Banks, Market Segmentation, and Local Development*

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Abstract

We document differences in interest rates for comparable loans across cities in Chile and investigate the causes and consequences of this geographical segmentation in capital markets. Using rich credit registry data, our evidence suggests that local market power in interest rate setting by banks and inter-bank frictions contribute to these differences. To assess the impact of capital market segmentation, we develop a quantitative spatial model with national banks located in different cities that is able to match the empirical patterns. Counterfactual exercises imply that reducing inter-bank market frictions would result in XX% welfare gains, while implementing pro-competitive measures in the banking industry would yield YY% welfare gains.

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1 Introduction

Explaining the drivers of income inequality between cities is among the central questions in spatial economics and a crucial step toward designing effective place-based policies. In this paper, we study the role of differences in the cost of investment (the interest rate that banks charge for their loans) across cities. We document that these differences are large and develop a framework that allows us to analyze policies equalizing the cost of investment across cities.

The first contribution of this paper is to document, using rich credit registry data from Chile, that differences in interest rates across cities are substantial. A firm located in a city at the 25th percentile of the distribution of interest rates faces an interest rate of XX basis points lower than a comparable firm receiving a comparable loan located in a city at the 75th percentile. Differences in interest rates between cities result from two characteristics of local credit supply: local competition between banks and the identity of the banks. As pointed out in other studies, the cost of issuing loans for a bank depends on the pool of cities the bank can tap into to attract deposits, highlighting the importance of studying banks jointly from the perspective of deposits and loans (Aguirregabiria et al., 2020; Oberfield et al., 2024).

The extent to which interest rate differentials will translate into output and welfare differences across cities is mediated by several channels: if interest rates in a city are high and the stock of capital is low, wages in that city would also be low due to complementarities between capital and labor. Fewer workers would be attracted to such a city due to the low wages, leading to a reduction in market access, and the incentives to invest for local firms. Our second contribution is to incorporate these general equilibrium channels by embedding banks into a quantitative spatial model with trade and migration. We use the quantified version of the model to study the effects of different policies aimed at reducing differences in the cost of capital across cities and find XXXX.

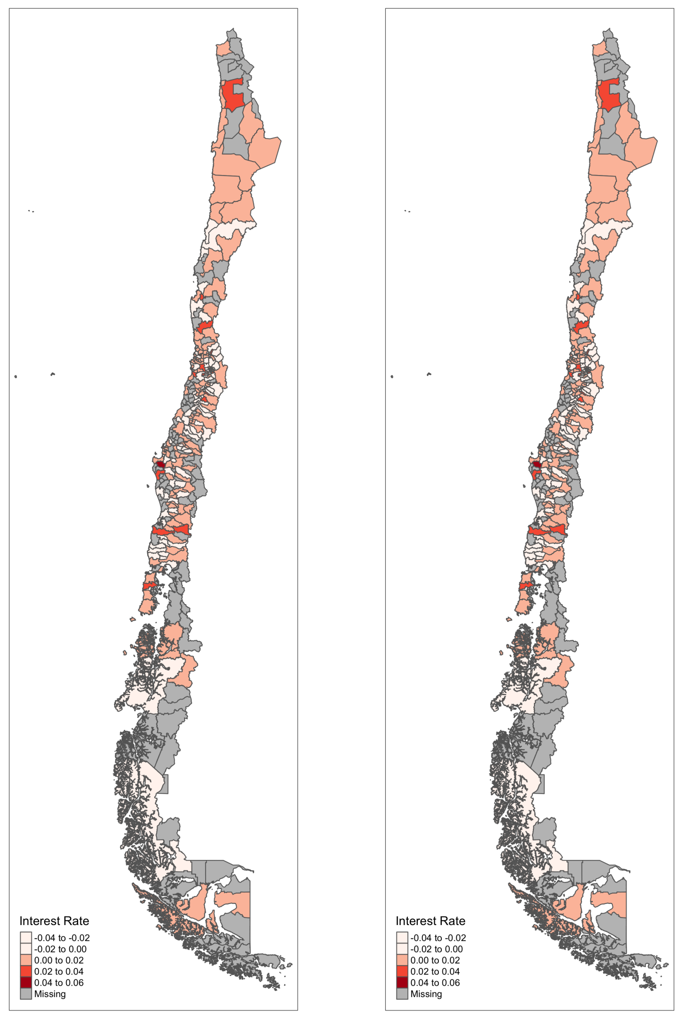
In the empirical section we document novel facts about geographical interest rate differentials. Most empirical studies of the spatial distribution of banks and their interaction within cities rely on aggregate data on deposits and loans at the bank-city level. This data typically reports only the average interest rate among all outstanding loans or deposits and studies have thus abstracted from interest rate data (Aguirregabiria et al., 2020; Bustos et al., 2020; Oberfield et al., 2024). We can overcome this limitation by leveraging detailed credit registry data from Chile, where we observe a rich set of borrower characteristics and loan characteristics.

Our first finding is that differences in interest rates across cities are substantial. Figure 1a shows the average interest rate for loans in each city in Chile during the period 2015-2023. Naturally, these differences could arise for various reasons: the loans being issued by different banks, differences in the borrowing firms in terms of size or sector, or riskiness. To address these issues we regress loan-specific interest rates on a battery of controls, including bank and city fixed effects (see Section 3 for details). The results, shown in Figure 1b, imply that banks charge different rates on similar loans issued to similar firms depending on the city in which that firm is located. Moreover, bank-fixed effects are also substantial (SHOW STH, GG: What do you mean by substantial?).

What underlies the interest rate differentials across cities? The first driver is the identity of local banks. This follows mechanically from the dispersion in bank-fixed effects. Bank-fixed effects can, in turn, be linked to the network of banks throughout the country: banks for which raising funds is costly will charge higher interest rates than those who can tap into funds easily. We document that following a positive shock to deposits in a region, banks affected by the shock lower their interest rates and issue more loans elsewhere (CHECK, GG: was not this checked already? MS: Yes for loans, not for rates.). Interestingly, the growth in loans happens homogeneously in all cities in the country, independent of the distance to the shock, and we do not find evidence of an increase in interbank lending. This result suggests there are frictions in the interbank market; if banks could lend to each other seamlessly, capital should flow to its highest return, independent of the identity of the banks present in a city. This result is aligned with other findings from Brazil and the United States (Gilje et al., 2016; Gilje, 2019; Bustos et al., 2020).

Figure 1: Geographical Differences in Interest Rates

(a) No Controls (b) With Controls



Our second empirical result is that local competition between banks matters. All else equal, cities in which competition between banks is stronger have lower interest rates. This stands in line with theoretical models of bank competition (Aguirregabiria et al., 2020), but the richness of our data allows us to substantiate empirically the role of competition.

These two empirical facts suggest that the geographical distribution of banks shapes how costly it is to finance new investments in different cities. How do these differences translate into differences in the stock of capital and, ultimately, income and welfare differences across cities? To speak to these questions, we embed banks into an otherwise standard quantitative spatial model with migration based on Kleinman et al. (2023). The model takes the geographical presence of banks as given and accounts explicitly for their strategic interaction at the local level. To speak to our results on capital flows within the bank network, we assume there are frictions in the inter-bank market. We quantify the model to match the data.

We used the quantified model to study the consequences of both local market power and the inter-bank frictions for interest rates. For the first exercise, we assume that savers and borrowers are not limited to the banks available in their city and can costlessly access all banks present in the country, therefore equalizing market power across cities. This leads to a XX effect on income and YY on the aggregate capital stock. The effects are heterogeneous: XXXX-YYYY. Our second exercise eliminates the frictions in the inter-bank market, where now banks can borrow and lend to each other seamlessly. We find ZZ.

The rest of this paper is organized as follows. In the remainder of this section, we discuss our contribution to the literature. In Section 2 and Section 3 we provide context for the Chilean setting and describe the data and our empirical findings. In Section 4 we present the quantitative spatial model with banks and quantify it in Section 5. In Section 6 we use the quantified model to study several policy counterfactuals. Section 7 concludes.

Related literature. We contribute mainly to the literature studying the determinants of spatial inequality. By highlighting the importance of bank branches at the local level, we relate to the literature on finance and industrial organization studying local credit markets and the economic effects of bank branches.

Differences in the cost of investing or capital intensity have been proposed as drivers of income differences between countries but not within countries (Lucas, 1990; Alfaro et al., 2008; Acemoglu and Dell, 2010). Acemoglu and Dell (2010) argue there is no role for such a mechanism since capital mobility within countries should be practically free. Our novel empirical results from Chile exploiting detailed credit-registry data run against that intuition. The model we build in the second part of the paper allows us to think about the quantitative importance of the frictions to capital mobility within countries coming from banks.

Imperfect capital mobility within countries as a result of the bank network has been studied in Brazil (Bustos et al., 2020) and the United States (Gilje et al., 2016; Gilje, 2019). Bustos et al. (2020) exploit a shock in savings in agricultural areas in Brazil. Following the shock, they compare urban areas integrated with the agricultural area through the bank network with those unconnected to it. They show that investment increased in the former relative to the latter, implying that capital does not flow perfectly across banks. Gilje et al. (2016) and Gilje (2019) find similar results exploiting shocks in the gas and oil industries in the United States. These are empirical papers and do not attempt to explore the general equilibrium effects of geographical segmentation in capital markets nor introduce local market power from banks' perspective. We build on these papers and propose similar empirical exercises (using shocks to the price of salmon) and find similar results, which we use to estimate parameters in our model. Moreover, having access to more detailed loan data, we can dig deeper into the mechanisms proposed by Bustos et al. (2020) and verify that movements in the interest rate explain the results (MAYBE).

Recent papers in the literature on spatial economics introduce capital to study short-run phenomena. Kleinman et al. (2023) introduce capital accumulation into a quantitative spatial model with migration and use it to study how capital accumulation affects convergence dynamics. Our model incorporates banks. A closely related paper to ours is Manigi (2023), which embeds banks into a quantitative spatial model and uses it to study the impact of deposit reallocation between banks. The contributions of our model relative to Manigi (2023) are two-fold. First, we make the supply of deposits into each bank branch, not only loan demand, endogenous. This is important because the supply of deposits in each city interacts with the reasons for taking loans. Secondly, our model allows for inter-regional trade and migration, while Manigi (2023) ignores the latter. A key difference between these two papers and ours is our focus on steady-state outcomes, instead of short-run phenomena.

Studies in both finance and industrial organization have highlighted the role of local market power when banks set interest rates (Aguirregabiria et al., 2020; Morelli et al., 2024; Oberfield et al., 2024). Aguirregabiria et al. (2020) analyze the bank network in the United States and highlight the role of local competition between banks. These studies also acknowledge that the cost of issuing loans is not the same across banks and is partly determined by the pool of deposits they can tap into. Morelli et al. (2024) introduces uncertainty and allows for geographical diversification to affect banks' marginal costs. Relative to this literature, we can improve the analysis by observing the universe of loans. At the theoretical level, the main contribution of our paper is to study the bank network jointly with the distribution of workers across locations. Oberfield et al. (2024) focus on the endogenous entry decision of heterogeneous banks across locations leveraging the changes in regulation in the United States after the repeal of the Riegle-Neal (CHECK). Our main contribution relative to these papers is to study the interaction in the banking industry jointly with other determinants of investment at the local level. We micro-found the demand for investment in cities and allow for linkages between capital and labor markets by endogenizing local population.

At the heart of our analysis and most of the papers discussed above is the idea that workers rely disproportionately on bank branches available locally. This idea is backed by a rich empirical literature studying the importance of bank branches for local credit. Nguyen (2019) finds, using data from the United States, that bank branch closures induced by mergers have a negative impact on the credit provided to small firms in that census tract. The author's interpretation of the mechanism focuses on the value of information that local bank branches are able to collect.

2 Context and data

Chile stands out in Latin America for its advanced financial development. Between 2010 and 2018, credit levels to the private sector were comparable to those in High-Income countries, with banks providing nearly 80% of this credit.[1] Survey data reveals that firms of all sizes rely heavily on banks, and households primarily choose banks as their preferred depository institution. Additionally, survey evidence shows that internet usage for financial transactions remains limited.[2] Based on these findings, in the rest of the paper, we focus exclusively on banks and assume that households and firms rely solely on the banking institutions available in their city.

The banking industry in Chile is highly concentrated. Between 2010 and 2018, the largest bank held a market share of approximately 20% in loans, the top three banks accounted for just under 60%, and the top five banks controlled around 80%. Collectively, the ten largest banks dominate nearly the entire market. The market for deposits exhibits a similar level of concentration.[3] Given the limited number of major players, the following sections will document the presence of local market power and explore its implications in our theoretical analysis. This stands in contrast with the case in other countries where large banks co-exist with small, local banks. Cite Paravisini, Gilje.

Between 2010 and 2018, the geographical network of banks in Chile remained stable. As shown in the first panel of Figure 2, the number of new and disappearing bank-city pairs fluctuated around 2% of the total, indicating that most cities saw little change in bank branch presence during this period.[4] Given this stability, we take the bank network as given and do not incorporate branch location decisions. Additionally, banks do not exhibit geographical clustering. Using the approach from Conley and Topa (2002), we find no statistically significant geographical correlation between bank presence and market share at various distances.[5] This underscores one of the paper's contributions: financial linkages between cities via the bank network are somewhat independent of other geographically driven linkages, such as trade and migration connections.

As in the United States, banks in Chile facilitate capital flow between cities (Aguirregabiria et al., 2020).

[1] See Appendix Section A.1.

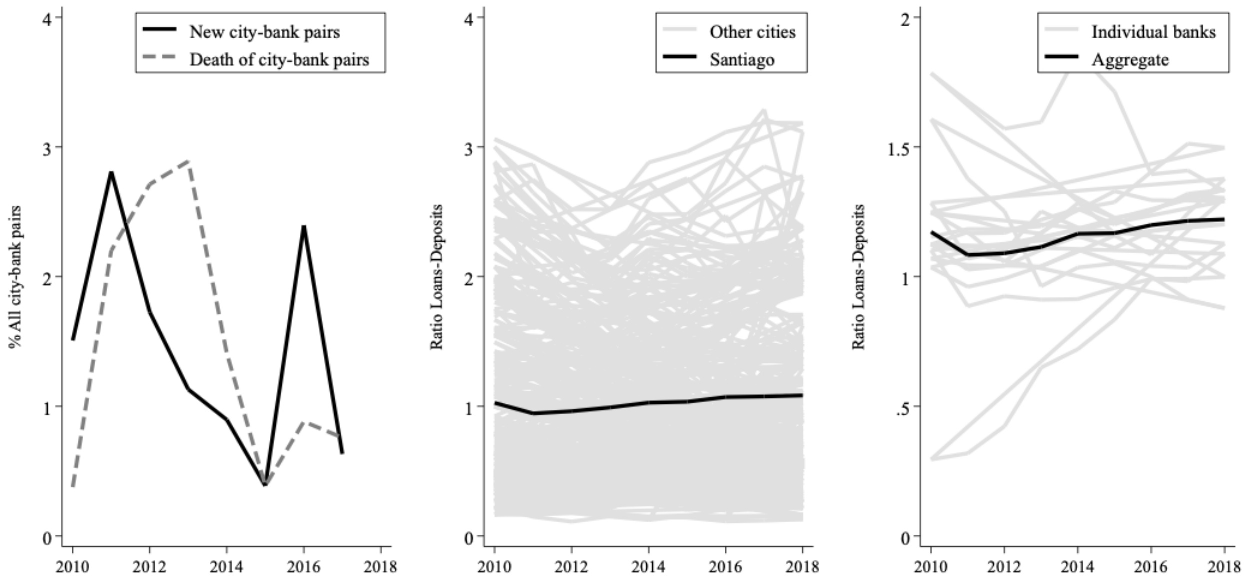
[2] See Appendix Section A.2.

[3] See Figure 9 in the Appendix Section A.3.

[4] In contrast, the United States historically regulated banks' ability to operate across state lines, leading to a variety of state-based banks. Oberfield et al. (2024) examine this geographical expansion.

[5] Results are presented in the Appendix Section A.4.

Figure 2: Banks and Financial Linkages between Cities



The middle panel of Figure 2 shows the ratio of loans to deposits across all Chilean cities. Some cities have a surplus, while others have a deficit, with capital moving between them through the banking network. The capital city, Santiago, is remarkably close to having a balanced capital account despite comprising $XX\%$ of the GDP in the country. The last panel of Figure 2 displays this ratio by bank, indicating that some banks rely on external funding sources to issue loans while others invest in assets beyond private-sector loans. Overall, however, the ratio of loans to deposits in the banking industry is close to one. Our model incorporates an inter-bank market with frictions but abstracts from other funding sources, such as equity, or other types of assets, like government bonds. We note here that these assumptions approximate the functioning of the banking industry taken as a whole.

Data. We use micro and aggregate data from four Chilean sources: the Unemployment Funds Administrator (AFC, in Spanish), the Financial Market Commission (CMF, in Spanish), Electronic Invoices (DTE, in Spanish), and geolocation information about firms and their branches. SOMETHING ON THE TIME FRAME.

Unemployment Funds Administrator: AFC is the regulated private entity that manages the contributions that every employed formal worker and their employer make to the worker's unemployment insurance fund. Monthly contributions are a defined percentage of the worker's salary. The database contains identifiers for both employers and employees, allowing us to construct a panel of workers across time. Some limitations of this data are that it only covers the private sector (excluding free-lance workers) and contributions are capped. Because contributions are capped, we can not recover actual wages for employees making more than 5,000 USD monthly.

Financial Market Commission: The CMF is the public agency that supervises the correct functioning, development, and stability of Chilean financial markets. The Commission collects detailed data from financial institutions under its regulatory umbrella to achieve its goals. For the part of our analysis relying on micro-data at the loan level, we focus on new loans that private firms take from commercial banks. We impose that these loans have to be denominated in Chilean pesos, not be associated with any kind of public guarantee, and have maturities ranging between 3 days and 10 years. We observe the amount and the associated interest rate of the loan. CHECK: We also see whether the firm has fallen into indebtedness in the past. We also see the total debt of the firm and whether the firm has defaulted on its debt in the last X years. The database contains identifiers both for banks and private firms.

We draw from data made publicly available by the CMF to construct aggregate outstanding loans and deposits at the bank-city level. Here we keep deposits and loans denominated in local currency, inflation-adjusted units, and foreign currency. We sum loans for commercial and mortgages purposes, and we sum deposits with different degrees of liquidity.

Electronic Invoices: Every formal transaction between firms must be registered electronically for tax purposes in what is called a DTE. This requirement became mandatory for all large firms in November 2014, while for the rest of firms compulsory adoption was imposed in a staggered way depending on firm size and whether the firm operated in an urban or rural area. By February 2018, coverage became universal. DTEs have information about the selling firm, the purchasing firm, product prices, product quantities, and a short description of every item included in the invoice. The sample only covers transactions between domestically based firms. Information has a daily frequency, but we aggregate it to monthly. WHAT DO WE USE THIS DATA FOR?

Headquarters and branches geolocation: To assign a municipality to every headquarter and branch reported by a firm, we rely on the legal requirement that, for tax purposes, every firm must report the location of their headquarters and its branches to the tax authority. Firms must also inform the authority of every change in the location of their branches within a 2-month window of any change. However, information is not updated regularly. We use the most recent issue of this database, which corresponds to December 2021.

We impose two additional filters on the sample. We require that firms must be present in the Firms' Directory that Chilean National Accounts use to compile their official statistics and that they have an average of 3 employees over the whole time period. We are thus left with a total of 160,482 firms over the whole sample. NO ME QUEDA CLARO A QUE DATA SOURCE APLICA ESTO. POR EJEMPLO, LAS LOANS SON SOLO LAS DE ESTAS FIRMAS?

3 Empirical analysis

Using several data sources from Chile, we document a set of novel facts about the dispersion of interest rates in space and the role of banks and local branches in explaining geographical variation in the cost of capital.

Fact 1: There is substantial dispersion in interest rates across cities. To capture geographical variation in the interest rates, we use data on the universe of loans to estimate the following equation

$$i_{\ell ft} = \delta_0 + \delta_t + \delta_{s(f)} + \delta_{c(f)} + \delta_b(\ell) + \sum_{\tau} \beta_\tau \times \mathbb{1}\{size_{ft} \in \tau\} + \gamma \times X_{\ell t} + \epsilon_{\ell ft}, \tag{1}$$

where $i_{\ell ft}$ is the net interest rate charged for loan ℓ extended to firm f at period t. We control for characteristics of the firm, including the firm's sector $s(f)$, city $c(f)$, and size. We measure the latter as the firms' employment decile in year t. We also include characteristics of the loan itself $X_{\ell t}$. These include the bank issuing the loan, $b(\ell)$, maturity, and the type of loan.

We are interested in the city-level fixed effects $\delta_{c(f)}$ in equation (1). Given that equation (1) includes year-level fixed effects, city-level fixed effects capture deviations relative to the yearly mean. Table 1 below shows the regression results as we progressively add more controls. Instead of showing the $\delta_{c(f)}$ directly, in each of the rows, we subtract the median among all $\delta_{c(f)}$ for that specification in order to focus on the dispersion between city-level fixed effects. Our results indicate that the difference in interest rates charged on a comparable loan issued to similar firms located in low-rate (percentile 10) versus high-rate cities (percentile 90) is 43 basis points.

Table 1: Dispersion in interest rates

Normalized percentile p of $\delta_{c(f)}$		i_{zt}		$ln(w_{it})$
$p = 10$	-0.212	-0.189	-0.178	-0.011
$p = 25$	-0.163	-0.15	-0.138	-0.008
$p = 75$	0.108	0.1	0.091	0.006
$p = 90$	0.285	0.271	0.253	0.016
Bank FE	No	Yes	Yes	-
Type of Loan FEs	No	No	Yes	-

How does the dispersion documented in Table 1 compare to that in other, more studied variables? An extensive literature in economic geography explores the causes behind the "urban wage premium"; workers earn higher wages in larger cities (Glaeser and Maré, 2001; Gould, 2007). With this literature in mind, we consider dispersion in labor incomes between cities as a benchmark. Following a similar procedure to the one described above, we measure dispersion in labor incomes in our empirical setting by estimating the following equation

$$log(w_{ift}) = \tilde{\delta}_t + \tilde{\delta}_{s(f)} + \tilde{\delta}_{c(f)} + \alpha_{edu(i)} + \tilde{\beta}_1 \times age + \tilde{\beta}_2 age^2 + \epsilon_{it}, \quad (2)$$

where w_{ift} is the wage of worker i employed by firm f in year t. We control for the employment sector, as well as worker characteristics like education, age, and age squared. We are interested, as before, in city-level fixed effects $\tilde{\delta}_{c(f)}$. Regression results are shown in the last column of Table 1. Our results indicate that the wage difference earned by similar workers employed in the same sector by similar firms in low-wage cities (percentile 10) versus high-wage cities (percentile 90) is 2.7 basis points.

The takeaway from comparing the last two columns of Table 1 is that between-cities variation in interest rates is larger than between-cities variation in wages. Note that because interest rates are low in absolute value, the specification equation (1) is similar to having expressed the left-hand side in logarithms but using the gross instead of the net interest rate, making these two columns comparable.

Variance decomposition. A limitation of comparing city-level fixed effects in Table 1 is that it does not normalize the variation induced by geography for the overall variation in the outcome variables, interest rates, and wages. To address this, we now focus on the contribution of city-level fixed effects to the overall variation explained by different factors.

We follow the method in Gibbons et al. (2014), which decomposes wage variation in individual and group effects. First, we regress the outcome variable of interest (interest rates or wages) on firm characteristics like industry and firm size. The R-squared of these regressions captures the proportion of overall variance explained by these two variables. Second, we repeat the same regression but add city-level fixed effects. The difference between the two R-squared measures informs us about the share of variation, which can be attributed to city-level fixed effects. For interest rates, we perform the analysis separately by type of loan, where two primary categories exist: traditional installment loans and factoring loans. "Factoring loans" are loans in which the borrower uses outstanding invoices as collateral, and are very popular in Chile (they represent approximately 14.8% of the value of total credit activities by banks with firms). For wages, we analyze different sub-samples by the education level of the workers.

The last column of Table 2 shows the variance decomposition results. City-level fixed effects explain 1.3%-1.9% of the overall variation in interest rates (depending on the type of loan), compared to 4.0%-6.9% of the overall variation in log-wages (depending on the worker's education level). Hence, geography plays a smaller role in explaining overall variation in interest rates than wages. These results are consistent with those in Table 1; because there is more variation in interest rates the higher dispersion in city-level fixed effects plays a smaller role in explaining variation in interest rates.

Table 2: Variance decomposition

	R^2 with fixed effects by...		Difference
	Industry + Size	Industry + Size + City	
A. Interest rates as the outcome variable			
Loans	0.333	0.346	0.013
Factoring	0.597	0.616	0.019
B. Log-wages as the outcome variable			
< High-school	0.156	0.226	0.069
High-school	0.151	0.191	0.040
College	0.188	0.236	0.048

Fact 2: Shocks to deposits propagate as loans across the bank network, not through gravity.

In this fact, we explore how capital propagates through space and consider two potential channels: the bank network and physical distance. If there are frictions in the interbank market, capital will flow within banks across cities, and therefore cities more financially integrated will have higher access to capital. Alternatively (or in addition), there might be geographical friction to the movement of capital. In this case, cities physically close to deposits will have higher access to capital.

Propagation of shocks. Add interest rates as outcome variable To test the role and relevance of both the bank network and physical distance, we estimate the impact of a shock to deposits in a particular region of the country on loans in other regions of the country. We then study how these effects vary with physical distance and financial distance, namely whether two cities share a bank.

We estimate the relationship between new loans issued by bank b in city i and shocks to deposits in all other city-bank pairs. We group other cities $j \neq i$, in sets $\mathcal{J}_{\tau_i}$ where τ measures the distance from i. We group distance in six categories τ spanning approximately 250 km intervals and estimate

$$\log\left(I^b_{it}\right) = \Phi_i + \Phi_t + \sum_{\tau=1}^{6} \beta_\tau \log\left(D^b_{\tau_i}\right) + \sum_{\tau=1}^{6} \tilde{\beta}_\tau \log\left(D^{-b}_{\tau_i}\right) + \epsilon_{it}. \tag{3}$$

The coefficients β and $\tilde{\beta}$ in equation (3) capture the importance of geographical and bank networks. If within-country capital flows were determined by gravity and not the bank network, both coefficients should be similar and decrease in τ. If, instead, the bank network was more important, the coefficients on shocks to deposits in the own bank β should be positive and independent of distance, while $\tilde{\beta}$ should be close to zero.

There are several reasons why shocks to deposits could be correlated to shocks to investment, leading to biased estimates of the coefficients in equation (3) through OLS. For example, if productivity shocks were geographically correlated. To estimate the coefficients in equation (3), we follow a shift-share instrumental variables approach, where we instrument for new deposits in the city j and bank b, D^b_{jt}, using shocks to the world price of fishery products and the share of employment in fisheries in city j. Instrumenting deposits through shocks to the price of the fishery is convenient for several reasons. First, it is a geographically clustered industry, where local firms located on the country's southern coasts produce and export to world markets. Chilean exports represent a small world market share, making price changes exogenous. Finally, most fishing firms have their headquarters in the same cities where production occurs, eliminating concerns that profits in the industry would be reflected in Santiago instead of the fishing cities. See Appendix for more details COMPLETE APPENDIX.

Our instrumental variables approach follows the empirical strategy in Bustos et al. (2020), who use the adoption (?) of GMO soybeans as an instrument instead of changes in world prices. The first stage of the instrumental variables strategy is given by

$$\log(D^b_{jt}) = \gamma_0 + \gamma_1 s^f_j \log(p^f_{t-6}) + \nu_{jt}, \tag{4}$$

where D_{jt} is the flow of new deposits in city j, s^f_j the share of employment in the fishing industry in the year 2015, and p^f_t is the export price of fishing products in period t. We lag the price of fishery products, as it should take some time before prices translate into higher wages for employees in a fishing city and, ultimately, deposits.

After running the first stage, we keep the predicted values of deposits at the city-bank pair $\hat{D}^b_{jt}$ which come from equation (4). Then, for each city-bank pair cb we sum the exogenous shocks to deposits in all other cities, distinguishing between shocks to the same bank and all other deposits b'. This gives us the exogenous measures of the elements on the right-hand side of equation (3). Figure **??** shows, in red, the coefficients β_τ and in blue, the coefficients $\tilde{\beta}_\tau$.

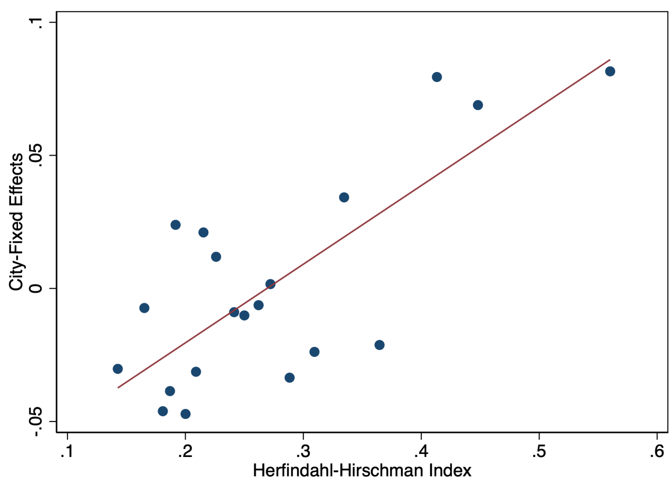
The the bank network plays a much more important role than distance. Shocks to deposits in the same bank translate to other cities where the bank is present, while shocks to other banks don't increase lending regardless of geographical distance.

Fact 3: Interest rates are higher in cities with weaker competition between banks. After showing that interests vary between cities, we now turn to what may explain that variation. We consider competition between banks. We use $\mathcal{B}^c$ to denote the list of banks active in the city c and s_{cbt} to denote the share of loans originated by bank b at t in city c. The city-level Herfindahl-Hirschman index in the loan market is given by

$$HHI_{ct} = \sum_{b \in \mathcal{B}^c} (s_{cbt})^2.$$

Figure 3 below shows a bin-scatter of city-level fixed effects against the city-specific HHI. The positive relationship implies less competition between banks, which leads to higher interest rates. Recall that our specification in equation (1) includes bank fixed effects, so composition effects do not drive this relationship, and they should be interpreted as the same bank charging higher interest rates in cities where they face less competition.

Figure 3: Less competition leads to higher interest rates



4 Model

The novel aspect of our model lies in its ability to explain geographical variation in interest rates and study the implications for output and welfare. Our modeling choices capture features described in the previous two sections: firms' and households' reliance on local branches, inter-bank frictions, and local competition between banks. We allow for various channels through which interest rate differentials can translate into differences in output and welfare: optimal investment decisions by local firms, trade, and migration linkages between cities.

4.1 Setup

The economy is comprised of N cities, indexed by n. Time is discrete. There are three types of agents: workers, capitalists, and bank owners. Workers are homogeneous, live hand-to-mouth, and can move freely between cities. Immobile capitalists are attached to their city and own local, immobile physical capital. They are restricted to borrow and save using the bank branches available in the city where they reside. We denote the set of banks in city n as $\mathcal{B}^n$.

The economy has B bank owners, each owning a bank indexed by b. Each bank operates in a set of cities $\mathcal{C}^b$. The bank network is assumed to be fixed, and the residence of bank owners will be unimportant for reasons discussed below.[6] Each bank owner sets city-specific nominal interest rates for deposits and loans, r_n^b and $\tilde{r}_n^b$, respectively, to maximize total profits. Banks face city-specific demand for loans and city-specific supply of savings and compete monopolistically with other banks within each city. Deposits and loans are assumed to be one-period risk-free instruments and are settled using money that is costlessly transferable between branches. Banks can also tap into the interbank market in which they borrow and lend to each other at a common interbank interest rate. The interbank market operates with frictions in a way described in detail below. The constraint for banks is a balance sheet constraint: total assets must equal total liabilities at the bank level, period by period.

We first derive the supply of savings and the demand for loans from the problem of workers and capitalists. We then move to the problem of banks where demand and supply for funds are taken as given.

4.1.1 Production

Each location produces a differentiated good. The representative firm in location n hires labor (ℓ_{nt}) and capital (k_{nt}) from workers and capitalists, respectively, and makes production decisions in a perfectly competitive environment. The firm has access to a constant-returns Cobb-Douglas technology

$$y_{nt} = z_n \left(\frac{\ell_{nt}}{\mu}\right)^{\mu} \left(\frac{k_{nt}}{1-\mu}\right)^{1-\mu},$$

where z_n denotes productivity. Trade is costly. For one unit to arrive in location n, $\tau_{ni} \geq 1$ units need to be shipped from location i. After standard steps, the price of a good of variety i for a consumer located in n is given by

$$p_{nit} = \tau_{nit} p_{iit} = \frac{\tau_{ni} w_{it}^{\mu} r_{it}^{1-\mu}}{z_{it}},$$

where p_{iit} denotes the free-on-board dollar price for the good produced in city i.

4.1.2 Workers

All workers are identical and infinitely-lived, and their total number is normalized to 1. Workers cannot access savings or investment instruments and live 'hand-to-mouth,' as in Kleinman et al. (2023). At period t, a worker located in city n decides how much to consume of each of the N goods in the economy, where the consumption basket aggregates goods from all origins with a constant elasticity of substitution,

$$C_{nt} = \left(\sum_{i=1}^{N} c_{it}^{\frac{\sigma_c - 1}{\sigma_c}}\right)^{\frac{\sigma_c}{\sigma_c - 1}}. \tag{5}$$

The consumption price index in city n, P_{nt}, and the fraction of expenditure of city n in goods from city i, π_{nit}, are given by

[6] See Oberfield et al. (2024) for an analysis of the evolution of the bank network in space.

$$P_{nt} \equiv \Big(\sum_{j}(\tau_{ni}p_{iit})^{1-\sigma_c}\Big)^{\frac{1}{1-\sigma_c}}, \tag{6}$$

$$\pi_{nit} = \Big(\frac{\tau_{ni}p_{iit}}{P_{nt}}\Big)^{1-\sigma_c}. \tag{7}$$

After consuming in period t the worker receives idiosyncratic shocks associated with moving to each other destination d, ϵ_{dt}, and decides whether to move and where.

The value of living in city n at t combines the amenity value b_n, the utility coming from consuming her real wage, and the continuation value after moving

$$V^w_{nt} = \log(\tfrac{b_n w_{nt}}{P_{nt}}) + \max_{d}\{\beta\mathbb{E}_t[V^w_{dt+1}] + \rho\epsilon_{dt}\} \tag{8}$$

We assume that idiosyncratic shocks ϵ are drawn from an extreme value distribution, $F(\epsilon) = e^{-(\epsilon-\bar{\gamma})}$. The parameter ρ captures the relative importance of idiosyncratic reasons for migration that are not captured by amenities or real income in a city. The expectation is taken with respect to future realizations of the idiosyncratic shocks ϵ_{dt+1}.

4.1.3 Capitalists

There is one capitalist per city who lives indefinitely and cannot move to other cities. The capitalist owns the local stock of physical capital and rents it to the producers of the final good. To transfer resources inter-temporally, the capitalist can invest in physical capital or save using the bank branches available in their city. We assume that to finance investments in physical capital, the capitalist needs to borrow from local banks. Moreover, loans from different banks are imperfect substitutes when funding new investments. This assumption is intended to capture, in a parsimonious way, heterogeneity between banks, which are specialized in funding different types of businesses.

The problem solved by the capitalist living in n can be divided into two stages. In the first stage, she decides how much to borrow from each bank to finance a given level of investment, i_{nt}, at the lowest cost. In the second stage, she maximizes her welfare by deciding how much to consume, save in deposits, and invest, taking the cost of investment $\mathcal{C}_{nt}(i_{nt})$ as given. Following Morelli et al. (2024), we assume that bank deposits also enter capitalists' utility functions. Using C^c_{nt} to denote a consumption basket for capitalists, analogous to the one for workers in equation (5), the problem of a capitalist at the second stage can be written as

$$\max_{\{C^c_{nt},D^b_{nt+1},k_{nt+1}\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t \Big[\log C^c_t + \log D_{nt+1} \Big] \tag{9}$$

$$\underline{s.t:}\ C^c_{nt} + \sum_b \frac{D^b_{nt+1}}{P_{nt}} + \frac{\mathcal{C}_{nt}(i_{nt-1})}{P_{nt}} = \frac{\hat{r}_{nt}}{P_{nt}} k_{nt} + \sum_b (1+\tilde{r}^b_{nt}) \frac{D^b_{nt}}{P_{nt}} + T_{nt} \tag{10}$$

$$k_{nt} = k_{nt-1}(1-\delta) + i_{nt-1} \tag{11}$$

$$D_{nt+1} = \Big[\sum_b {D^b_{nt+1}}^{1-\frac{1}{\eta}} \Big]^{\frac{\eta}{\eta-1}} \tag{12}$$

$$k_{n0}, \{D^b_{n0}, L^b_{n0}\}_b \tag{13}$$

where the budget constraint equation (10) is expressed in real terms: the capitalist spends income from renting out capital at rental rate $\hat{r}$, the payout of her $t-1$ deposits and a lump-sum transfer T_{nt} to finance consumption, new deposits and re-paying loans maturing at t. The function $\mathcal{C}_{nt}(i_{nt-1})$ comes from solving the minimization problem

$$\mathcal{C}_{nt}(i_{nt-1}) = \min_{\{L^b_{nt}\}_b} \sum_{b\in\mathcal{B}} L^b_{nt}(1+r^b_{nt-1})$$
$$s.t: \Big[\sum_{b\in\mathcal{B}} (\gamma^b \tfrac{L^b_{nt}}{P_{nt-1}})^{\frac{\sigma-1}{\sigma}} \Big]^{\frac{\sigma}{\sigma-1}} = i_{nt-1} \tag{14}$$

in the first stage. The parameter σ captures the elasticity of substitution between loans from different banks. As stated above, this elasticity is intended to capture heterogeneity between banks in their ability to fund other types of businesses. In what follows, we drop subscript n for clarity when referring to the problem of immobile capitalists.

Manipulating the first-order conditions, we can express the equilibrium loans from bank b as

$$\frac{L^b_t}{P_{t-1}} = \Big(\frac{R_{t-1}}{1+r^b_{t-1}} \Big)^{\sigma} i_{t-1} (\gamma^b)^{\sigma-1}. \tag{15}$$

where $R_{t-1} \equiv \Big[\sum_{b\in\mathcal{B}} (\frac{1+r^b_{t-1}}{\gamma^b})^{1-\sigma} \Big]^{\frac{1}{1-\sigma}}$. From equation (14) and equation (15) it follows that

$$\mathcal{C}_t(i_{t-1}) = \sum_{b\in\mathcal{B}} L^b_t(1+r^b_{t-1}) = i_{t-1}R_{t-1}P_{t-1}. \tag{16}$$

Plugging this functional form for $\mathcal{C}_t(i_{t-1})$ into the budget constraint and manipulating first-order conditions, the demand for deposits into bank b will be

$$D^b_{t+1} = D_{t+1} \left(\frac{Q_t}{q^b_t} \right)^{\eta}, \tag{17}$$

where

$$q^b_t \equiv 1 - \underbrace{\Big(1+\tilde{r}^b_t\Big)}_{\text{Return on deposits}} \Big/ \underbrace{\left(\frac{(1-\delta)R_tP_t}{R_{t-1}P_{t-1} - \hat{r}_t} \right)}_{\text{Return on investment}} \ \text{ and } \ Q_t \equiv \left(\sum_b (q^b_t)^{1-\eta} \right)^{\frac{1}{1-\eta}}. \tag{18}$$

The variable q_t^b can be interpreted as the effective cost of depositing one dollar in bank b, which will be one dollar less today net of the interest income accruing tomorrow. The pecuniary cost is adjusted by the marginal rate of substitution between periods, where the latter can be equated with the rate at which resources can be transferred between periods through investing in physical capital. This rate is captured in the term dividing $1 + \tilde{r}_t^b$.

After some algebra, the total demand for deposits and consumption is given by

$$D_{t+1} = \frac{M_t}{Q_t + Q_t^\eta \tilde{Q}_t} \tag{19}$$

$$\text{and } P_t C_t^c = \frac{Q_t M_t}{Q_t + Q_t^\eta \tilde{Q}_t} \tag{20}$$

where we have defined total income as $M_t \equiv \hat{r}_t k_t + \sum_b (1 + \tilde{r}_t^b) D_t^b - (k_t - (1-\delta)k_{t-1}) R_{t-1} P_{t-1}$ and $\tilde{Q}_t$ is an alternative way of aggregating q_t^b, defined in the appendix.

From equation (15), equation (17) and equation (19) the bank-specific demand for deposits and loans are described by

$$D_{t+1}^b = \frac{M_t}{Q_t + Q_t^\eta \tilde{Q}_t} \left(\frac{Q_t}{q_t^b} \right)^\eta \tag{21}$$

$$\text{and } L_{t+1}^b = i_t P_t \Big(\frac{R_t}{1 + r_t^b} \Big)^\sigma (\gamma^b)^{\sigma - 1}, \tag{22}$$

By increasing the interest rate on deposits $\tilde{r}_t^b$ (which translates into a decrease in q_t^b), the supply of deposits into bank b will increase. By increasing the interest rate on loans r_t^b, the demand for loans from bank b will decrease. We now turn to the problem of banks who set interest rates, taking these two functions as given.

4.1.4 Banks

Banks choose the active and passive interest rates in each of the cities in which they operate in order to maximize profits. They take the supply of deposits and demand for loans coming from local capitalists, equation (21)-equation (22), as given. In order to issue loans while satisfying their balance sheet constraint, banks can attract deposits and borrow from other banks in the interbank market. If the rate in the interbank market is high enough, they would lend to other banks instead of lending to the private sector. Omitting super-script b for clarity in this section, the problem of a bank at $t = 0$ is

$$\begin{aligned}
\max_{\{\{r_{nt}, \tilde{r}_{nt}\}, \bar{W}_t, \underline{W}_t\}_{t=0}^\infty} \quad & \sum_{t=0}^\infty \beta^t \sum_n L_{nt}(1 + r_{nt-1}) + D_{nt+1} + \bar{W}_t(1 + r^w) + \underline{W}_{t+1} \\
& - L_{nt+1} - D_{nt}(1 + \tilde{r}_{nt-1}) - \underline{W}_t(1 + r_{t-1}^w)(1 + \tau) - \bar{W}_{t+1} \\
\underline{s.t:}\ [\lambda_t] \quad & \sum_n L_{nt+1} + \bar{W}_{t+1} = \sum_n D_{nt+1} + \underline{W}_{t+1} \quad \forall t \\
[\bar{\lambda}_t] \quad & \bar{W}_{t+1} \geq 0 \quad \forall t \\
[\underline{\lambda}_t] \quad & \underline{W}_{t+1} \geq 0 \quad \forall t.
\end{aligned}$$

Where profits reflect the discounted sum of per-period cash flows. At each t, inflows come from maturing loans issued to firms and other banks and new deposits borrowed from capitalists or other banks. Outflows come from extending new loans to firms or other banks and maturing deposits borrowed from capitalists and other banks.

Manipulating the first-order conditions with respect to active and passive interest rates we get

$$\frac{1}{\bar{\epsilon}^L} + (1 + r_n) - \frac{1}{\beta} = \frac{\lambda_t}{\beta^{t+1}} \quad \forall n$$
$$\frac{1}{\bar{\epsilon}^D} + (1 + \tilde{r}_n) - \frac{1}{\beta} = \frac{\lambda_t}{\beta^{t+1}} \quad \forall n$$

Where $\bar{\epsilon}^L = \frac{\partial L_n}{\partial r_n}\frac{1}{L_n}$ and $\bar{\epsilon}^D = \frac{\partial D_n}{\partial \tilde{r}_n}\frac{1}{D_n}$ denote the semi-elasticities of loans and deposits with respect to an individual bank's interest rates. The left hand side of the first set of equations describes the marginal revenue associated with issuing one more dollar of loans in city n. This has to be equalized across cities, otherwise the bank would prefer to allocate her scarce funds to the city with the highest marginal revenue. The left hand side of the second set of equations describes the marginal cost of attracting funds from city n. This has to be equalized across cities, otherwise the bank would prefer to attract deposits from the city with lower marginal cost. Finally, if marginal costs were lower than marginal benefits the bank would like to expand the size of its balance sheets and reduce it otherwise. See Appendix Section B.1 for a full derivation and a discussions of banks' reliance on the interbank market.

4.2 Steady State

Productivity and amenity values, $\{z_n, b_n\}_{n\in N}$, together with the set of cities in which each bank is present, $\{\mathcal{C}^b\}_{b\in B}$, are constant. A steady state consists of city-specific wages, prices of final goods and bank-specific interest rates $\{\{w_n, p_n, \{r_n, \tilde{r}_n\}_{b\in B}\}_{n\in N}$ and labor, production, consumption, savings, borrowing and capital decisions $\{\ell_n, k_n, y_n, C_n, C_n^c, k_n, \{L_n^b, D_n^b\}_{b\in B}\}_{n\in N}, r^{ib}$ such that

- Workers' consumption and migration decisions maximize their lifetime utility, equation (7)-equation (8). From optimal migration decisions it follows that teady-state labor shares reflect flow utility,

$$\ell_n = \frac{\left(\frac{b_n w_n}{P_n}\right)^{\frac{\beta}{\rho}}}{\sum_{i=1}^N \left(\frac{b_i w_i}{P_i}\right)^{\frac{\beta}{\rho}}}. \tag{23}$$

- Capitalists' consumption, saving and borrowing decisions maximize their lifetime utility, equation (20)-equation (21)-equation (22).

- Bank-specific interest rates set optimally, equation (65)-equation (71) in the Appendix.

- The inter-bank market clears and the bank's profits are rebated to consumers in the form of transfers

$$\sum_b \bar{W}^b = \sum_b \underline{W}^b \text{ and } T_n = \sum_{b\in\mathcal{B}^n} L_n^b r_n^b - D_n^b \tilde{r}_n^b. \tag{24}$$

- Labor markets clear at the national level

$$\sum_n \ell_n = 1. \tag{25}$$

- Final good revenue in city n, equal to total cost, equals expenditure by workers and capitalists (for consumption and investment purposes) in all other cities in that same good:

$$w_n \ell_n + \hat{r} k_n = \sum_{i=1}^{N} \pi_{ni} (P_i C_i + P_i C_i^c + \sum_{b \in \mathcal{B}^i} L_i^b) \tag{26}$$

In the Appendix Section B.3 we describe our solution method.

4.3 Illustrative example: linear geography

To illustrate the economic effects of segmented capital markets in the model we consider the case of a linear geography, a well-studied benchmark in the spatial literature. Productivity in city n is parametrized as $z(n) = \gamma_0 e^{-\gamma n}$ and transport costs as $\tau_{ni} = \tau e^{\alpha |i-n|}$. In this stylized framework, cities closer to $n = 1$ have a higher productivity, while cities close the center of the grid have a geographical proximity advantage. We assume there are two banks in the country. In the benchmark case, both banks have branches in every city.[7]

The left panel of Figure 4 describes the environment and the equilibrium outcomes. The yellow line in the top panel describes exogenous productivity, while the blue line describes the prices of the final good in different locations. The middle panel shows the distribution of capital and labor productivity in equilibrium. Cities located slightly to the left of the center attain the higher combination of productivity and market access together, leading to higher investment. This capital deepening leads to higher labor productivity in equilibrium, even though exogenous productivity exhibits a different pattern. For this particular parametrization, banks equalize the interest rate they charge across cities.

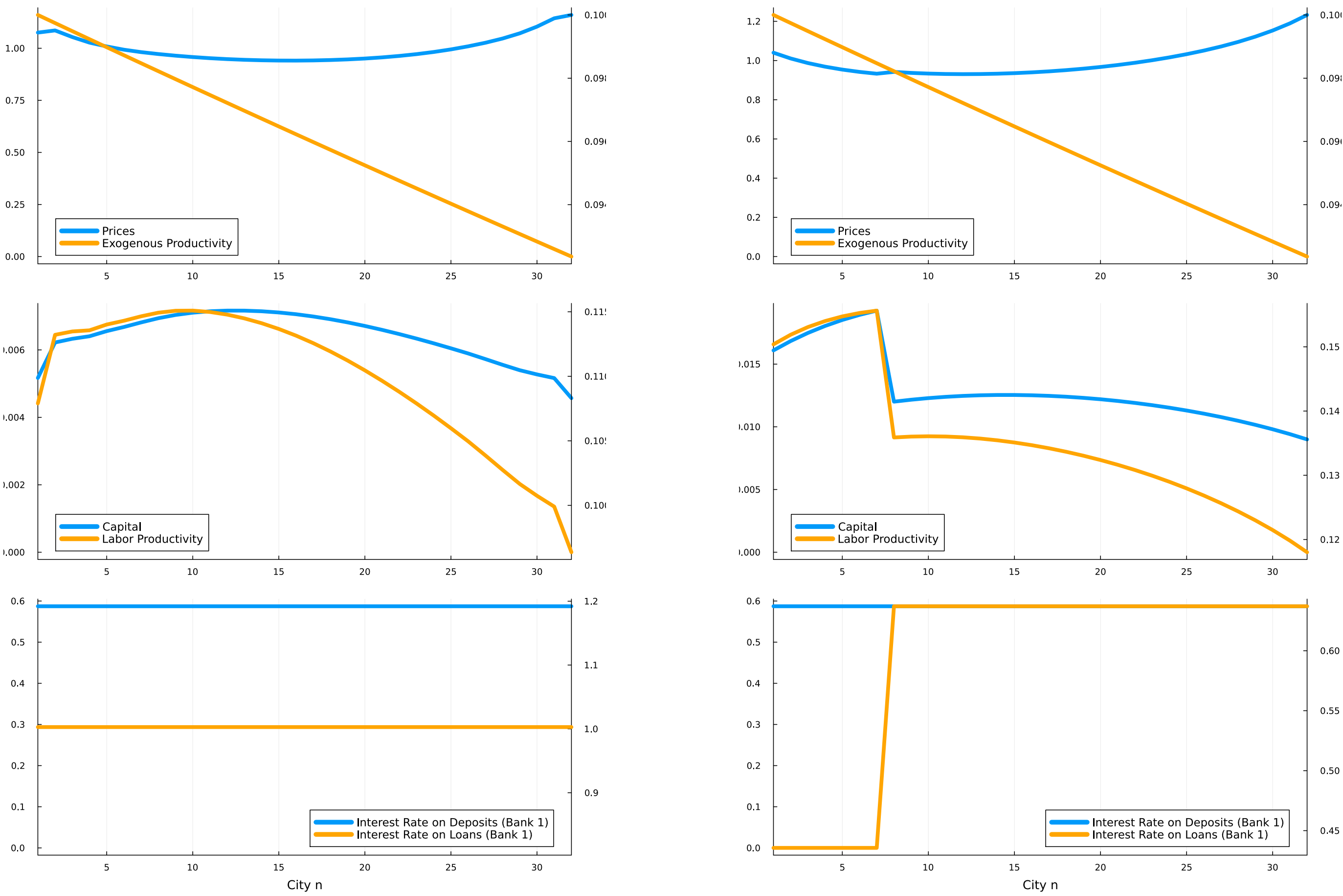
How would a different bank network affect the equilibrium? We consider an economy identical in every respect to the one just described, but where Bank 2 is restricted to operate in a segment of cities. We assume it operates in $n < 8$ only. The right panel in Figure 4 describes this new equilibrium.

Once market are segmented outcomes around $n = 8$ look sharply diferent. The top subfigure shows that prices increase slighly in the cities with only one bank ($n \geq 8$). There is also a sharp drop in labor productivity around the threshold caused by reduced capital deepening, as the middle sub-figure in the panel shows. The last panel shows how Bank 1 sets interest rates in different cities. For this particular parametrization the bank still equalizes interest rate on deposits across cities. This is a consequence of the low elasticity of substitution we have assumed for deposit taking behaviour $\eta = 2$). On the other hand, the interest rate that the bank charges on its loans increases sharply around the threshold. Bank 1 exploits its market power in cities with little competition between banks, and this in turns affects differences in labor productivity and real incomes (not shown) across cities. In the rest of the paper we explore the extent of these effects empirically using data from Chile.

[7] We set the values of the main parameters as $\mu = 0.3, \sigma_c = 4, \eta = 2, \sigma = 25, \beta = 0.63, \delta = 0.1, \rho = 1.9, \gamma_0 = 1, \gamma = 366, \alpha = 1.05$. See Appendix for a complete list of the parameters in this numerical example.

Figure 4: Illustration with Linear Geography

(a) Both banks present everywhere (b) Bank 1 everywhere, Bank 2 in $n < 8$ only



5 Quantification

We quantify the model using data from Chile between 2002 and 2017.[8] For each city we observe wages, population, deposits and loans under-written by each bank. Once we clean the data and keep cities for which we observe all variables, we are left with 34 cities (excluding the capital, Santiago, from the analysis). The data sources were described in detail in Section 2. Table 3 summarizes the moments we construct from the data, the parameters in the model to which they are more closely related, and data sources.

We assume that the city-bank fit γ_n^b can be decomposed as

$$\gamma_n^b = \gamma_n + \gamma^b \tag{27}$$

in order to reduce the dimension of the vector to be estimated.

[8] A quantification exercise currently in progress will exploit administrative data on wages and loans; the current version uses publicly available data from surveys which restricts the number of cities we can target.

Table 3: Empirical Targets

Empirical Target	Related Parameter in the Model	Data Source
Directly Linked to Parameters		
Travel Times $\{\{t_{in}\}_{n=1}^{N}\}_{i=1}^{N}$	τ_{ni}	Google API
Targeted Moments		
Average Wage $\{w_n\}_{n=1}^{N}$	z_n	CASEN Survey
Employment Shares $\{\ell_n\}_{n=1}^{N}$	b_n	Census
Loans-Deposits ratio by city $\{\frac{\sum_{b\in\mathcal{B}^n} L_n^b}{\sum_{b\in\mathcal{B}^n} D_n^b}\}_{n=1}^{N}$	γ_n	CMF
Loans-Deposits ratio by bank $\{\frac{\sum_{c\in\mathcal{C}^b} L_n^b}{\sum_{n\in\mathcal{C}^b} D_n^b}\}_{b=1}^{B}$	γ^b	CMF

We assume that transport costs between any city-pair are a function of the travel times between these cities, which capture geographical ruggedness and how well-connected each city is. We borrow from Redding and Rossi-Hansberg (2017) and assume that ice-berg costs can be written as $\tau_{ni} = t_{ni}^{0.375}$. We observe travel-times from the data.

Other data moments we target are employment and wages in each city. As it is standard in the estimation of spatial models, the joint distribution of these variables informs us about productivity and amenities. Cities with a high population despite low wages are rationalized through better amenities through the lens of the model. Differently than in other settings, in our model productivity and amenity values cannot be directly recovered from the data given that we do not observe physical capital in the data.

The last block of moments we exploit are directly related to banks. We use the ratio of loans over deposits per city and per bank (as shown in the middle and right panels of Figure 2). The first of these moments capture capital inflows into each city, while the second one captures the participation of each bank in the inter-bank market. Cities with high capital inflows are rationalized through high values of γ_n, while banks borrowing in the inter-bank market in order to borrow directly to firms are rationalized through a high value of γ^b. Given our assumption in equation (27), from these we can recover γ_n^b.

Table 4 shows a complete list of the parameters in our model divided between those externally calibrated and those estimated from the data. Parameters α, β and δ are standard in the macro literature, while we borrow σ_c from the trade literature. We set $\eta = 2$ for the problem of the bank to be well-defined. With a low value of η the marginal cost of raising deposits increases fast in every city, allowing us to find an interior-solution for the bank's problem.[9]

We estimate σ, the elasticity of substitution between loans issued by different banks, by exploiting a natural experiment. The next subseciton describes this estimation.

[9] An estimation of this parameter analogously to how we estimated σ is in progress.

Table 4: Calibration

	Description	Value	Source or Objective
		Externally calibrated	
α	Capital share	0.30	Standard
σ_c	Elasticity of substitution (consumption)	4	Redding and Rossi-Hansberg (2017)
β	Discount factor over 10 years	0.66	Annual equivalent of 0.96
δ	Rate of depreciation over 10 years	0.1	Annual equivalent $\approx 1\%$
η	Elasticity of substitution (deposits)	2	Problem of the bank well-defined
$\{\tau_{nj}\}_{n,j=1,..,N}$	Trade costs as a function of travel times t_{ij}	$t_{ij}^{0.375}$	Redding and Rossi-Hansberg (2017)
		Internally estimated	
σ	Elasticity of substitution (loans)	28	Corpbanca-Itau merge
$\{z_n\}_{n=1}^N$	Productivities	[X,Y]	Geographic distribution of employment
$\{b_n\}_{n=1}^N$	Productivities	[X,Y]	Geographic distribution of Wages
$\{\gamma_n^b\}_{n=1}^N$	Productivities	[X,Y]	Internal capital flows

5.1 Reduced form evidence from the Itaú-Corpbanca merge

In January 2014, the authorities of Itaú, a Brazilian bank, announced that the bank would buy the Chilean bank Corpbanca. At the time, both banks were important players in the loan market. This was the biggest transaction in Chile's financial history at the time, and it was motivated by factors exogenous to Chile. According to Reuters, *Itaú is contending with slowing economic growth and rising household debt in Brazil, where it trails state-run lender Banco do Brasil SA*.[10] The merge was made effective in April 2016.[11]

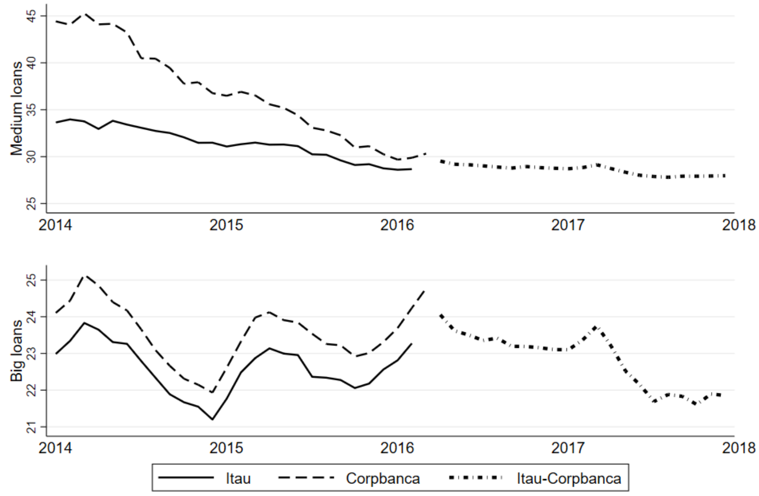
Figure 5 below compares the average interest rate that the two banks were charging for commercial loans of different sizes in the period leading to the merger. These are calculated from aggregate data, so differences in the type of firms taking these loans — after controlling for the size of the loan —-can't be ruled out.[12] However, as a first approximation, Itaú was able to charge lower interest rates than Corpbanca. In the months immediately after the merger, the interest rates charged by Itau move upwards to an intermediate level between the rates previously charged by each bank separately.

[10]This quote and the description of the merge come from https://www.reuters.com/article/corpbanca-chile-itauunibanco/update-4-ita-to-expand-in-chile-and-colombia-with-corpbanca-deal-idUSL2N0L30LL20140129, accessed on April 25 2023.

[11]https://citywire.com/americas/news/banco-itau-chile-and-corpbanca-complete-merger/a895936, access on April 25 2023.

[12]The estimation using the credit registry data, where we can rule out these concerns, is in progress.

Figure 5: Interest rate comparison between Itau and Corpbanca



Source: CMF. Medium loans: 2000-9000 USD. Big loans: 9000-220000 USD.

The merger between these two banks induced exogenous variation in interest rates at the city level, as cities that had some Itaú branches and none Corpbanca branches saw an exogenous *increase* in the interest charged by the merged bank. As a consequence, firms should have switched to other banks and away for Itaú-Corpbanca for their loans. The rate at which this substitution should have happened can be linked to σ through equation (15).

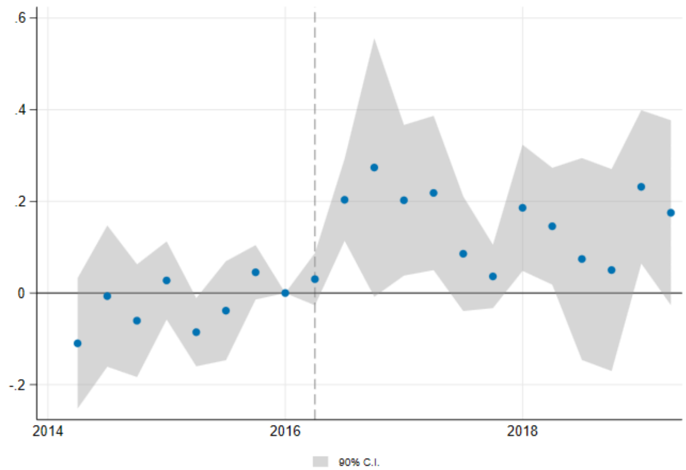
We use quarterly data on the new loans issued at the city-bank level. Our treatment and control are defined at the city level. The treatment group encompasses cities in which Itau was present but Corpbanca was not and our control group is defined as cities in which neither of the banks were present, as these markets shoudl have been unaffected by the shock (we drop cities in which neither of these conditions holds).

We run the following regression in the subset of the data we just defined,

$$l_{nt}^b = \gamma_t^b + \gamma_n^b + \sum_{\tilde{t}} \beta_{\tilde{t}} \mathbb{1}_{[n \in \mathcal{T}]} \mathbb{1}_{[t=\tilde{t}]} + \epsilon_{nt}^b \tag{28}$$

where l_{nt}^b is the log of loans issued by bank b in city n at quarter t. The fixed effects γ_t^b and γ_n^b capture shocks at the the month-bank and city-bank levels, respectively, and represent common shocks to r_t^b and the quality of the match γ_n^b (through equation (15)). We are interested in $\beta_{\tilde{t}}$ in equation (28) around April 2016, the date at which the merger became effective. Figure 6 below shows the results.

Figure 6: Estimates for $\beta_{\bar{t}}$



The estimated coefficients became positive and statistically significant around the date of the merger, indicating that firms substituted from Itaú-Corpbanca towards other banks around the date of the merge. The size is economically significant; loans increased by 20% after the interest rate charged by Itaú increased by 100 basis points (see Figure 5).

The main identifying assumption for the difference in differences to be valid is that, absent the merger, loans given by branches in treated cities would have evolved similarly as in the control cities. We control both for bank-level changes in time (bank-quarter FE) and for bank-city specific characteristics, like the fit of a specific bank to the city's industry mix. Therefore, there would have to be bank-city-specific shocks happening at the same time as the Itau-Corpbanca merger for our identifying assumption to be violated.

We now show how our estimated effect can be mapped to σ. Taking logarithms in equation (15)

$$\log(L^b_{nt}) = \log(P_{nt}) + \sigma\log(R_{nt}) - \sigma\log(1+r^b_t) + \log(i_{nt}) + (\sigma-1)\gamma^b_n (29)$$

The merger can be thought of as a positive exogenous shock to R_{nt} induced by a change in $(1+r^{Itau}_{\text{April 2016}})$ in those cities where Itau was present, relative to those cities in which it was not. According to our model, for banks in treated cities, loans should have changed according to the following:

$$\beta^b_n = \frac{\partial\log(L^b_{nt})}{\partial(1+r^{Itau}_t)} = \sigma\frac{\partial\log(R_{nt})}{\partial(1+r^{Itau}_t)} \tag{30}$$

$$= \sigma\frac{(\gamma^{Itau}_n)^{\sigma-1}(1+r^{Itau}_t)^{-\sigma}}{\sum_{b\in\mathcal{B}^n}(\frac{1+r^b_t}{\gamma^b_n})^{1-\sigma}} \tag{31}$$

We observe monthly interest rates, and we recover γ^b_n from the fixed effects from our regression, so the right-hand side can be calculated for each guess of σ. The difference in difference estimate captures the average effect on the treated units. We therefore calibrate the value of σ so that the average β^b_n across treated branches equals 0.2:

$$\tilde{\sigma} : \sum_{n \in \mathcal{T}} \frac{1}{\mathcal{B}^n} \beta_n^b = 0.2$$

We recover $\tilde{\sigma} = 28$. It is intuitive that this elasticity of substitution is significantly higher than, for example, the elasticity of substitution between goods, which typically lies below 10. If there is less scope for differentiation of loans from different banks, movements in the interest rate will induce big changes in loans for other banks.

5.2 Calibration of z

We then set $\sigma = 28, \rho = \frac{1}{\sigma}$ and fix $\gamma_n^b = 1 \forall n, b$ to calibrate the value of $\{z_n\}$. We assume the economy was in a steady state in 2017 and choose productivities to match the level of employment in each city. We observe the presence of bank branches in all cities from the loan data, which allows us to construct $\mathcal{B}^n \forall n$. We say that a bank was present in a city if it gave a positive amount of loans or deposits in that city. In equilibrium, we require the balance sheet of each of these banks to hold separately.

Figure 7: Calibrated Z and endogenous variables

(a) Employment (b) Capital (c) R_n

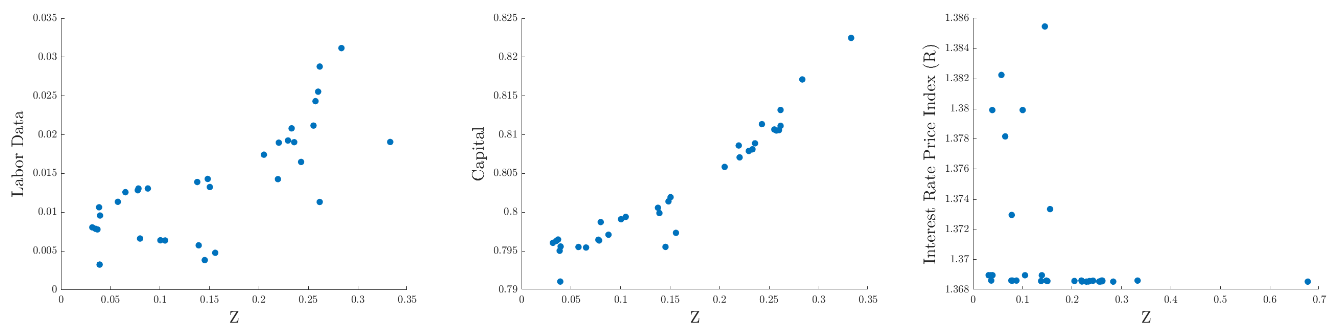


Figure 7 shows how the estimated z correlate with endogenous variables of interest. As expected, the model rationalizes high levels of employment with high productivity and a high level of capital.

6 Counterfactual

7 Conclusion

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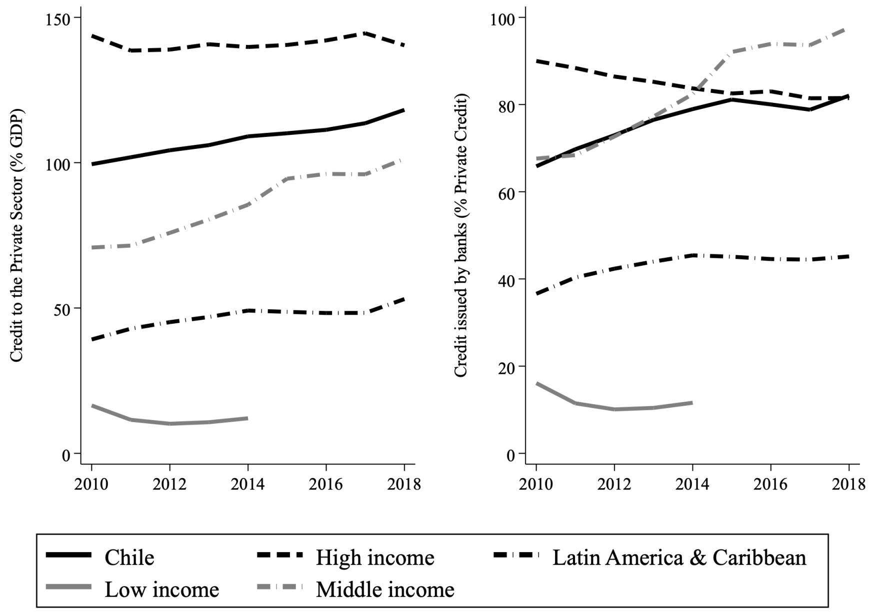
Appendix

A Empirical appendix

A.1 Chile's financial development

We use data publicly accessed from the World Banks' website on June 2024. Figure 8 below shows the two facts mentioned in the main text.

Figure 8: Financial development



A.2 The importance of banks for domestic credit in Chile: Survey evidence

Firms and households rely mostly on banks for financial services and local branches play a significant role.

Firms. Banks were fundamental sources of credit in Chile. Aggregate data shows that during 2007-2017, 71.5% of credit to the private sector was sourced from banks.[13] To delve deeper into the importance of banks for private firms in Chile, we rely on firm-level data from the 2015 *Encuesta longitudinal de empresas* (ELE), a nationally representative survey that includes a module on firms' sources of credit. We calculate the percentage of private firms that borrow from banks and the percentage of firms for which banks constitute the main source of credit. We exclude Santiago, the capital city and home to approximately 29% of the population and bigger firms, to show that Santiago does not drive the results. The first two columns of Table 5 show that banks stand out as the main source of credit for large private firms even outside the capital area.

Next, we turn to the importance of local bank branches for firms. We use credit registry data covering the universe of loans in Chile over the period January 2015-April 2023 to calculate the share of loans issued by banks with branches in the same city as the borrowing firm. We find that 87% of the firms borrow from banks with branches in their location. This is slightly higher than what we would obtain if loans were randomly assigned across firms (86%).

[13]The importance of banks in other developing regions was even higher: 93% in Latin America and the Caribbean, 95.6% in Middle-Income countries, and 97.1% among Lower-Middle income countries. Data comes from the World Bank and combines two variables: *Domestic private sector by banks*, and *Domestic private sector*.

Table 5: Credit sources for firms (excluding Santiago)

Firm size	2015 ELE		
	% borrows from banks	% biggest loan comes from banks	% private employment
Micro	57.1	16.7	7.7
Small	66.4	29.6	39.3
Medium	77.7	42.1	21.9
Large	80.5	50.4	30.1

Households. In 2007 and 2017, the *Encuesta financiera de hogares* (EFH), a nationally representative survey of households' financial behavior, included modules on the financial assets held by households; using these modules, we first document that households rely significantly on banks to purchase financial assets (compared to other institutions) and, secondly, that Internet banking remains limited.

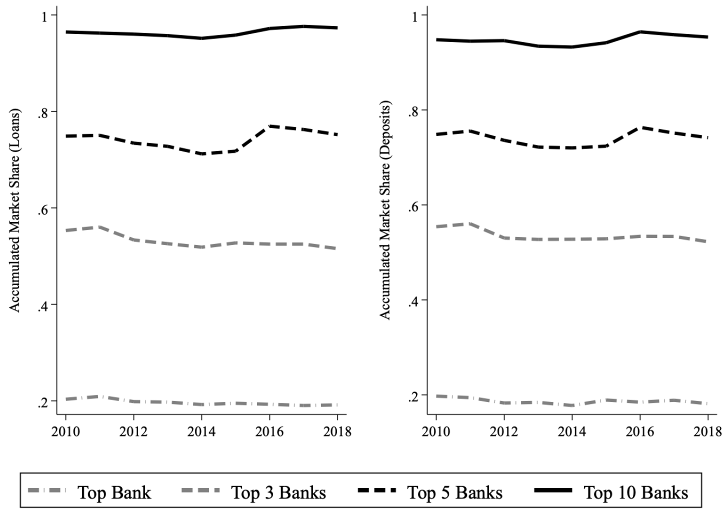
In the EFH we separately observe the total amount invested by an individual household in stocks, mutual funds, fixed income, saving accounts, and other instruments. The survey contains information on the financial institution through which these assets were purchased. Panel A in Table 6 shows — for the sub-sample of respondents with positive financial assets — what percentage of savings were allocated to each asset and the percentage of respondents who used banks to purchase that asset. Banks are the primary institutions used by households to invest in mutual funds and fixed-income assets and to open savings accounts. These represent around half the total investment in financial assets in 2007 and 2017.

The main concern regarding reliance on local branches is the expansion of Internet banking, which makes it easier to save and borrow from geographically distant banks. The EFH includes a question on the use of Internet banking, where people are asked whether they used the Internet to carry out a variety of financial transactions. Panel B in Table 6 shows the share of respondents who used the Internet to purchase financial assets or get new loans. In both cases, we calculate the percentage over the total number of respondents who either purchase assets or get new loans. Internet was used more intensively to purchase new financial assets than to get loans. Although there was an increase in both uses between 2007 and 2017, a majority of the transactions still happen in physical branches. Moreover, the survey does not distinguish between new transactions and the first transaction with a bank, therefore representing an upper bound on the reliance on the Internet to start new financial relationships with an institution.

Table 6: Households' savings behavior

A. Asset types	2007 EFH		2017 EFH	
	% of assets	% purchased through banks	% of assets	% purchased through banks
Stock	19.1	36.1	15.1	44.2
Mutual Fund	30.8	80.4	24.3	83.7
Fixed-income	9.4	82.9	21.3	90.0
Saving Account	7.0	91.6	7.3	72.3
Other	33.6	-	31.7	-
B. Used the internet to...	% respondents in 2007		% respondents in 2017	
purchase financial assets	6.5		21.0	
get a loan	0.3		2.1	

Figure 9: Concentration in the Banking Industry



A.3 Concentration in banking industry

We calculate the market share for top banks using aggregate data from the CMF. Results are shown in Figure 9.

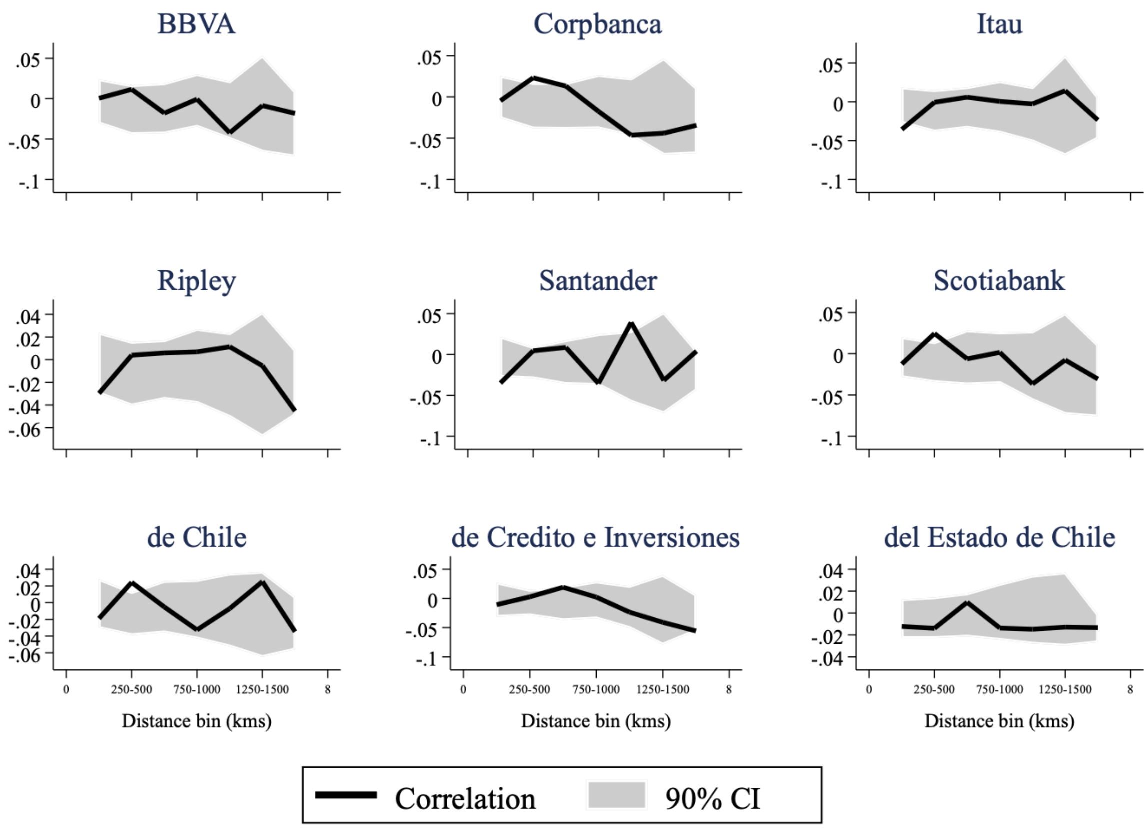
A.4 Spatial Clustering of Banks

To determine whether banks' economic activity is geographically clustered we follow the approach in Conley and Topa (2002), who study the degree of spatial correlation in unemployment between neighborhoods. More closely related to our setting, the approach has been used to study the degree of geographical concentration in market shares for a variety of consumer goods in Bronnenberg et al. (2007). For this exercise we use aggregate data from the year 2015 (publicly available through the CMF) and focus exclusively on banks present in at least ten cities in 2015. These banks explained 96.8% of all the outstanding loans in that year. We exclude the metropolitan area around Santiago.

Extensive margin. First, we define the dummy variable X_{ib}, which takes the value 1 if bank b gave any loans in city i. We are interested in the correlation of X_{ib} between pairs of cities i, j as the distance between i and j changes. Figure 10 shows these correlations for each individual bank, where we have defined bins of 250 kilometers in size.

A correlation close to zero suggests that banks' presence is independent across cities. To determine how close to zero the observed measures of correlation would be if the X_{ib} were independent we follow the bootstrap approach in Conley and Topa (2002). We create 100 samples in which we randomize the identity of the cities in which each bank is present by drawing (with replacement) from the observed distribution of that particular bank. The two dashed lines in each figure show the 90% confidence interval across bootstrapped samples. For almost all banks and all distance bins we cannot reject that the observed correlations are different than what we would observe if banks' presence was independent across cities.

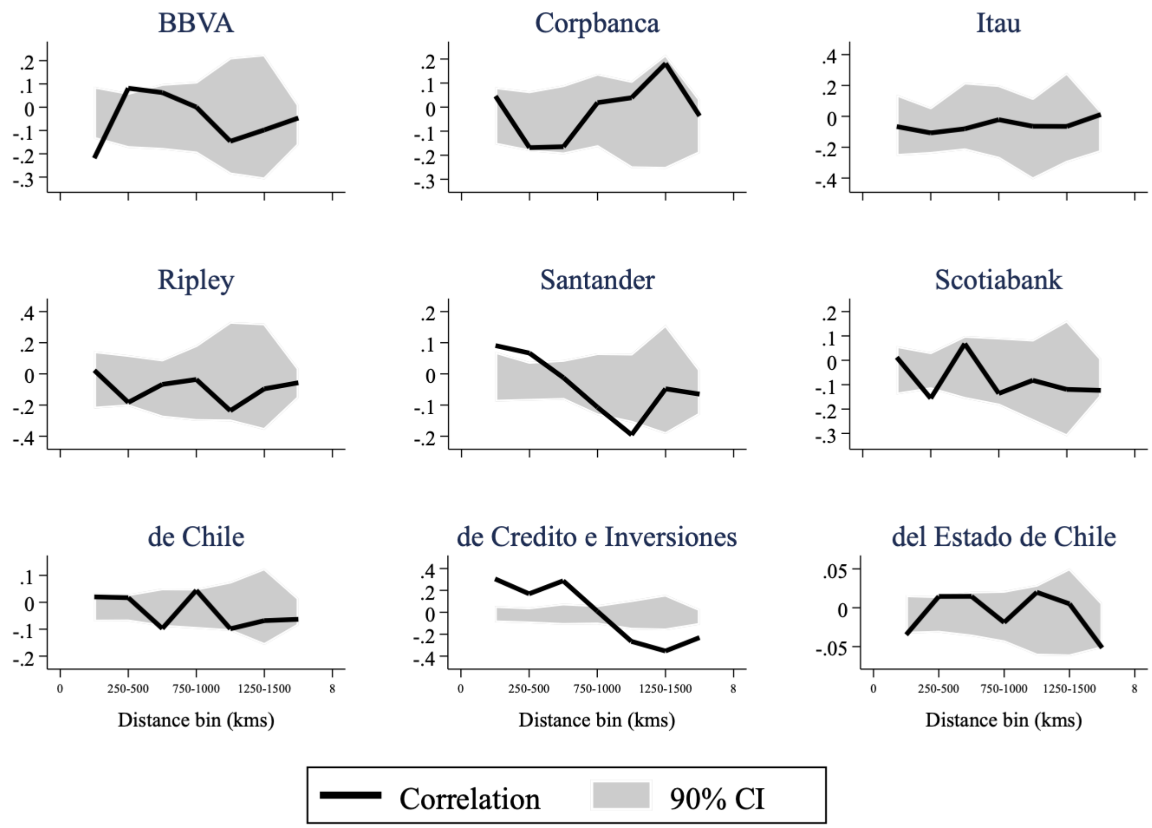
Figure 10: Spatial Correlation in Bank's Presence (Extensive Margin)



Intensive margin. To complement the previous analysis, we study whether there is spatial correlation in market shares (conditional on banks' presence). The approach is analogous to the one described above except that, in this case, the outcome variable is defined as the share of outstanding loans in city i issued by bank b in 2015. When we construct the confidence intervals, we randomize the particular market share of a bank in a city without changing the cities in which a bank is present, therefore focusing exclusively on the intensive margin.

Figure 11 shows the results. The conclusion is similar to the one before, albeit less clear-cut. *Banco de Crédito e Inversiones* and *Banco Santander* exhibit patterns of geographical clustering in market shares.

Figure 11: Spatial Correlation in Loan Market Shares (Intensive Margin)



B Mathematical appendix

B.1 Capitalist' problem

Throughout the description of the capitalist's problem in the appendix we drop n from the sub-indices for clarity, as the problem is identical for all capitalists. This problem can be divided in two stages. In a first stage, the capitalist decides from which banks to borrow in order to finance a level of investment i_t for the lowest cost. In a second stage she maximizes her welfare by deciding how much investment to make taking the cost of investment, $\mathcal{C}_t(i_t)$, as given. The problem at the second stage an be written as

$$\max_{\{C_t^c, D_{t+1}^b, k_{t+1}\}} \sum_{t=0}^{\infty} \beta^t \Big[\log C_t^c + \log D_{t+1} \Big] \tag{32}$$

$$\underline{s.t:}\ C_t^c + \sum_b \frac{D_{t+1}^b}{P_t} + \frac{\mathcal{C}_t(i_{t-1})}{P_t} = \frac{\hat{r}_t}{P_t} k_t + \sum_b (1+\tilde{r}_t^b) \frac{D_t^b}{P_t} + \frac{T_{nt}}{P_{nt}} \tag{33}$$

$$k_t = k_{t-1}(1-\delta) + i_{t-1} \tag{34}$$

$$D_{t+1} = \Big[\sum_b {D_{t+1}^b}^{1-\frac{1}{\eta}} \Big]^{\frac{\eta}{\eta-1}} \tag{35}$$

$$k_0, \{D_0^b, L_0^b\}_b \tag{36}$$

and $\mathcal{C}_t(i_{t-1})$ comes from solving the minimization problem

$$\mathcal{C}_t(i_{t-1}) = \min_{\{L_t^b\}_b} \sum_{b \in \mathcal{B}} L_t^b (1 + r_{t-1}^b)$$
$$s.t: \Big[\sum_{b\in\mathcal{B}} (\gamma^b \tfrac{L_t^b}{P_{t-1}})^{\frac{\sigma-1}{\sigma}} \Big]^{\frac{\sigma}{\sigma-1}} = i_{t-1}. \tag{37}$$

We start with deriving $\mathcal{C}_t$. From the first order condition with respect to an arbitrary L_t^b,

$$\mu(\tfrac{\gamma^b}{P_{t-1}})^{\frac{\sigma-1}{\sigma}} \Big(\frac{i_{t-1}}{L_t^b} \Big)^{\frac{1}{\sigma}} = (1 + r_{t-1}^b), \tag{38}$$

where μ is the multiplier associated with the constraint in equation (37). Taking the ratio of equation (38) for two banks b, b'

$$\frac{L_t^{b'}}{L_t^b} = \Big[\frac{(1+r_{t-1}^b)}{(1+r_{t-1}^{b'})} \Big]^{\sigma} \Big[\frac{\gamma^{b'}}{\gamma^b} \Big]^{\sigma-1}.$$

From here, picking an arbitrary b':

$$i_{t-1} = \Big(\sum_{b\in\mathcal{B}} (\gamma^b \tfrac{L_t^b}{P_{t-1}})^{\frac{\sigma-1}{\sigma}} \Big)^{\frac{\sigma}{\sigma-1}} = (1+r_{t-1}^{b'})^{\sigma} (\gamma^{b'})^{1-\sigma} \tfrac{L_t^{b'}}{P_{t-1}} \Big[\sum_{b\in\mathcal{B}} (\tfrac{1+r_{t-1}^b}{\gamma^b})^{1-\sigma} \Big]^{-\frac{\sigma}{1-\sigma}}. \tag{39}$$

Defining $R_{t-1} \equiv \Big[\sum_{b\in\mathcal{B}} (\frac{1+r_{t-1}^b}{\gamma^b})^{1-\sigma} \Big]^{\frac{1}{1-\sigma}}$, the previous equation can be written as

$$i_{t-1} R_{t-1}^{\sigma} = (1+r_{t-1}^b)^{\sigma} (\gamma^b)^{1-\sigma} \tfrac{L_t^b}{P_{t-1}} \tag{40}$$

and from here we can express the equilibrium loans from bank b as

$$\frac{L_t^b}{P_{t-1}} = \Big(\frac{R_{t-1}}{1+r_{t-1}^b}\Big)^{\sigma} i_{t-1}(\gamma^b)^{\sigma-1}. \tag{41}$$

as in the main text. From equation (41) and the definition of $\mathcal{C}_t(i_{t-1})$,

$$\mathcal{C}_t(i_{t-1}) = \sum_{b\in\mathcal{B}} L_t^b(1+r_{t-1}^b) = i_{t-1}R_{t-1}P_{t-1}. \tag{42}$$

Plugging $\mathcal{C}_t(i_{t-1})$ into the budget constraint equation (33) and law of motion for capital equation (34), the problem of the capitalist becomes

$$\max_{\{C_t^c, D_{t+1}^b, k_{t+1}\}} \sum_{t=0}^{\infty} \beta^t \Big[\log C_t^c + \log D_{t+1}\Big] \tag{43}$$

$$\underline{s.t:}\ C_t^c + \sum_b \frac{D_{t+1}^b}{P_t} = (\frac{\hat{r}_t - R_{t-1}P_{t-1}}{P_t})k_t + \frac{(1-\delta)R_{t-1}P_{t-1}}{P_t}k_{t-1} + \sum_b R_t^b \frac{D_t^b}{P_t} + \frac{T_{nt}}{P_{nt}} \tag{44}$$

$$D_{t+1} = \Big[\sum_b {D_{t+1}^b}^{1-\frac{1}{\eta}}\Big]^{\frac{\eta}{\eta-1}} \tag{45}$$

$$k_0, \{D_0^b, L_0^b\}_b \tag{46}$$

First-order conditions with respect to k_t, C_t^c and D_{t+1}^b yield

$$\lambda_t \frac{\hat{r}_t}{P_t} + \lambda_{t+1}\frac{(1-\delta)R_tP_t}{P_{t+1}} = \lambda_t \frac{R_{t-1}P_{t-1}}{P_t} + \frac{T_{nt}}{P_{nt}} \tag{47}$$

$$\frac{\beta^t}{C_t^c} = \lambda_t \tag{48}$$

$$\beta^t D_{t+1}^{\frac{1-\eta}{\eta}} (D_{t+1}^b)^{-\frac{1}{\eta}} + \lambda_{t+1}\frac{1+\tilde{r}_t^b}{P_{t+1}} = \frac{\lambda_t}{P_t} \tag{49}$$

Equation (47) captures that the capitalist equates the marginal benefit of an extra unit of capital in period t, which consists of the per-period rental rate and the extra capital she would carry to period $t+1$, to its cost, which is the sum of loan repayment in period t. The first order condition with respect to consumption, equation (48), is standard. The first order condition with respect to deposits in a specific bank, equation (49), reflects the dual role of deposits in the model: they increase utility and transfer resources between periods.

Capitalist's demand for deposits. By combining equation (47) and equation (48) we derive the following Euler equation,

$$\frac{P_{t+1}C_{t+1}}{P_tC_t} = \beta(1-\delta)\frac{R_tP_t}{R_{t-1}P_{t-1} - \hat{r}_t}. \tag{50}$$

Replacing equation (48) into equation (49), and then replacing $C_{t+1}P_{t+1}$ from the Euler equation above, we get

$$\frac{1}{D_{t+1}}\left(\frac{D_{t+1}}{D_{t+1}^b}\right)^{\frac{1}{\eta}} = \frac{1}{P_tC_t}\left[1 - \frac{(1+\tilde{r}_t^b)(R_{t-1}P_{t-1}-\hat{r}_t)}{(1-\delta)R_tP_t}\right].$$

Dividing this equation for two banks, b and b', we get

$$\frac{D_{t+1}^b}{D_{t+1}^{b'}} = \left(\frac{q_t^b}{q_t^{b'}}\right)^{-\eta}, \tag{51}$$

where we defined q_t^b as

$$q_t^b \equiv 1 - \left(1 + \tilde{r}_t^b\right) / \left(\frac{(1-\delta)R_t P_t}{R_{t-1}P_{t-1} - \hat{r}_t}\right). \tag{52}$$

Let us define the deposit price index as

$$Q_t \equiv \left(\sum_b (q_t^b)^{1-\eta}\right)^{\frac{1}{1-\eta}}. \tag{53}$$

It follows from equation (51) and the definition of D_{t+1} that the supply of deposits to bank b is given by

$$D_{t+1}^b = D_{t+1}\left(\frac{Q_t}{q_t^b}\right)^{\eta}. \tag{54}$$

Replacing this back into equation (49) we get the usual equalization of expenditure on the two 'goods' available to the consumer

$$D_{t+1}Q_t = P_t C_t. \tag{55}$$

The nominal value invested on deposits at t is given by

$$\sum_b D_{t+1}^b = \sum_b D_{t+1}(\tfrac{Q_t}{q_t^b})^{\eta} = D_{t+1}Q_t^{\eta}\overbrace{\sum_b (q_t^b)^{-\eta}}^{\equiv \tilde{Q}_t}. \tag{56}$$

Then, plugging this into the budget constraint equation (44) and using equation (55), we get

$$Q_t D_{t+1} + D_{t+1}Q_t^{\eta}\tilde{Q}_t = M_t \rightarrow D_{t+1} = \frac{M_t}{Q_t + Q_t^{\eta}\tilde{Q}_t} \tag{57}$$

$$\text{and } P_t C_t^c = \frac{Q_t M_t}{Q_t + Q_t^{\eta}\tilde{Q}_t}. \tag{58}$$

where we have defined total income at t as $M_t \equiv \hat{r}_t k_t + \sum_b (1+\tilde{r}_t^b)D_t^b - (k_t - (1-\delta)k_{t-1})R_{t-1}P_{t-1} + T_{nt}$. Let A_{t+1} denote financial assets at $t+1$. They can be written as

$$\begin{aligned} A_{t+1} &\equiv \sum_b D_{t+1}^b(1+r_t^b) \\ &= \sum_b D_{t+1}(\tfrac{Q_t}{q_t^b})^{\eta}(1+r_t^b) \\ &= D_{t+1}\,\overbrace{Q_t^{\eta}[\sum_b \frac{(1+r_t^b)}{(q_t^b)^{\eta}}]}^{\equiv Q^A} \end{aligned} \tag{59}$$

From equation (59), equation (58) evaluated at $t+1$ and equation (57)

$$P_{t+1}C_{t+1} = \frac{1}{1+Q_{t+1}^{\eta-1}\tilde{Q}_t}\left[k_{t+1}(\hat{r}_{t+1} - R_t P_t) + M_t \tfrac{Q_t^A}{Q_t + Q_t^{\eta}\tilde{Q}_t} + k_t(1-\delta)R_t P_t\right] \tag{60}$$

Plugging this and equation (58) into equation (50) we end up with an equation that implicitly defines a policy function of k_{t+1},

$$\beta(1-\delta)\frac{R_tP_t}{R_{t-1}P_{t-1}-\hat{r}_t} = \frac{\hat{r}_{t+1}k_{t+1} + D_{t+1}Q_t^\eta \sum_b (1+\tilde{r}^b_{t+1})/(q^b_t)^\eta - (k_{t+1}-(1-\delta)k_t)R_tP_t}{M_t}\frac{1+Q_t^{\eta-1}\tilde{Q}_t}{1+Q_{t+1}^{\eta-1}\tilde{Q}_{t+1}}$$

$$k_{t+1} = \frac{1}{R_tP_t-\hat{r}_{t+1}}\left[(1-\delta)R_tP_tk_t + D_{t+1}Q_t^\eta\sum_b\frac{(1+\tilde{r}^b_{t+1})}{(q^b_t)^\eta} - \beta(1-\delta)M_t\frac{R_tP_t}{R_{t-1}P_{t-1}-\hat{r}_t}\frac{1+Q_{t+1}^{\eta-1}\tilde{Q}_{t+1}}{1+Q_t^{\eta-1}\tilde{Q}_t}\right]$$

$$k_{t+1} = \frac{1}{R_tP_t-\hat{r}_{t+1}}\left[(1-\delta)R_tP_tk_t + M_t\frac{Q_t^A}{Q_t+Q_t^\eta\tilde{Q}_t} - \beta(1-\delta)M_t\frac{R_tP_t}{R_{t-1}P_{t-1}-\hat{r}_t}\frac{1+Q_{t+1}^{\eta-1}\tilde{Q}_{t+1}}{1+Q_t^{\eta-1}\tilde{Q}_t}\right]$$

We can compute the derivative of k_{t+1} with respect to R_t

$$\frac{\partial k_{t+1}}{\partial R_t} = -\frac{k_{t+1}P_t}{R_tP_t-\hat{r}_{t+1}} + \frac{1}{R_tP_t-\hat{r}_{t+1}}\left[(1-\delta)P_tk_t - \beta(1-\delta)\frac{P_tM_t}{R_{t-1}P_{t-1}-\hat{r}_t}\frac{1+Q_{t+1}^{\eta-1}\tilde{Q}_{t+1}}{1+Q_t^{\eta-1}\tilde{Q}_t}\right] \tag{61}$$

$$= -\frac{P_t}{R_tP_t-\hat{r}_{t+1}}\left[i_t + \beta(1-\delta)\frac{M_t}{R_{t-1}P_{t-1}-\hat{r}_t}\frac{1+Q_{t+1}^{\eta-1}\tilde{Q}_{t+1}}{1+Q_t^{\eta-1}\tilde{Q}_t}\right] \tag{62}$$

Derivatives. We collect the derivatives of deposits and loans with respect to the interest rate of individual banks. From the definition of Q and $\tilde{Q}$,

$$\frac{\partial Q_t}{\partial q^b_t} = \left(\frac{Q_t}{q^b_t}\right)^\eta \text{ and } \frac{\partial \tilde{Q}_t}{\partial q^b_t} = -\eta(q^b_t)^{-(1+\eta)}. \tag{63}$$

Then, the derivative of D^b_n with respect to the cost becomes

$$\frac{\partial D^b_n}{\partial q^b_n} = \underbrace{\eta\frac{D^b_n}{Q_n}\left(\frac{Q_n}{q^b_n}\right)^\eta}_{\frac{\partial D^b_n}{\partial Q_n}\frac{\partial Q_n}{\partial q^b_n}} \underbrace{-\eta\frac{D^b_n}{q^b_n}}_{\frac{\partial D^b_n}{\partial q^b_n}} + \underbrace{\frac{D^b_n}{D_n}}_{\frac{\partial D^b_n}{\partial D_n}}\underbrace{\frac{D_n}{Q_n+Q_n^\eta\tilde{Q}_n}\left(\frac{Q_n}{q^b_n}\right)^\eta\left(1+\eta Q_n^{\eta-1}\tilde{Q}_n - \frac{\eta}{q^b_n}\right)}_{\frac{\partial D_n}{\partial q^b_n}}$$

And we can recover the derivative with respect to interest rates from $\frac{\partial q^b_t}{\partial r^b_t} = -\frac{R_{t-1}P_{t-1}-\hat{r}_t}{(1-\delta)R_tP_t}$ and the chain rule. From the definition of R,

$$\frac{\partial R_t}{\partial r^b_t} = \left(\frac{R_t}{1+r^b_t}\right)^\sigma(\gamma^b)^{\sigma-1}. \tag{64}$$

The derivative of an individual city-bank pair's loans with respect to the interest rate is

$$\frac{\partial L^b_n}{\partial r^b_n} = \underbrace{\sigma\frac{(L^b_n)^2}{i_nR_nP_n}}_{\frac{\partial L^b_n}{\partial R_n}\frac{\partial R_n}{\partial r_n}} \underbrace{-\sigma\frac{L^b_n}{1+r^b_n}}_{\frac{\partial L^b_n}{\partial r^b_n}} + \underbrace{\left(\frac{L^b_n}{i_n}\right)^2\frac{1}{P_n}}_{\frac{\partial L^b_n}{\partial i_n}\frac{\partial R_n}{\partial r_n}}\frac{\partial i_n}{\partial R_n}$$

which follows from $\frac{\partial R_n}{\partial r_n} = \frac{L^b_n}{i_nP_n}$ and $\frac{\partial i_n}{\partial R_n}$ is given byequation (62).

And then, we know that:

$$\frac{\partial q_t^b}{\partial \tilde{r}_t^b} = -\frac{R_{t-1}P_{t-1} - \hat{r}_t}{(1-\delta)R_t P_t} \underbrace{= -\beta}_{\text{in SS}}$$

B.2 Bank's problem

The problem of the bank at $t = 0$ is

$$\begin{aligned}
\max_{\{\{r_{nt},\tilde{r}_{nt}\},\bar{W}_t,\underline{W}_t\}_{t=0}^{\infty}} \quad & \sum_{t=0}^{\infty}\beta^t \sum_n L_{nt}(1+r_{nt-1}) + D_{nt+1} + \bar{W}_t(1+r^w) + \underline{W}_{t+1} \\
& - L_{nt+1} - D_{nt}(1+\tilde{r}_{nt-1}) - \underline{W}_t(1+r^w_{t-1})(1+\tau) - \bar{W}_{t+1} \\
\underline{s.t:}\ [\lambda_t^b] \quad & \sum_n L_{nt+1} + \bar{W}_{t+1} = \sum_n D_{nt+1} + \underline{W}_{t+1} \quad \forall t \\
[\bar{\lambda}_t] \quad & \bar{W}_{t+1} \geq 0 \quad \forall t \\
[\underline{\lambda}_t] \quad & \underline{W}_{t+1} \geq 0 \quad \forall t
\end{aligned}$$

Where profits reflect the discounted sum of per-period cash flows. At each t, inflows come from maturing loans issued to firms and other banks and new deposits borrowed from capitalists or other banks. Outflows come from extending new loans to firms or other banks and maturing deposits borrowed from capitalists and other banks. The first-order conditions with respect to active and passive interest rates are, respectively,

$$\begin{aligned}
\frac{\partial L_{nt+1}}{\partial r_{nt}}[-\beta^t + \beta^{t+1}(1+r_{nt}) - \lambda_t] + L_{nt+1}\beta^{t+1} = 0, \\
\frac{\partial D_{nt+1}}{\partial \tilde{r}_{nt}}[-\beta^t + \beta^{t+1}(1+\tilde{r}_{nt}) - \lambda_t] + D_{nt+1}\beta^{t+1} = 0.
\end{aligned}$$

Dividing by β^t and normalizing the multipliers as $\mu_t = \frac{\lambda_t}{\beta^{t+1}}$, after some manipulation we obtain

$$\frac{1}{\epsilon^L} + (1+r_n) - \frac{1}{\beta} = \mu \tag{65}$$

$$\frac{1}{\epsilon^D} + (1+\tilde{r}_n) - \frac{1}{\beta} = \mu \tag{66}$$

$$\mu \leq (1+r^w) - \frac{1}{\beta} \tag{67}$$

$$\mu \geq (1+r^w)(1+\tau) - \frac{1}{\beta} \tag{68}$$

$$\bar{W}(\mu - [(1+r^w) - \frac{1}{\beta}]) = 0 \tag{69}$$

$$\underline{W}[\mu - ((1+r^w)(1+\tau) - \frac{1}{\beta})] = 0 \tag{70}$$

$$\bar{W} \geq 0 \tag{71}$$

$$\underline{W} \geq 0 \tag{72}$$

Where ϵ^L, ϵ^D are the elasticities of loan and deposits with respect to interest rates. It follows from equation (68) and equation (69) that banks would either lend or borrow in the inter-bank market, but not both.

B.3 Solution Method

To guarantee that the solution of the non-linear system of equations that characterizes a steady state in this economy satisfies the non-negativity constraints for $\bar{W}$ and $\underline{W}$ we first look for a solution in which there was no inter-bank market. Then we order banks in terms of their μ^b and consider what would happen as we move the threshold bank (ordered using the multiplier) that enters the inter-bank market as a lender or a borrower. If we cannot find a solution in which only the bank with the highest μ^b lends (and all other banks borrow) in the interbank market, we move on to look for one in which the two banks with the highest multipliers lend (and all other borrow), and continue in this fashion sequentially.

In the case **without** an inter-bank market, the system of equations for a steady has $N + 2 \times \tilde{N} + B$ unknowns, where $\tilde{N} = \sum_b \mathcal{B}^n$ is the number of city-bank pairs in the economy. The unknowns we need to solve for are $\{p_{nn}, \{r_n^b, \tilde{r}_n^b\}_{\mathcal{B}^n}\}_{n=1}^N, \{\mu_b\}_{b=1}^B$.

Knowing individual rates, we can calculate $R, Q, \tilde{Q}, Q^A$ from the definition of these indices. From p we can obtain P and trade shares as

We can calculate the steady-state rental rate of capital in each city from

$$\hat{r}_n = R_n P_n (1 - \beta(1 - \delta)),$$

and wages follow from optimality from the equalization of price and marginal cost

$$w_n = \left(\frac{p_n z_n}{\hat{r}_n^{1-\mu}}\right)^{\frac{1}{\mu}}.$$

In equilibrium, labor shares respond to real wages and amenities, mediated by the importance of idiosyncratic shocks,

$$\ell_n = \frac{\left(\frac{b_n w_n}{P_n}\right)^{\frac{\beta}{\rho}}}{\sum_i \left(\frac{b_i w_i}{P_i}\right)^{\frac{\beta}{\rho}}}$$

And we can calculate the equilibrium level of physical capital from firms' optimality

$$k_n = \ell_n \frac{1 - \mu}{\mu} \frac{w_n}{\hat{r}_n}$$

Because in steady-state $i_n = \delta k_n$ we are ready to calculate the demand for loans in each city-bank pair as

$$L_n^b = P_n \delta k_n \left(\frac{R_n}{1 + r_n^b}\right)^{\sigma} \gamma_n^{b\,\sigma-1}$$

Knowing the value of loans in each city-bank pair we can calculate M_n from its definition, and D_n^b from equation (57). Individual deposits in each city-bank pair follow from equation (21).