firm FE		✓	✓	✓	✓
ILST FE			✓		
Bank FE		✓			✓
Bank x Time FE			✓		
Bank x NACE2 FE				✓	
Firm-Bank Size Bins					✓

Notes: the table presents OLS estimates of a regression of the (log) share of borrowing that a firm f borrows from a bank b on a cross-border indicator for firm and banks being located in different countries. Time is a quarter. ILST FE refers to firm industry x location x size x time fixed effects, as in Degryse et al (2019). Firm-bank size bins are defined by the interaction of firm and bank size deciles. Clustered standard errors at the bank country, firm country, and country-pair reported in parentheses. The number of observations, banks and firms changes due to standard connectedness requirements imposed by the set of fixed effects.

Table 9: Cross-Border Wedges in Bank Entry

	(1)	(2)	(3)	(4)	(5)
Cross-Border	-4.635***	-4.635***	-4.365***	-4.847***	-6.026***
	(0.018)	(0.018)	(0.019)	(0.022)	(0.036)
N	748014	748014	748014	748014	748014
Time FE	✓	✓	✓	✓	✓
Entry Country FE	✓	✓	✓	✓	✓
Group Country FE	✓			✓	
Group FE		✓			✓
Group x Time FE			✓		
Model Profits				✓	✓

Notes: The table presents PPML estimates of a regression of an entry indicator on a cross-border indicator for banking group being present in a country other than its origin country. Heteroskedasticity-robust standard errors reported in parentheses.



(a) Loan Shares (b) Interest Rates

Figure 13: Correlations of Cross-Border Barriers with Policy Distances

Notes: The coefficient plots report OLS estimates for the policy variables on equation (4) with one-sided confidence bands based on heteroskedasticity-robust standard errors. Panel (a) reports results for the quantity wedges (loan shares conditional on relationships). Panel (b) reports results for the interest rate wedges. All policy variables are jointly included in the regression. The specifications include origin and destination fixed effects and non-policy controls for Pellegrino et al. (2025) (measures of geographical, cultural, and linguistic distances; indicators for shared border, languages, or legal origin; and statutory bilateral capital tax rates). Both wedges are estimated from microdata with bank and firm fixed effects via OLS (column 2, Tables 3 and 8).

Table 10: Regulatory Drivers of Cross-Border Frictions

Friction	(1) Relationship	(2) Loan Amount	(3) Interest Rate	(4) Bank Entry
	Panel A: Regulatory Distance			
Pooled	-1.134***	-0.118	-0.0067	-1.378***
	(0.153)	(1.378)	(0.0165)	(0.180)
	Panel B: By Policy Category			
Bankruptcy	-0.222***	0.066	-0.0022	-0.115*
	(0.051)	(0.686)	(0.0102)	(0.0810)
Deposit Insurance	-0.244***	-1.135*	-0.0246	-0.570***
	(0.098)	(1.229)	(0.0182)	(0.146)
Entry	0.014	-0.543	0.0041	-0.0564
	(0.044)	(0.727)	(0.0089)	(0.0447)
Governance	-0.635***	-0.293	-0.0007	-0.0640***
	(0.026)	(0.342)	(0.0050)	(0.0284)
Macroprudential	-0.395***	-0.719	0.0259**	-0.318**
	(0.080)	(0.996)	(0.0141)	(0.1660)
Microprudential	-0.148*	2.711	-0.0105	-0.320***
	(0.010)	(1.410)	(0.0156)	(0.129)
Resolution	-0.139***	0.837	-0.0050	-0.190***
	(0.054)	(0.754)	(0.0096)	(0.0691)
Supervision	-0.081	-0.009	0.0019	-0.0645*
	(0.040)	(0.391)	(0.0048)	(0.0397)
N	400	324	324	400
Origin FE	✓	✓	✓	✓
Destination FE	✓	✓	✓	✓
Non-Regulatory	✓	✓	✓	✓

Notes. the table presents OLS estimates of the bilateral wedges on regulatory frictions. Column 1 reports results for the relationship wedges, column 2 reports results for loan amount wedges, column 3 reports results for interest rate wedges, and column 4 reports results for the bank entry wedges. All specifications include country of origin and country of destination fixed effects; and non-regulatory controls obtained from Pellegrino et al. (2025). Significance stars on columns 1, 2, and 4 (3) are based on one-sided tests against the null hypothesis that coefficients are positive (negative). Heteroscedasticity-robust standard errors reported in parentheses.

B Data Appendix

B.1 AnaCredit

AnaCredit (Analytical Credit Datasets) is a granular credit database established by the European Central Bank (ECB) that collects detailed loan-by-loan data from credit institutions across the euro area. It was launched in September 2018. The registry covers loans granted by euro area credit institutions to legal entities (corporations, governments, and other organizations), with a reporting threshold of 25,000 EUR. Each loan record contains approximately 100 data attributes spanning information on the creditor, the debtor, the instrument characteristics, and associated credit risk measures. Key data points include the loan amount, maturity, interest rate, collateral details, probability of default, and the debtor's economic sector and location. National central banks collect the data from reporting agents in their jurisdictions and transmit it to the ECB, which maintains the centralized database. While the primary focus is on loans to legal entities, natural persons (individuals) are generally excluded from reporting to protect personal data privacy.

We use cleaning procedures developed and implemented with ECB Research economists. This includes correcting some known data issues as well as ensuring reported quantities are sensible (e.g. no interest rates less than -10% or above 30% on any instrument), correction of decimal reporting errors for outstanding and committed amounts (no loans with outstanding amounts of 100 billion EUR, etc.). For further information on the cleaning procedure, please reach out to the corresponding author.

B.2 RIAD and Group Structure Algorithm

This appendix describes the ownership and control information that we use from RIAD to recover group structures and, in particular, to map branches to their ultimate parents. Throughout, the relevant statistical unit in RIAD is the *organisational unit* (OU), which comprises legal entities as well as affiliates such as branches and subsidiaries. RIAD stores bilateral relationships among OUs and uses these links to derive several group structures. For our purposes, the key information is the set of bilateral ownership, control, and branch relationships, after

RIAD's internal data-quality checks.

Data quality stems from the administrative nature of the dataset. The underlying data comes from mandatory reporting under IFRS 10 (accounting standards for private enterprises) and the ECB RIAD guidelines (2018/16 for national central banks; 2020/16 for national competent authorities). Further work by regulators, as established in the CRRs, plus granular information from AnaCredit for additional scrutiny contributes to availability and accuracy of links.

B.2.1 Underlying RIAD relationships

The starting point is the set of bilateral links recorded between OUs. The relationships most relevant for ownership-based group reconstruction are the following:

1. **Is Owner**. This relationship records an ownership link, including the capital share and a control flag.

2. **Is Branch**. This relationship links a non-resident branch to its headquarters. In RIAD, this link is treated as equivalent to a 100% control relation from the headquarter to the branch.

3. **Is Direct Parent**. This is a derived relation obtained from ownership links with effective control.

4. **Is Ultimate Parent**. This identifies the entity that has no parent undertaking.

RIAD also distinguishes between *direct* and *indirect* control. Direct control is present when the control flag is true, when the ownership share exceeds 50%, or when the relation is an `Is Branch` link. Indirect control arises when control is exercised through controlled subsidiaries that together own more than 50% of the investee. These conventions are central because they imply that branches can be embedded in the same control tree as legal entities and subsidiaries.

B.2.2 Control-based group structures

The ownership structure that is most useful for our purposes is the control-based group, which has three defining features. First, the *head* of the group is an OU that is not controlled, either directly or indirectly, by any other entity. Second, the members of the group are all OUs that are directly or indirectly controlled by that head. Third, each entity is placed uniquely in the tree: RIAD's construction rules rule out cycles and back-references, so that each unit has a unique position in the hierarchy.

In practice, the mapping identifies a unique top entity for each connected control structure. Since branches are explicitly treated as controlled affiliates of their headquarters, they enter the same tree as the corresponding head office and, through that office, can be linked to the rest of the group hierarchy. The head of the group is therefore the natural *ultimate parent* for our empirical mapping.

B.2.3 Mapping branches to ultimate parents

We map each branch to its ultimate parent in two steps.

Step 1: Identify the branch–headquarter relation. For every organisational unit classified as a branch, we use the `Is Branch` relationship to identify the corresponding headquarter. By RIAD convention, this link is treated as a full-control relation from the headquarter to the branch. This ensures that the branch enters the same control structure as the head office even though the branch is not a separate legal subsidiary.

Step 2: Climb the control hierarchy to the group head. Starting from the branch's headquarter, we follow the validated control chain upward using RIAD's control-based group structure until we reach the top entity that is not controlled by any other OU. In this process we restrict our top entity to be a deposit-taking MFI (S122).Equivalently, we assign the branch to the head of the corresponding group. This top entity is the branch's ultimate parent in our data.

Formally, let b denote a branch and let $h(b)$ denote the headquarter linked to b through an `Is Branch` relation. Let $p(\cdot)$ denote the controlling parent in the RIAD control tree. We define the ultimate parent of branch b as

$$UP(b) = p^{(k)}\big(h(b)\big),$$

where $p^{(k)}\big(h(b)\big)$ is the first ancestor in the control chain with no parent undertaking. Because RIAD imposes unique placement in the group tree, this mapping is single-valued.

This procedure yields a consistent way to associate each observed branch with the ultimate banking parent that controls the wider banking group. The resulting mapping is useful whenever one wants to reassign branch-level activity to the parent banking group rather than to the branch's host country alone. In our setting, this allows us to move from the legal location of a branch to the ownership-based location of the institution that ultimately controls it.

B.3 iBSI

The Individual Balance Sheet Items (iBSI) database is a granular, bank-level dataset maintained by the ECB that collects balance sheet data from individual monetary financial institutions (MFIs) across the euro area. It was launched in 2014, shortly after the ECB announced its three-year maturity longer-term refinancing operations (LTROs), to help assess the effectiveness of non-standard monetary policy measures. The database contains several balance sheet indicators for nearly the universe of euro area MFIs, accounting for roughly 95% of the total assets of the euro area banking sector. Data are collected at a monthly frequency and follows the same template and definitions used by the Eurosystem to construct aggregate euro area money and credit statistics (such as M3). The iBSI database includes end-of-month outstanding amounts and monthly transactions, covering key balance sheet positions such as loans, deposits, debt securities, equity holdings, and other assets and liabilities. In 2014, the regular transmission was expanded to include individual MFI interest rate (IMIR) data, and in 2015 the sample was extended to approximately 300 credit institutions. Since late 2019, the dataset now covers nearly all European Banks including smaller local and regional banks with few exceptions. National central banks collect the data from individual MFIs and transmit it to the ECB, where quality checks benchmark individual observations against corresponding country aggregates.

B.4 Regulatory Dataset

This appendix describes the data sources and cleaning routines used to construct the regulatory fragmentation measures. A list of variables and their assigned policy categories can be found at the authors' websites.

B.4.1 OECD Insolvency Indicators

The OECD Insolvency Indicators for 2010, 2016, and 2022 are publicly available and can be accessed via the OECD website (Organisation for Economic Co-operation and Development, 2016, 2022). The dataset includes indicator values for OECD countries in each of these years. We added variables to indicate whether a country is located in Europe and in the European Economic Area (EEA).

B.4.2 European Systemic Risk Board Data

Raw data on capital conservation buffer, countercyclical buffers, matrix of reciprocation, and borrower-based measures are publicly available on the ESRB website (European Systemic Risk Board, 2026a,b).

Combined Capital Buffer Requirements. The most recent version of the dataset is publicly available from the European Systemic Risk Board (ESRB). Earlier vintages, beginning in 2017, were obtained directly from the European Central Bank (ECB) upon request. Our bank level dataset contains, for each reporting financial institution, the applicable capital conservation buffer (CCoB), countercyclical capital buffer (CCyB), global systemically important institution buffer (G-SII), other systemically important institution buffer (O-SII), systemic risk buffer (SyRB), sectoral systemic risk buffer (sectoral SyRB), and the resulting combined buffer requirement.

From the bank-level data, we aggregate to the country level by constructing, for each buffer category, the maximum, midpoint and minimum buffer requirements across institutions within a country. We construct additional count variables for the G-SII, O-SII, SyRB, and SRB buffers, indicating the number of financial institutions subject to each buffer in each period.

In a small number of cases, buffer rates were reported as ranges or differentiated across institutions. For Liechtenstein (7 October 2022), the systemic risk buffer was described as "1% for exposures secured by real estate property in Liechtenstein"; we treat the systemic risk requirement as ranging from 0–1% for this period. For Norway, where the SyRB was reported as "3% for all banks, 5% for one bank and one mortgage company," we record the applicable range of 3–5%. For Romania (survey dates May 1, July 1, and October 1, 2020), buffer requirements were explicitly reported as ranges at the bank level; in these instances, we assign the midpoint of the reported range. These adjustments ensure consistency in constructing a harmonized panel across jurisdictions and time.

Capital Conservation Buffers. The raw data on capital conservation buffers (CCoB) contains textual descriptions of each change in CCoB policy by national authorities. The final dataset is structured as a quarterly panel covering 31 countries over 2013–2024. We construct a dummy variable, exemption, to indicate whether exemptions to the buffer requirement were available in a given quarter. To fill missing observations, ESRB data were supplemented with information from the central banks of Portugal and Slovakia, which is publicly available from the respective central bank websites.

Countercyclical Capital Buffers. Each observation in the raw data corresponds to a policy announcement and/or policy decision made by a national authority regarding the countercyclical capital buffer (CCyB) rate. We clean the data to retain only announcements associated with an effective policy action. Specifically, we exclude observations that do not result in a change in the CCyB rate. The retained sample includes CCyB increases, decreases, first-time settings of the buffer, as well as decisions that overwrite a previously announced CCyB path (e.g., cases in which an authority had announced a future increase but subsequently decided not to implement it). We then aggregate the announcement-level data to the country–quarter level. Each country has a unique observation in each quarter, with the exception of Iceland, which implemented two CCyB policy changes in 2020Q1.The final dataset covers 30 countries over the period 2014–2024.

Reciprocation of Macroprudential Buffers. The raw data are provided in matrix form. Each cell contains a unique measure code that identifies whether the corresponding measure was reciprocated. We reshape the matrix to construct the dataset at the originating-measure level. Information on the status of the measure within the reciprocating country is obtained by merging the reciprocation data with the ESRB Capital Overview of Macroprudential Measures dataset using the unique Measure Reference. This merge allows us to identify whether the reciprocating measure remains active as of December 16, 2025, reflecting the most recent ESRB dataset available at the time of compilation.

Borrower-Based Measures. The raw dataset consists of textual descriptions of each policy decision on borrower-based measures (BoBM) made by the national competent authority. From this, we construct a dataset that includes a dummy variable indicating whether a borrower-based restriction or recommendation was implemented at a given time, as well as a dummy variable capturing whether exemptions to the requirement were permitted. To capture the legal status of measures, we include a variable indicating whether a measure was framed as a recommendation in the narrative text. Supplementary information is required to fully populate this variable, as not all policy decisions listed in the raw data were legally binding, and some recommendations were not explicitly flagged as such. This variable is not used in our analysis. The final dataset is organized at the country–policy decision date level, with each observation corresponding to the date on which a decision regarding a borrower-based measure was announced.

B.4.3 European Banking Authority Data

Raw data can be found on the European Banking Authority website (European Banking Authority, 2026b,c,a). The raw data are provided in Excel file format.

Liquidity Waivers. The liquidity waivers dataset is drawn from Supervisory Disclosure Annex 4 Part 6 Revisions 1 and 2, covering the survey years 2022 and 2023. The dataset reports the number of institutions that received each specified waiver during the relevant survey period. No additional variables were created. [18]

Options and Discretions. The options and discretions dataset is based on Supervisory Disclosure Annex 2 Part 1 Revision 2, published 19 November 2024 and Supervisory Disclosure Annex 2 Part 1, published on 26 February 2020. Where an option or discretion had an Article 493 counterpart — a regulation granting similar powers but conferring authority to the government — we split these into separate variables labeled "a" and "b." The "a" variables capture the permissions granted to the national competent authority, while the "b" variables capture the permissions

[18] An amendment was made to the raw data on PL (Poland) sheet, index number 019. The variable "Percentage of the consolidated own funds requirements allocated to subsidiaries established in third countries (%)" was reported as 976. As percentage values cannot exceed 100, this observation is treated as a clerical error in the source file and changed to missing.

granted to the government. The dataset covers 32 countries over the 2 survey periods (2020 and 2024). [19]

Deposit Guarantee Schemes. DGS data can be downloaded in Excel format. Raw data aggregates DGS data from 2015-2024. The final dataset was structured on the country-year level. No additional variables were created.

B.5 World Bank Regulation and Supervision Survey

The WBRSS consists of bank regulation and supervision indicators collected annually via questionnaires sent to central banks and supervisory authorities. The latest survey covers the period 2011–2016 and is publicly available on the WBRSS website in Excel format (World Bank Group, 2026). Variables were extracted on bank entry, bank ownership, bank capital, bank activity, auditing, governance, bank liquidity, deposit insurance, asset classification, provisioning, and write-offs. Data are reported at the country-year level, and coverage within the final dataset is restricted to EU countries.

B.6 International Association of Deposit Insurers Survey

The IADI survey data for the period 2014–2024 are publicly available from the IADI website (International Association of Deposit Insurers, 2026). We compile these survey waves to construct a harmonized dataset spanning the full sample period. The data are hand-checked to identify potential measurement errors and to ensure internal consistency across years. Where discrepancies were detected, entries were corrected based on cross-referencing with the original survey documentation and reports from official sources. This task was aided by the use of artificial intelligence – we inquired with a prompt whenever there seems to be a discrepancy, asking the model to verify the result against a web search and provide a source.

[19] An inconsistency was identified in the "Ireland" sheet of the 2024 disclosure (column I, rows 38-48) where references to Article 400(2)(b) do not correspond with the Articles mentioned in column D. Based on the structure of the dataset and the narrative of the surrounding entries, these references were corrected to align with the relevant article. For example, in row 44, Article 400(2), point (i) and 493(3), point (i) (column D), the narrative should read: "Yes on a case-by-case basis for Article 400(2)(i) subject to fulfillment of certain criteria N for Article 493(3)(i)" instead of the existing narrative within the raw data. These corrections reflect minor clerical errors in the source file and do not alter the substantive coding of the measures.

All modifications to the raw data are documented, and a complete spreadsheet detailing these changes is available from the authors upon request.

B.7 Compiling the Dataset

The cleaned individual datasets are consolidated into a single harmonized file for the computation of distance metrics. The data are organized in matrix format, with each row representing a variable–year observation and each column representing an EU member state.

We then assign each individual variable into one of eight categories. Seven of these categories strive to conceptually capture key dimensions of banking regulations, requirements, and their implementation. These categories are supervision, microprudential, macroprudential, resolution, entry, governance, and deposit insurance. The eighth category is bankruptcy, which is included given its importance for credit outcomes.

While some of the datasets align well with a particular category (e.g., the OECD bankruptcy indicators or the IADI survey), some datasets contain information on multiple categories. In these cases, we have followed consensus in how to ascribe each variable to a conceptual bucket. For example, for each Option & Discretion in the EBA data, we read the text of the policy, and assigned it to micro vs macroprudential depending on whether the policy related mostly to exemptions to a micro or macroprudential requirement. Similarly,

B.8 Potential Limitations

Beyond prudential requirements and DGS, we have not tracked country-specific policies over time. For more recent time periods, some of our measures of regulatory fragmentation may thus suffer from measurement error.

We do not think there are considerable measurement concerns on microprudential, entry or auditing requirements. Microprudential and entry requirements are stringently dictated by the CRR, and deviations occur mainly through the take-up of O&Ds or waivers, both of which we measure. On auditing, the 2014 Auditing Directive had to be completely phased-in by mid-2016.

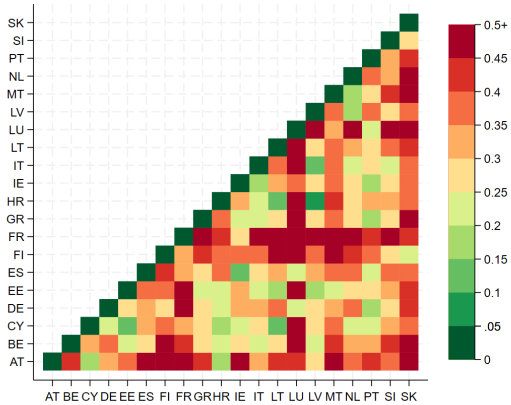
Some residual concerns may arise on accounting and governance. On accounting, our measures may overstate the degree of fragmentation due to the adoption of IFRS9 standards effective January 2018. On governance, the 2013 CRD IV had tasked the EBA with developing internal governance guidelines, which were released in 2017 but only effective June 2018.

Another potential concern is the evolving landscape of Basel III, whose rules have been transposed at the EU level since the CRD IV. Iterations of the framework have been transposed into follow-up EU level directives and regulations, such as CRR2/CRD5. Using the BIS adoption trackers, we have verified that the adoption of each standard has been synchronized between the EU and the countries that are individually tracked (Germany, France, Italy, Spain and the Netherlands). This assuages concerns that unsynchronized adoption of Basel III could bias the regulatory distances.

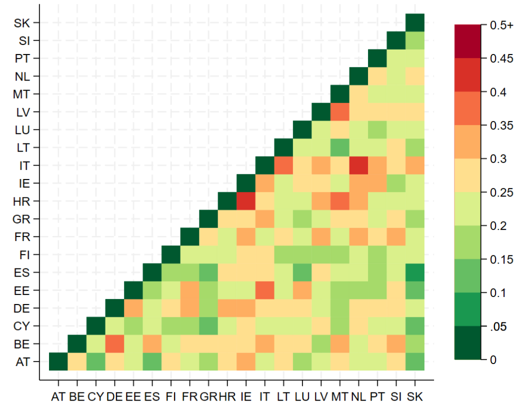
Remaining divergences across countries due to Basel III could occur due to macroprudential buffers, capital phase-ins, and Pillar II requirements. We actively track national macroprudential buffers over time. Capital phase-ins would induce transitory variation around the anchor defined by the CRRs until full convergence. The only source of concern would be supervisory discretion over Pillar II requirements for non-significant institutions supervised by national competent authorities. It is unclear in which direction this would bias our measurement.

B.9 Distance Metrics by Categories

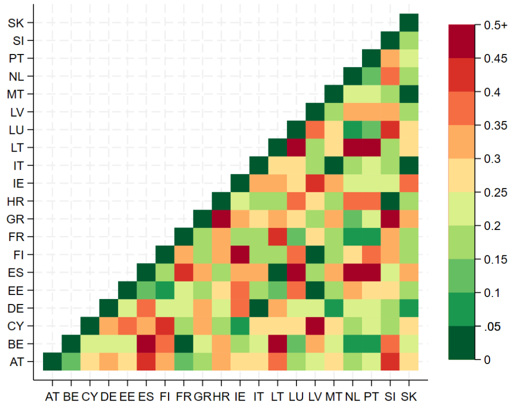
Figure 14 reproduces Figure 3, breaking down the distance index into its eight subcomponents. Table 11 collects the number of variables in each subcomponent.



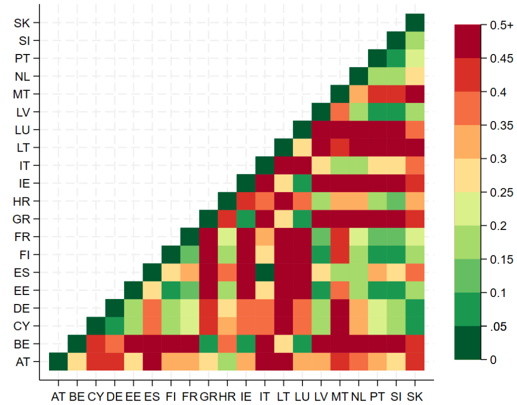
(a) Bankruptcy



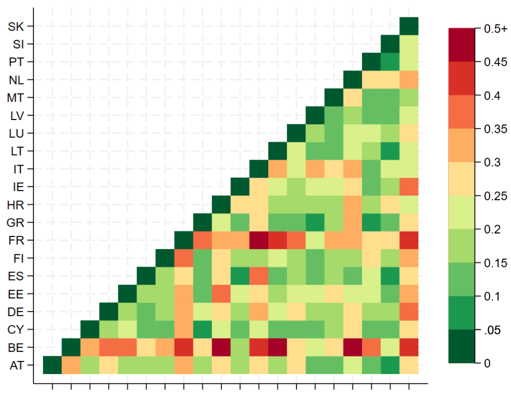
(b) Deposit Insurance



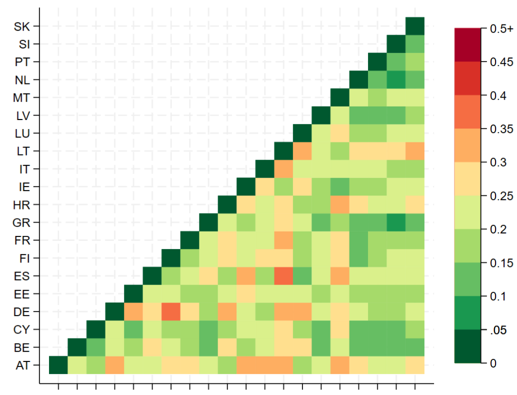
(c) Entry



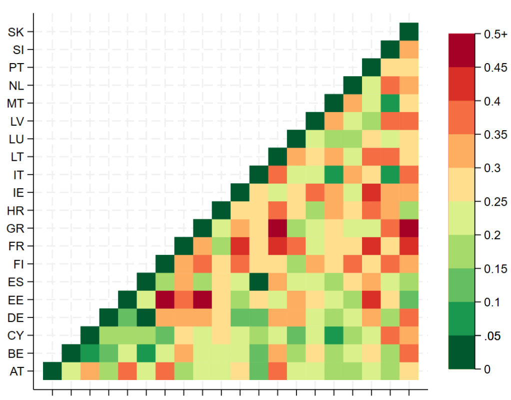
(d) Governance



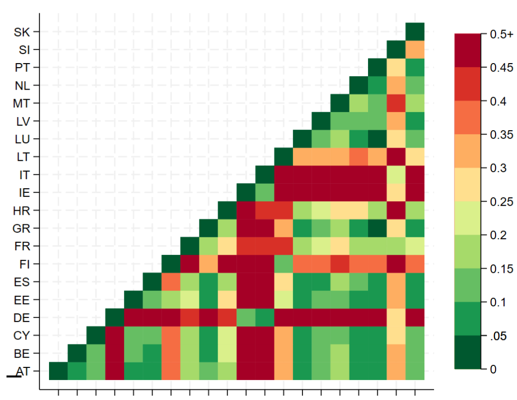
(e) Macroprudential



(f) Microprudential



(g) Resolution



(h) Supervision

Figure 14: Distance Metrics by Categories

Table 11: Number of Variables, by Category

Category	Number of Variables
Bankruptcy	13
Deposit Insurance	94
Entry	30
Governance	83
Macroprudential	46
Microprudential	167
Resolution	46
Supervision	53

Notes: This table shows the number of variables present within each of the 8 sub-components: Bankruptcy, Deposit Insurance, Entry, Governance, Macroprudential, Microprudential, Resolution, and Supervision. A full list of the names of the variables can be found at the authors' websites.

C Selected Model Proofs

C.1 Proof of Bank Choice Probability: Equation (8)

Household i choose the bank b to maximize

$$u_{bi} \; = \; \sigma^D \ln(r_b^D) + \ln(\mathcal{A}_{bi}^D) + \varepsilon_{bi}, \tag{C.1}$$

where $r_b^D > 0, \mathcal{A}_{bi}^D > 0 \; \forall \; b, i$, and where ε_{bi} is assumed to be independently and identically distributed across banks according to a standard Type I Extreme Value (Gumbel) distribution with CDF:

$$F(\varepsilon) \; = \; \exp\left(-\exp(-\varepsilon)\right). \tag{C.2}$$

Let

$$V_{bi} \equiv \sigma^D \ln(r_b^D) + \ln(\mathcal{A}_{bi}^D) \tag{C.3}$$

denote the deterministic component of utility, so that

$$u_{bi} \; = \; V_{bi} + \varepsilon_{bi}. \tag{C.4}$$

The probability that household i chooses bank b is

$$p_{bi}^D \; = \; \Pr(u_{bi} > u_{b'i} \text{ for all } b' \neq b). \tag{C.5}$$

Substituting the utility specification yields

$$p_{bi}^D \; = \; \Pr(V_{bi} + \varepsilon_{bi} > V_{b'i} + \varepsilon_{b'i} \text{ for all } b' \neq b), \tag{C.6}$$

or equivalently,

$$p_{bi}^D \; = \; \Pr(\varepsilon_{b'i} < \varepsilon_{bi} + V_{bi} - V_{b'i} \text{ for all } b' \neq b). \tag{C.7}$$

Conditioning on a realization of ε_{bi} and using the independence of the error terms across banks, we obtain

$$p_{bi}^D \; = \; \int_{-\infty}^{\infty} \prod_{b' \neq b} F\left(\varepsilon + V_{bi} - V_{b'i}\right) f(\varepsilon)\, d\varepsilon, \tag{C.8}$$

where $f(\varepsilon)$ is the density associated with the standard Type I Extreme Value distribution:

$$f(\varepsilon) \; = \; \exp(-\varepsilon) \exp\left(-\exp(-\varepsilon)\right). \tag{C.9}$$

Substituting the Gumbel cumulative distribution function gives

$$p_{bi}^D \;=\; \int_{-\infty}^{\infty} \prod_{b' \neq b} \exp\left[-\exp\left(-\varepsilon - V_{bi} + V_{b'i}\right)\right] \exp(-\varepsilon) \exp\left(-\exp(-\varepsilon)\right)\, d\varepsilon. \tag{C.10}$$

Combining the exponential terms,

$$p_{bi}^D \;=\; \int_{-\infty}^{\infty} \exp\left[-\exp(-\varepsilon)\left(1 + \sum_{b' \neq b} \exp(V_{b'i} - V_{bi})\right)\right] \exp(-\varepsilon)\, d\varepsilon. \tag{C.11}$$

Define

$$S_{bi} \equiv 1 + \sum_{b' \neq b} \exp(V_{b'i} - V_{bi}) \;=\; \exp(-V_{bi}) \sum_{b'} \exp(V_{b'i}). \tag{C.12}$$

Then

$$p_{bi}^D \;=\; \int_{-\infty}^{\infty} \exp\left[-S_{bi} \exp(-\varepsilon)\right] \exp(-\varepsilon)\, d\varepsilon. \tag{C.13}$$

Now apply the change of variables

$$t \;=\; S_{bi} \exp(-\varepsilon), \tag{C.14}$$

so that

$$dt \;=\; -S_{bi} \exp(-\varepsilon)\, d\varepsilon, \qquad \exp(-\varepsilon)\, d\varepsilon \;=\; -\frac{dt}{S_{bi}}. \tag{C.15}$$

As $\varepsilon \to -\infty$, $t \to \infty$, and as $\varepsilon \to \infty$, $t \to 0$. Therefore,

$$p_{bi}^D \;=\; -\frac{1}{S_{bi}} \int_{\infty}^{0} e^{-t}\, dt \;=\; \frac{1}{S_{bi}} \int_{0}^{\infty} e^{-t}\, dt \;=\; \frac{1}{S_{bi}} \tag{C.16}$$

given that $\int_0^\infty e^{-t}\, dt = 1$. Substituting back for S_{bi} yields

$$p_{bi}^D \;=\; \frac{1}{\exp(-V_{bi}) \sum_{b'} \exp(V_{b'i})} \;=\; \frac{\exp(V_{bi})}{\sum_{b'} \exp(V_{b'i})}. \tag{C.17}$$

Finally, using the definition of V_{bi},

$$\exp(V_{bi}) \;=\; \exp\left(\sigma^D \ln(r_b^D) + \ln(\mathcal{A}_{bi}^D)\right) \;=\; (r_b^D)^{\sigma^D} \mathcal{A}_{bi}^D. \tag{C.18}$$

Hence,

$$p_{bi}^D \;=\; \frac{\mathcal{A}_{bi}^D (r_b^D)^{\sigma^D}}{\sum_{b'} \mathcal{A}_{b'i}^D (r_{b'}^D)^{\sigma^D}}, \tag{C.19}$$

which is equation (8).

C.2 Proof of Elasticities: (26) and (27)

Starting from the expression for expected profits, and substituting in $W_b = (L_b - D_b)$ using the balance-sheet identity (23), we obtain

$$\pi_b^B = \left[R_b^L - R_W\right] L_b - \left[R_b^D - R_W\right] D_b. \tag{C.20}$$

The first order conditions are given by,

$$\left(R_b^L - R_W\right) \frac{\partial L_b}{\partial R_b^L} + L_b = 0, \tag{C.21}$$

$$(R_b^D - R_W) \frac{\partial D_b}{\partial R_b^D} + D_b = 0, \tag{C.22}$$

which in turn give the respective markup and markdown conditions:

$$R_b^L = R_W - R_b^L \varepsilon_{L/R_b^L}^{-1}, \tag{C.23}$$

$$R_b^D = R_W - R_b^D \varepsilon_{D/R_b^D}^{-1}. \tag{C.24}$$

where $\varepsilon_{L/R_b^L} \equiv \partial \ln L_b / \partial \ln R_b^L < 0$ and $\varepsilon_{D/R_b^D} \equiv \partial \ln D_b / \partial \ln R_b^D > 0$, implying:

$$R_b^L = \frac{1}{1 + \varepsilon_{L/R_b^L}^{-1}} R_W \tag{C.25}$$

$$R_b^D = \frac{1}{1 + \varepsilon_{D/R_b^D}^{-1}} R_W \tag{C.26}$$

C.3 Proof of Optimal Interest Rate Conditions: Equation (24)

Equations (C.25) characterizes the bank's optimal baseline interest rates or risk-free equivalent. Loans extended to firms are subject to idiosyncratic default risk and bank-firm specific intermediation frictions. Let G_f denote the probability of default for firm f, and $\alpha \in [0, 1]$ the loss-given-default (LGD) parameter, such that the bank's expected recovery rate on a unit of loan is $(1 - \alpha G_f)$. Furthermore, let $\mathcal{A}_{bf}^R$ denote a bank-firm specific wedge. For the bank to be willing to issue the loan, the expected return on the firm-specific loan (net of default losses) must be equal to the target baseline return R_b^L, adjusted by the idiosyncratic wedge $\mathcal{A}_{bf}^R$. This no-arbitrage condition requires:

$$R_{bf}^L \times \underbrace{(1 - \alpha G_f)}_{\text{Expected Repayment Share}} = R_b^L \times \underbrace{\mathcal{A}_{bf}^R}_{\text{Cost/Markup Wedge}} \tag{C.27}$$

Rearranging (C.27) yields the optimal firm-specific rate:

$$R_{bf}^L \;=\; R_b^L \frac{\mathcal{A}_{bf}^R}{1-\alpha G_f}. \tag{C.28}$$

C.4 Expressions for Elasticities

We start with computing the derivative of loan demand L_b to the interest rate R_b^L

$$\frac{\partial L_b}{\partial R^L} = \int_f \left(\frac{\partial p_{bf}}{\partial R_b^L} \ell_f + \frac{\partial \ell_f}{\partial R_b^L} p_{bf} \right) df \tag{C.29}$$

We compute both derivatives inside the bracket:

$$\frac{\partial p_{bf}}{\partial R_b^L} = \frac{\partial p_{bf}}{\partial u_{bf}} \frac{\partial u_{bf}}{\partial R_{bf}} \frac{\partial R_{bf}}{\partial R_b^L} \tag{C.30}$$

$$= -\sigma^L \frac{1}{u_{bf}} p_{bf}(1-p_{bf}) q(1-\alpha G_f) \frac{\mathcal{A}_{bf}^R}{1-\alpha G_f} \tag{C.31}$$

$$= -\sigma^L \frac{1}{R_{bf}^L(1-\alpha G_f)+\delta-1} p_{bf}(1-p_{bf}) \mathcal{A}_{bf}^R \tag{C.32}$$

$$\frac{\partial \ell_f}{\partial R_b^L} = \frac{\partial \ell_f}{\partial R_f^L} \frac{\partial R_f^L}{\partial R_b^L} = q \frac{\partial k_f}{\partial u_f} \frac{\partial u_f}{\partial u_{bf}} \frac{\partial u_{bf}}{\partial R_{bf}^L} \frac{\partial R_{bf}^L}{\partial R_b^L} \tag{C.33}$$

$$= -q \frac{1-\lambda}{1-\lambda-\kappa} \frac{k_f}{u_f} \mathcal{A}_{bf}^L \left(\frac{u_{bf}}{u_f} \right)^{-1-\sigma^L} q(1-\alpha G_f) \frac{\mathcal{A}_{bf}^R}{1-\alpha G_f} \tag{C.34}$$

$$= -q^2 \frac{1-\lambda}{1-\lambda-\kappa} q k_f \mathcal{A}_{bf}^L u_f^{\sigma^L} (u_{bf})^{-1-\sigma^L} \mathcal{A}_{bf}^R \tag{C.35}$$

Putting everything together gives

$$\begin{aligned} \frac{\partial L_b}{\partial R_b^L} =& -\sigma^L \int_f \frac{\ell_f}{R_{bf}^L(1-\alpha G_f)+\delta-1} p_{bf}(1-p_{bf}) \mathcal{A}_{bf}^R df \\ & - q^2 \int_f \frac{1-\lambda}{1-\lambda-\kappa} k_f \mathcal{A}_{bf}^L u_f^{\sigma^L} (u_{bf})^{-1-\sigma^L} \mathcal{A}_{bf}^R p_{bf} df \end{aligned} \tag{C.36}$$

and the elasticity is given by

$$\begin{aligned} \frac{R_b^L}{L_b} \frac{\partial L_b}{\partial R_b^L} =& -\sigma^L \int_f \frac{\ell_f}{L_b} \frac{R_b^L}{R_{bf}^L(1-\alpha G_f)+\delta-1} p_{bf}(1-p_{bf}) \mathcal{A}_{bf}^R df \\ & - q^2 \int_f \frac{1-\lambda}{1-\lambda-\kappa} k_f u_f^{\sigma^L} (u_{bf})^{-1-\sigma^L} \frac{R_b^L}{L_b} \mathcal{A}_{bf}^L \mathcal{A}_{bf}^R p_{bf} df \end{aligned} \tag{C.37}$$

We now turn to the elasticity of deposits to the deposits rate. It is

$$\frac{\partial D_b}{\partial R_b^D} = \int_h \frac{\partial p_{bh}^D}{\partial r_b^D} \frac{\partial r_b^D}{\partial R_b^D} d_h dh \tag{C.38}$$

The derivative of p_{bh}^D to r_b^D inside the bracket is given by

$$\frac{\partial p_{bf}^D}{\partial r_b^D} = \sigma^D \frac{1}{r_b^D} p_{bh}^D (1 - p_{bh}^D) \tag{C.39}$$

Putting everything together gives

$$\frac{\partial D_b}{\partial R_b^D} = \sigma^D \frac{1}{r_b^D} \int_h p_{bh}^D (1 - p_{bh}^D) d_h dh \tag{C.40}$$

and the elasticity is given by

$$\frac{R_b^D}{D_b} \frac{\partial D_b}{\partial R_b^D} = \sigma^D \frac{1 + r_b^D}{r_b^D} \int_h \frac{d_h}{\int p_{bh}^D d_h dh} p_{bh}^D (1 - p_{bh}^D) dh \tag{C.41}$$

D Additional Model Results

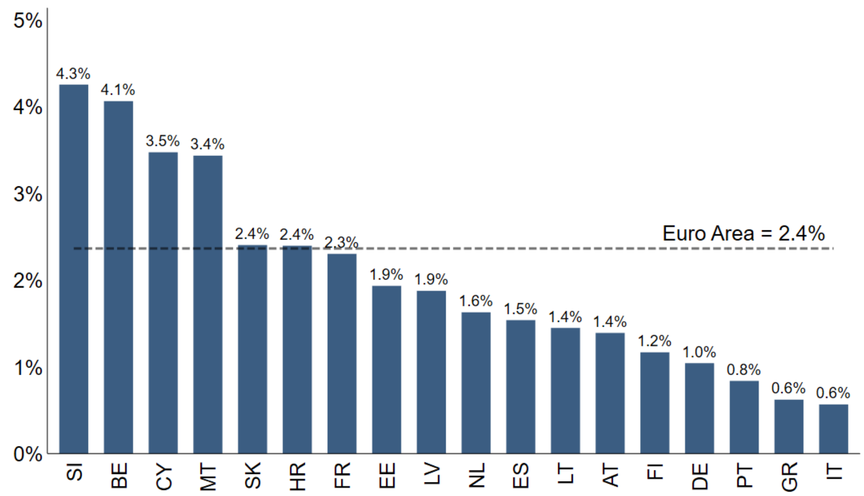


Figure D.1: Increase in Productive Capital

Notes: This figure shows the counterfactual change in productive capital across euro area countries resulting from the removal of estimated cross-border barriers. Changes are computed using the calibrated structural model.

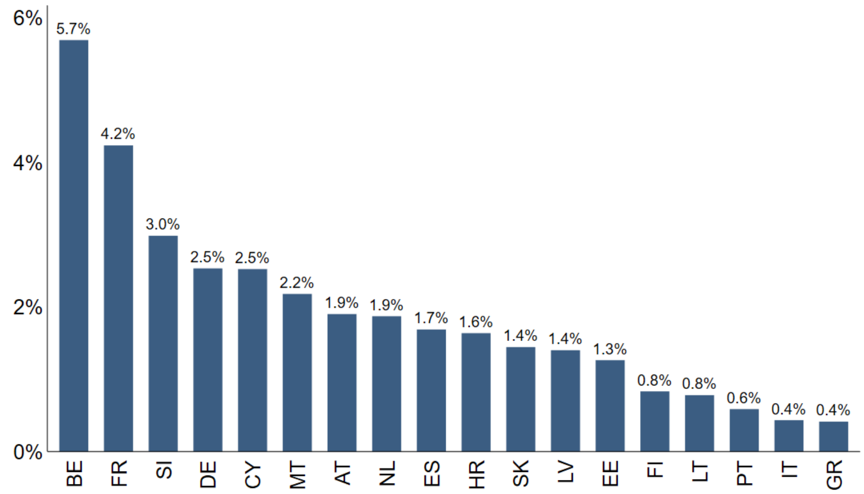


Figure D.2: Increase in Lending

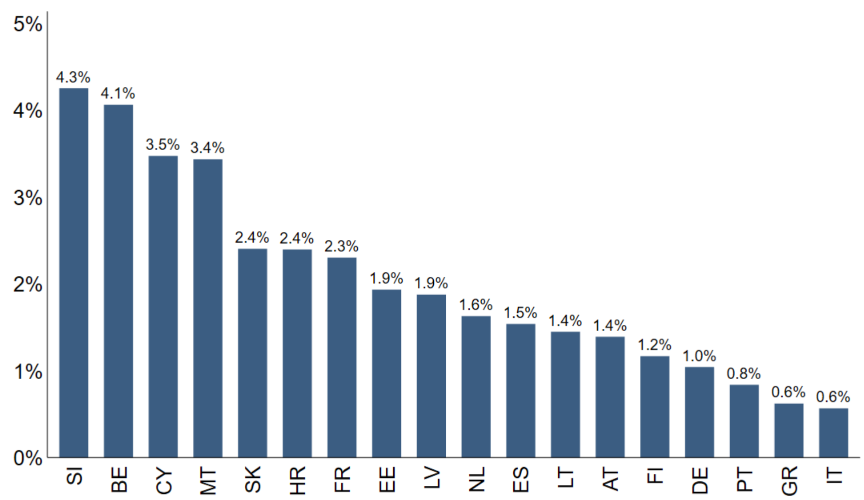
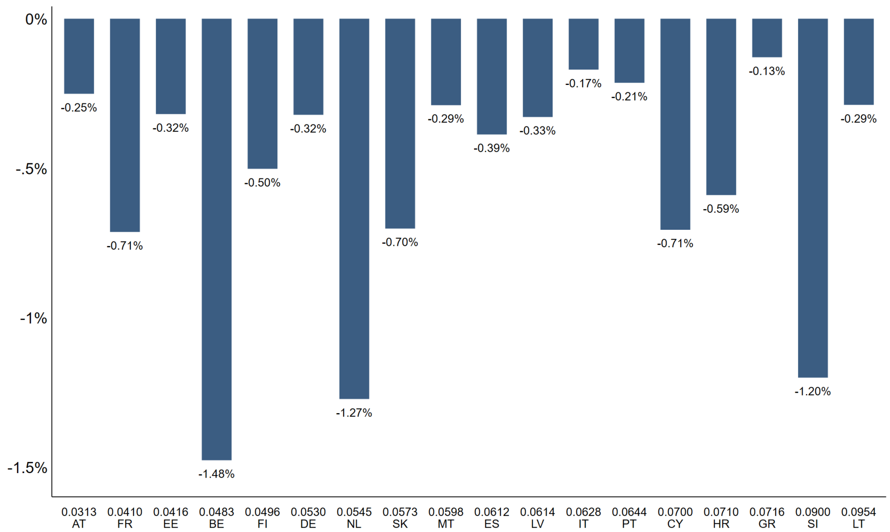
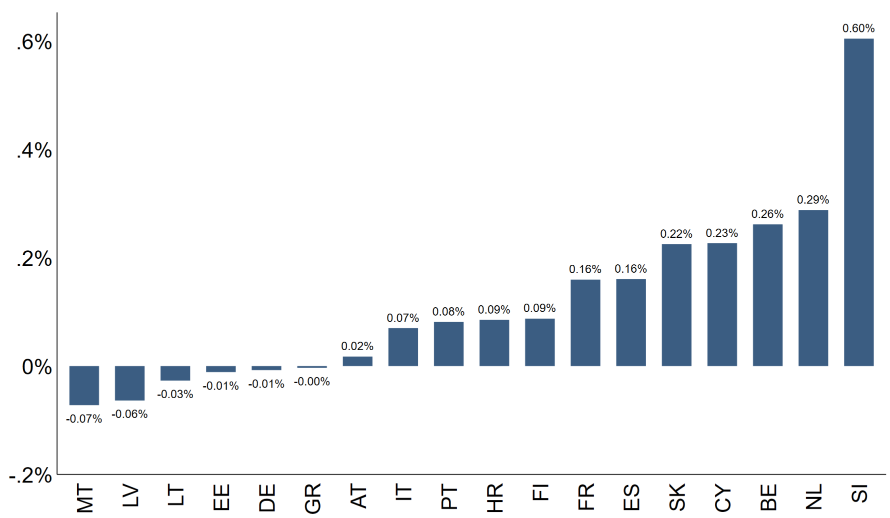


Figure D.3: Increase in Borrowing

Notes to Figures C.6 and C.7: These figures illustrate the estimated changes in cross-border lending and borrowing volumes resulting from the reduction of regulatory barriers and financial fragmentation.



(a) Change in Average User Costs



(b) Change in Variance of log(User Costs)

Figure D.4: Effects of Banking Integration on User Costs of Capital

Notes: The figure reports the effects on user costs of a 10% reduction in cross-border relationship wedges (τ^L) across all country pairs. Panel (a) shows the percent change in average user costs for each euro area country, relative to the baseline calibration. Panel (b) shows the percent change in the variance of log(user costs), relative to the baseline calibration.

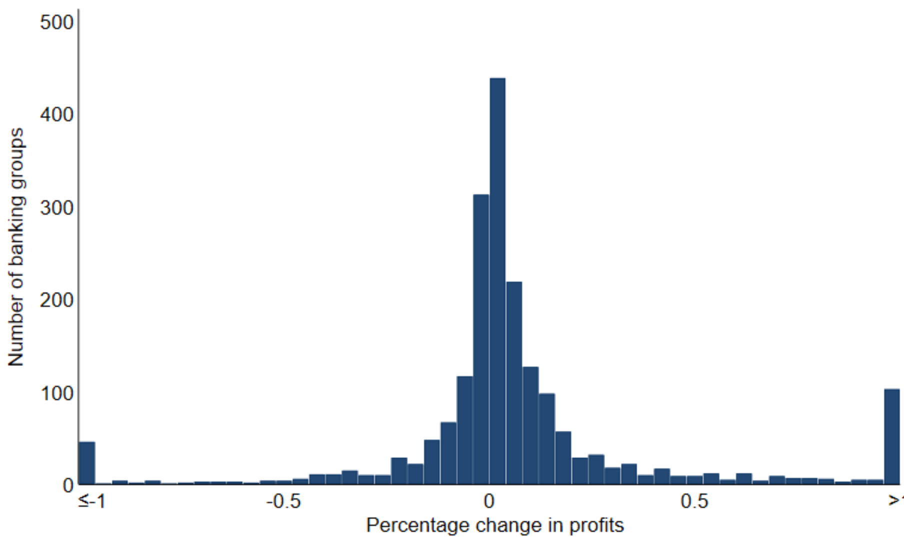


Figure D.5: Cannibalization Test: Change in Banking Groups' Profits

PUBLICATIONS

Barriers to a European Banking Union
Working Paper No. WP/2026/123