Banks, Market Segmentation, and Local Development*

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September 30, 2024

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Abstract

We study how bank branches' local market power in interest-rate setting and frictions in the interbank market lead to misallocation of investment across cities. Using loan-level data from Chile, we document interest rate differences both across cities within the same bank and between banks within the same city, consistent with the theoretical mechanisms we propose. We develop a quantitative spatial model with banks that allows us to quantify the impact of the bank network on spatial inequality. Preliminary analysis indicates that pro-competitive reforms in the banking sector increase aggregate welfare by 1.63% and lead to significant reductions in spatial inequality.

Key words: capital misallocation, banks, spatial inequality.

JEL codes: G21, O16, R12.

*We are grateful to Milena Almagro, Jonathan Dingel, Santiago Franco, Esteban Rossi-Hansberg and audiences at the University of Chicago and the UEA European meetings for helpful comments and suggestions. Esteban Aguilera and Sebastián Andalaft provided superb research assistance.

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1 Introduction

Understanding the drivers of income inequality between cities is a central question in spatial and development economics and a crucial step toward designing effective place-based policies. In this paper, we provide novel evidence of geographic disparities in interest rates across cities and explore the role of banks in explaining these differences. To study how these differences in interest rates translate into differences in income and welfare we embed banks into a quantitative spatial model with investment, trade, and migration and use it to quantify the effect of a pro-competitive policy in the banking sector. This policy reduces interest rate dispersion across cities and leads to an increase of 1.64% in aggregate welfare and a reduction in the dispersion of welfare across cities of almost 30%.

The first contribution of this paper is to show that, all else equal, firms' capital costs vary based on their location. Using detailed credit registry data from Chile where we can control for borrower, loan, and bank characteristics, our findings reveal that interest rates in cities at the 10th percentile of the distribution are 305 basis points lower than those at the 90th percentile. We then investigate the factors behind these differences. Our first result is that local bank competition significantly impacts rates — cities with more competition have lower interest rates. Second, the identity of banks in a city matters, as banks with better access to deposits through their branch network offer lower interest rates in every city where they are present. As a consequence, different banks will offer different rates in the same city.

The second contribution of this paper is to embed banks into a quantitative spatial model with investment, trade, and migration and use it to study how interest rate disparities translate into income disparities. We use the estimated model to evaluate the impact of a pro-competitive policy that works by allowing savers and borrowers in every city to interact with any bank in the economy. Preliminary results show that this policy increases aggregate welfare by 1.63% and has heterogenous local effects. Welfare increases substantially in cities with low levels of pre-policy welfare and goes down in cities where pre-policy welfare was high. The policy leads to a reduction in the standard deviation of welfare across cities of 29.3%.

Our evidence on geographic dispersion in interest rates is novel. Most empirical studies on the spatial distribution of banks and their interactions within cities rely on aggregated data on deposits and loans at the city-bank level. This data typically only reports the average interest rate across all outstanding loans or deposits, leading previous studies to abstract from detailed interest rate analysis (Aguirregabiria et al., 2020; Bustos et al., 2020; Oberfield et al., 2024). We overcome this limitation by leveraging detailed credit registry data from Chile, which provides a comprehensive set of borrower and loan characteristics.

Our first finding is that differences in interest rates across cities are substantial. A naive comparison of average interest rates across cities implies that the difference between cities at the 10-90th percentiles of the interest rate distribution is 330 basis points. However, this raw difference overlooks variations in loan composition, bank identity, and firm characteristics across cities. To address these issues, we regress loan-specific interest rates on a set of controls, such as bank fixed effects, loan characteristics, and firm characteristics, including the firms' industry and proxies for risk (see Section 3 for details). After controlling for these observable characteristics, we find differences of 305 basis points between cities at the 10-90th percentiles of the interest rate distribution. This suggests that banks charge different rates on similar loans issued to similar firms depending on the city in which that firm is located. Furthermore, when we add the local Hirschman-Herfindahl index as a control, we find a strong negative effect of local competition on 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.

The previous result controls for the identity of the banks to isolate the effect of geography, but the average interest rate in a city is partly shaped by the identity of the banks with local branches. All else equal, some banks charge higher interest rate than others. In line with other papers studying the interaction between banks and space, we link these differences to the pool of deposits that a bank can tap into. If borrowing externally is subject to frictions, an increase in the deposits a bank can tap into should lead to a reduction in the bank-specific interest rate and an increase in the loans issued elsewhere. Evidence from Brazil and the United States is consistent with this mechanism (Gilje et al., 2016; Gilje, 2019; Bustos et al., 2020). We provide additional evidence of this mechanism in Chile: following a positive shock to deposits in a region, banks affected by the shock issue more loans elsewhere. The growth in loans happens homogeneously in all cities in the country, independent of the distance to the shock.

In order to study the general equilibrium effects of the bank network and segmented capital markets in general equilibrium, we embed banks into an otherwise standard quantitative spatial model with investment in physical capital, trade, and migration based on Kleinman et al. (2023). The model takes the geographic presence of banks as given and accounts explicitly for their strategic interaction at the local level. The model also includes frictions in the inter-bank market, which allows us to replicate our findings.

To estimate the model, we follow two complementary approaches. First, we exploit the Itaú-Corpbanca merger in 2016 as a natural experiment to study local bank competition and estimate how firms substitute loans, and households substitute deposits across banks. After the merger, interest rates went up in cities that used to have Itaú branch (and no Corpbanca) but now had an Itaú-Corpbanca branch. We examine how loans issued by other banks responded to this plausibly exogenous increase in the interest rate of one bank in the city around this date to estimate the elasticity of substitution, a key parameter in the model. We estimate the elasticity of substitution for deposits analogously. For the other parameters of the model, we follow a standard approach in spatial economics and invert the model from observed data on loans, wages, employment, and interest rates at the local level (Redding and Rossi-Hansberg, 2017). We then use the quantified model to study the welfare effects of a pro-competitive policy in which borrowers and deposit makers can access all banks in the country. This policy equalizes both market power across cities and access to deposits across banks. The policy generates an increase in aggregate welfare of 1.63%.

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, we provide context for the Chilean setting and describe the data, while Section 3 presents our empirical analysis. In Section 4, we describe the quantitative spatial model with banks and quantify it in Section 5. In Section 6, we use the quantified model to study our policy counterfactuals and 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) discard this mechanism, arguing that there are few formal impediments to capital mobility within countries. Our novel empirical results from Chile, together with the papers discussed below, provide evidence that these impediments matter. 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 geographic 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.

In the spatial economics literature, recent contributions 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 between US states. Our model incorporates banks into their model. 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.

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 that a bank 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 passage of the Riegle-Neal Act. 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.

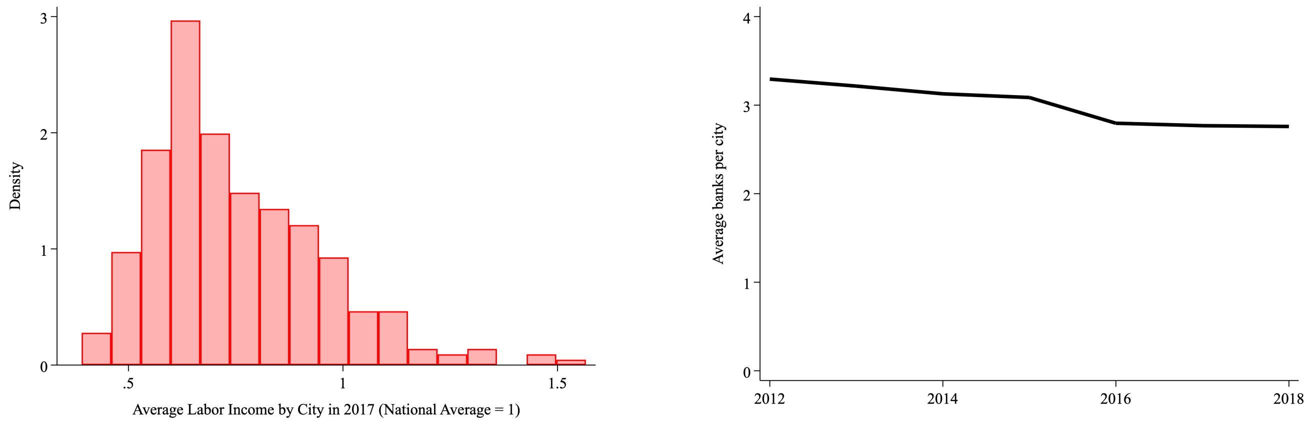
At the heart of our analysis and most of the papers discussed above is the idea that workers rely disproportionately on bank branches available locally. This idea is backed by a rich empirical literature studying the importance of bank branches for local credit. Nguyen (2019) finds, using data from the 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 Sources

Our empirical analysis will focus on Chile, one of the most unequal countries in Latin America and with high levels of spatial inequality. In Figure 1a, we leverage data on the universe of workers in the formal private sector and compare the average labor income in each city to the national average. For this exercise group together all the municipalities that belong Santiago, the capital city. In 10% of the cities, average labor income is at or below half of the national average, while in 50% of the cities, it is 70% or less of the national average. It is in this context that we explore the role of capital misallocation induced by the bank network for spatial inequality.

Figure 1: Spatial Inequality and Bank Network

(a) (b)



Sources: AFC and CMF.

Chile also stands out in Latin America for its advanced financial development and the role of banks in the financial landscape. 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. Survey data reveals that firms of all sizes rely heavily on banks, and households primarily choose banks as their preferred depository institution.[1]

In the rest of the paper we explore banks' market power in interest-rate setting at the local level. A structural feature of the banking industry that underlies this mechanism is that there are few important banks. 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.[2]

Some key features of the distribution of banks across cities are: *i*) the number of banks per city is small, *ii*) the distribution remained stable during 2012-2018, and *iii*) banks do not cluster geographically. In Figure 1b we show that the average number of banks per city remained stable at around 3 between 2012-2018. Although a constant average could in principle mask a high turnover in branch openings and closings, the number of new and disappearing bank-city pairs fluctuated around 2% of the total, indicating that most

[1]See Appendix Section A.1 and Section A.2 for a discussion of the empirical results in this paragraph.

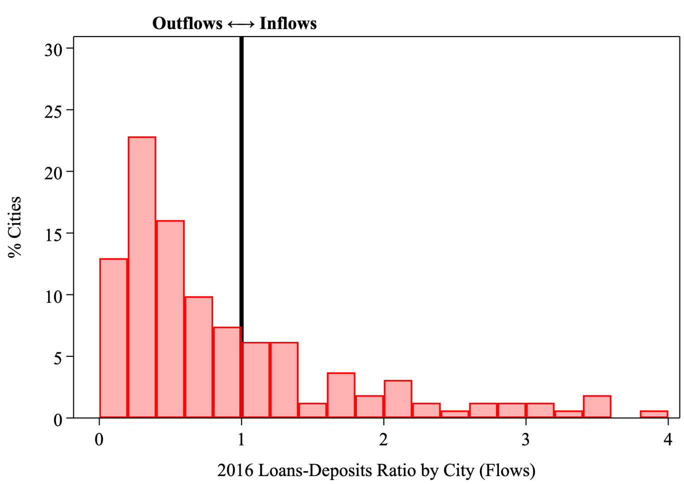
[2]See Figure 11 in the Appendix Section A.3.

cities saw little change in bank branch presence during this period.[3] Given this stability, in our analysis we take the bank network as given and do not incorporate branch location decisions. Finally, in Chile banks do not cluster geographically. Following the approach in Conley and Topa (2002), we find no statistically significant geographical correlation between bank presence and market share at various distances.[4] 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.

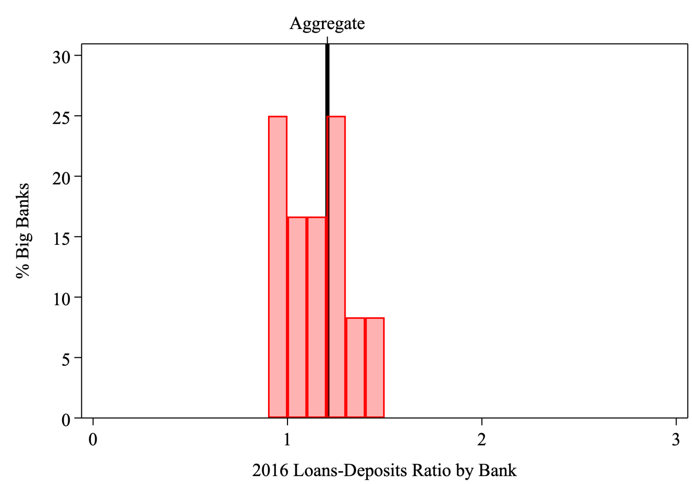
The picture that emerges from the previous points is that of a bank network in which few national banks interact locally in the cities where they are present. These banks, however, are national, and therefore the decisions need to add up at the national level allowing them to finance loans in one city with deposits drawn from a different city. The importance of banks in allowing capital flows between cities has been shown using data from the United States (Aguirregabiria et al., 2020) and also plays a role in Chile. The left panel in 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. Moreover, although deposits are not the only source through which banks fund loans, they are the main one. The right panel in Figure 2 displays the loan-deposit ratio for the biggest bank, indicating that most banks rely on external funding sources to issue loans. Our model will speak to this feature of the banking network by allowing banks to issue bonds in the wholesale market to finance their loans to the private sector.

Figure 2: Loan-Deposit Ratios by City and Bank

(a)



(b)



Source: CMF. Figure 2a computes the new loans and new deposits in each city between August 2016 and August 2017 and shows the ratio of the two. Figure 2b shows the ratio of the stock of loans and deposits per bank in August 2017. For 2b we keep banks with a stock of loans above one billion Chilean pesos, the 11 biggest in 2017.

[3] 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.

[4] See the results in the Appendix Section A.4.

2.1 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.

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. 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 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.

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.

3 Empirical analysis

Using several data sources from Chile, we document a set of novel facts about the dispersion of interest rates in space. Then, we study the local credit market characteristics that lead to higher interest rates. Although our previous analysis controls for bank fixed effects, part of the variation in the interest rates that firms face is related to the identity of the banks in their city. In the second part of this section, we show that the pool of deposits that a bank can tap into affects the interest rate that the same bank charges on its loans. This highlights the importance of studying the bank network from the perspective both of loans and deposits.

3.1 Geographic Dispersion in Interest Rates

We estimate the following equation

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

using micro-data on the universe of loans. The outcome variable $i_{\ell ft}$ 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 $X_{\ell t}$: like maturity and type of loan, in addition to a fixed-effect for the bank issuing the loan, $b(\ell)$.

Figure 3 below shows, in gray, the distribution of $\delta_{c(f)}$ after subtracting the mean. We find substantial dispersion in interest rates: a firm located in a city at the 10th percentile of the interest rate distribution faces an interest rate that is 305 basis points lower than a comparable firm receiving a similar loan in a city at the 90th percentile. To have as a benchmark, the Figure also shows, in red, the distribution of fixed effects we would have estimated in an equation like equation (1) if we had only included the city fixed effects $\delta_{c(f)}$. The gap between the 10-90th percentile in this case is 330 basis points. The comparison between the two distributions indicates that adding controls reduces the variance in the city fixed effects, as part of it has to do with composition effects. However, the dispersion remains substantial, suggesting that geography plays a prominent role.

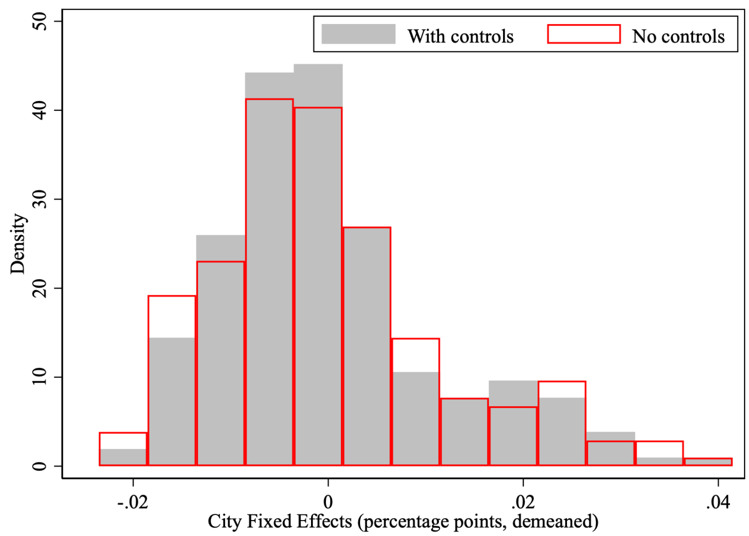
In the regression underlying Figure 3, loans are weighted by the loan amount. In the Appendix Section A.5 we provide alternative specifications where we weight loans by firm's employment or we weight all loans equally, and results remain similar.

After showing that interests vary between cities, we now consider what may explain this 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

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

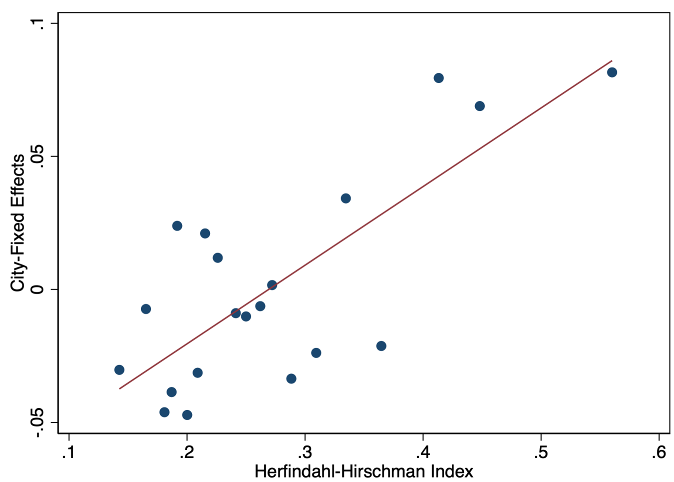
Figure 4 below shows a bin-scatter of city-level fixed effects against the city-specific HHI. The positive relationship implies less competition between banks, which leads to higher interest rates. Recall that our specification in equation (1) includes bank fixed effects, so composition effects do not drive this relationship, and they should be interpreted as the same bank charging higher interest rates in cities where they face less

Figure 3: Geographic Differences in Interest Rates



competition.

Figure 4: Less competition leads to higher interest rates



3.2 Deposits are a key source of funding

We examine how shocks to deposits into one bank translate into increased loans elsewhere. In principle, the impact could depend on the city where the deposits increased, the bank involved, or both. If frictions in the interbank market are strong, capital would flow within the same bank and across cities. Alternatively, geographical frictions might cause the same bank branch to lend primarily to nearby branches, resulting in geographically close cities being more exposed and experiencing greater loan growth. To analyze this, we follow the empirical approach in Gilje et al. (2016), who analyze the same question using data from the United States. They show that localized shocks to deposits driven by natural gas discoveries led to increased loans issued by banks in other counties, a phenomenon they label 'exporting liquidity.'

Given our focus on Chile, we use variation in the world price of salmon to construct exogenous shocks to deposits. Salmon is an important industry in Chile, accounting for 7.8% of non-copper exports between 2005 and 2019 and rising to 12.8% in 2019. To identify which cities specialize in salmon, we used data from AFC in 2015 and calculated employment in the fishing industry as a percentage of local employment. The results, shown in Figure 15 in the Appendix A.7, indicate that cities specializing in Fishing cluster in the country's South. We construct an indicator dummy that equals one if a city's employment share in Fishing is above 4.33% (the 90^{th} percentile). Then, we calculate the share of deposits that a bank received from these cities in the 1998-2001 period, leveraging aggregate data on deposits by city-bank pair from the CMF. We observe the outstanding stock of deposits or loans every February and August throughout 2005-2019, so the analysis in this section is done at the semester level. Our last piece of data is the world price of salmon, which comes from the IMF Commodity Price series. Figure 16 in the Appendix A.7 shows the evolution of the world price of salmon throughout the 2005-2019 period.

Our empirical strategy relies on comparing banks differentially exposed to changes in the world price of salmon. We estimate

$$Deposits_t^b = \beta_0 + \beta_1 Deposits_{t-1}^b + \beta_2 p_t^{salmon} + \beta_3 p_t^{salmon} \times Exposure^b + \gamma X_t^b + \epsilon_t^b \tag{2}$$

to gauge the effect of movements in the world price of salmon on the stock of deposits that each bank can attract. Our control variables include the lagged value of deposits, bank fixed effects and an interaction between the bank fixed effect and a dummy for the years of 2008 and 2009 to control for the Global Financial Crisis (GFC). The results are shown in the first column of Table 1. There is a statistically significant and economically large relationship between the world price of salmon and deposits. If a bank's deposits came fully from Fishing cities, a one percent increase in the world price of salmon would translate into a 3.28% increase in the bank's total deposits. To have as a benchmark, during the period, deposits grew at an average (median) rate of 2.92% (3.43%).

We then move to estimate the effect on loans by estimating

$$Loans_{nt}^b = \beta_0 + \beta_1 Loans_{nt-1}^b + \beta_2 p_t^{salmon} + \beta_3 p_t^{salmon} \times Exposure^b + \gamma X_t^b + \epsilon_t^b \tag{3}$$

on aggregate loan data at the city-bank level, which we denote by n and b, respectively. Our control variables include the lagged value of loans in the city-bank pair, city-bank fixed effects, and the previous control interacting bank fixed effects with the GFC period. The results, shown in the second column of Table 1, indicate a strong and statistically significant effect on loans. A bank with a reliance on fishing cities of 0.25 would have issued around 0.67% more loans in each branch following a 1% increase in the price of salmon. To have as a benchmark, during the period, loans at the city-bank level grew at an average (median) rate of 0.77% (-0.13%).

The third column of Table 1 expands equation (3) by adding an interaction between our exposure measure and the distance between city n and the 'Fishing cities' we have defined above. We find that this interaction is not statistically significant. This suggests that when the deposits of a bank increase, lending in all other branches increases regardless of the specific branch receiving deposits. We conclude from these results that the bank network plays a much more important role than distance.

Table 1: Propagation of Deposits Shocks due to changes in the World Price of Salmon

	Bank Deposits (Logs)	**City-Bank Loans (Logs)**	**City-Bank Loans (Logs)**
Log Deposits$_{t-1}$	0.221***		
	(0.042)		
Log Loans$_{t-1}$		0.130***	0.137***
		(0.019)	(0.018)
Log Price of Salmon$_{t-1}$	1.520***	1.383***	1.241***
	(0.0.361)	(0.097)	0.133)
Log Price of Salmon$_{t-1}$ $\times$ Reliance on Fishing Cities	3.287*	2.700**	3.060**
	(1.598)	(1.057)	(1.254)
Log Price of Salmon$_{t-1}$ $\times$			-0.0003
Reliance on Fishing Cities $\times$ Distance to Fishing Cities			(0.0008)
Controls included			
Bank FE	Yes	-	-
Bank FE $\times$ GFC Dummy	Yes	Yes	Yes
Bank $\times$ City FE	-	Yes	Yes
Within R-squared	0.611	0.400	0.406
Observations	255	13317	11776
Number of Banks	13	12	12

Statistical significance denoted as * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors clustered at the bank level.

4 Model

The novel aspect of our model lies in its ability to explain geographical variation in interest rates and study the implications of interest rate differentials output and welfare. Our modeling choices capture features described in the previous two sections: firms' and households' reliance on local branches, interbank 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.[5] 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. However, the interbank market is subject to frictions. 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 given by

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

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,

$$C_{nt} = \left(\sum_{i=1}^{N} c_{it}^{\frac{\sigma_c - 1}{\sigma_c}} \right)^{\frac{\sigma_c}{\sigma_c - 1}}. \tag{4}$$

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

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

$$P_{nt} \equiv \Big(\sum_j (\tau_{ni} p_{iit})^{1-\sigma_c}\Big)^{\frac{1}{1-\sigma_c}}, \tag{5}$$

$$\pi_{nit} = \Big(\frac{\tau_{ni} p_{iit}}{P_{nt}}\Big)^{1-\sigma_c}. \tag{6}$$

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

$$V^w_{nt} = \log(\tfrac{b_n w_{nt}}{P_{nt}}) + \max_d\{\beta \mathbb{E}_t[V^w_{dt+1}] + \rho\epsilon_{dt}\} \tag{7}$$

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 (4), the problem of a capitalist at the second stage can be written as

$$\max_{\{C^c_{nt}, D^b_{nt+1}, k_{nt+1}\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t \Big[\log C^c_t + \log D_{nt+1} \Big] \tag{8}$$

$$\underline{s.t:}\; C^c_{nt} + \sum_b \frac{D^b_{nt+1}}{P_{nt}} + \frac{\mathcal{C}_{nt}(i_{nt-1})}{P_{nt}} = \frac{\hat{r}_{nt}}{P_{nt}} k_{nt} + \sum_b (1+\tilde{r}^b_{nt}) \frac{D^b_{nt}}{P_{nt}} + T_{nt} \tag{9}$$

$$k_{nt} = k_{nt-1}(1-\delta) + i_{nt-1} \tag{10}$$

$$D_{nt+1} = \Big[\sum_b {D^b_{nt+1}}^{1-\frac{1}{\eta}} \Big]^{\frac{\eta}{\eta-1}} \tag{11}$$

$$k_{n0}, \{D^b_{n0}, L^b_{n0}\}_b \tag{12}$$

where the budget constraint equation (9) 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

$$\mathcal{C}_{nt}(i_{nt-1}) = \min_{\{L^b_{nt}\}_b} \sum_{b\in\mathcal{B}} L^b_{nt}(1+r^b_{nt-1})$$
$$s.t: \Big[\sum_{b\in\mathcal{B}} (\gamma^b \tfrac{L^b_{nt}}{P_{nt-1}})^{\frac{\sigma-1}{\sigma}} \Big]^{\frac{\sigma}{\sigma-1}} = i_{nt-1} \tag{13}$$

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

$$\frac{L^b_t}{P_{t-1}} = \Big(\frac{R_{t-1}}{1+r^b_{t-1}} \Big)^{\sigma} i_{t-1} (\gamma^b)^{\sigma-1}. \tag{14}$$

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 (13) and equation (14) it follows that

$$\mathcal{C}_t(i_{t-1}) = \sum_{b\in\mathcal{B}} L^b_t(1+r^b_{t-1}) = i_{t-1} R_{t-1} P_{t-1}. \tag{15}$$

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

$$D^b_{t+1} = D_{t+1} \left(\frac{Q_t}{q^b_t} \right)^{\eta}, \tag{16}$$

where

$$q^b_t \equiv 1 - \underbrace{\Big(1+\tilde{r}^b_t\Big)}_{\text{Return on deposits}} \Big/ \underbrace{\left(\frac{(1-\delta)R_t P_t}{R_{t-1}P_{t-1} - \hat{r}_t} \right)}_{\text{Return on investment}} \quad \text{and} \quad Q_t \equiv \left(\sum_b (q^b_t)^{1-\eta} \right)^{\frac{1}{1-\eta}}. \tag{17}$$

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

$$D_{t+1} = \frac{M_t}{Q_t + Q_t^\eta \tilde{Q}_t} \tag{18}$$

$$\text{and } P_t C_t^c = \frac{Q_t M_t}{Q_t + Q_t^\eta \tilde{Q}_t} \tag{19}$$

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 (14), equation (16) and equation (18) the bank-specific demand for deposits and loans are described by

$$D_{t+1}^b = \frac{M_t}{Q_t + Q_t^\eta \tilde{Q}_t} \left(\frac{Q_t}{q_t^b} \right)^\eta \tag{20}$$

$$\text{and } L_{t+1}^b = i_t P_t \Big(\frac{R_t}{1 + r_t^b} \Big)^\sigma (\gamma^b)^{\sigma - 1}, \tag{21}$$

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 (20)-equation (21), 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

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

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 $\{\ell_n, k_n, y_n, C_n, C^c_n, k_n, \{L^b_n, D^b_n\}_{b\in B}\}_{n\in N}, r^{ib}$ such that

- Workers' consumption and migration decisions maximize their lifetime utility, equation (6)-equation (7). From optimal migration decisions it follows that teady-state labor shares reflect flow utility,

$$\ell_n = \frac{\left(\frac{b_n w_n}{P_n}\right)^{\frac{\beta}{\rho}}}{\sum_{i=1}^{N}\left(\frac{b_i w_i}{P_i}\right)^{\frac{\beta}{\rho}}}. \tag{22}$$

- Capitalists' consumption, saving and borrowing decisions maximize their lifetime utility, equation (19)-equation (20)-equation (21).

- Bank-specific interest rates set optimally, equation (70)-equation (68) in the Appendix.

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

$$\sum_b \bar{W}^b = \sum_b \underline{W}^b \text{ and } T_n = \sum_{b\in\mathcal{B}^n} L^b_n r^b_n - D^b_n \tilde{r}^b_n. \tag{23}$$

- Labor markets clear at the national level

$$\sum_n \ell_n = 1. \tag{24}$$

- 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:

$$w_n \ell_n + \hat{r} k_n = \sum_{i=1}^{N} \pi_{ni} (P_i C_i + P_i C_i^c + \sum_{b \in \mathcal{B}^i} L_i^b) \tag{25}$$

In the Appendix Section B.4 we describe our solution method.

4.3 Illustrative example: linear geography

To illustrate theoretically the effects of segmented capital markets, we consider the case of a linear geography, a well-studied benchmark in the spatial literature. We index cities by their location in the line, $n \in \{1, .., N$, and transport costs from city n to city i are parametrized as $\tau_{ni} = \tau e^{\alpha |i-n|}$. We consider a case where productivity and amenities are the same across cities. Therefore, the only heterogeneity across cities comes from their geographical proximity to other cities and the accompanying market access. Cities at the middle of the line have better market access to consumption goods than cities at the extremes of the line. We assume there are two banks in the country.[6]

The left panel of Figure 6 describes the environment and the equilibrium outcomes in a benchmark scenario where both banks have branches in every city. The top panel describes the price of the final good in different locations. The middle panel shows the distribution of capital and wages in equilibrium. Cities in the middle of the lines have higher market access, leading to higher investment. This capital deepening leads to higher labor productivity and wages in equilibrium, even though exogenous productivity is constant in space. 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, $n < 8$. The right panel in Figure 6 describes this new equilibrium.

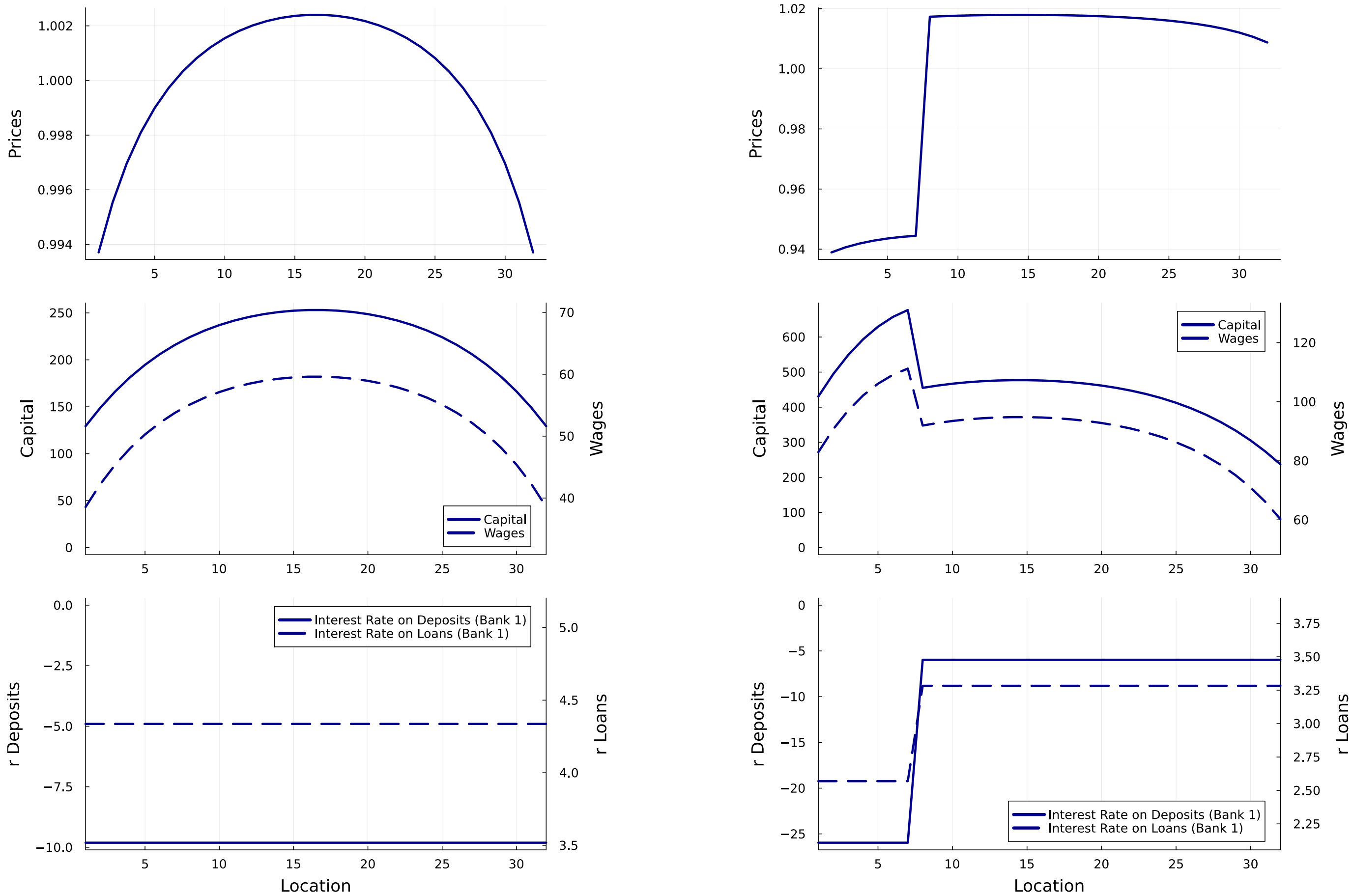
Once markets are segmented, outcomes around $n = 8$ look sharply different. The top subfigure shows that prices increase in the cities with only one bank ($n \geq 8$). There is also a sharp drop in labor productivity and wages around the threshold caused by reduced capital deepening, as the middle sub-figure in the panel shows. The last panel shows how Bank 1 sets interest rates in different cities. Bank 1 charges lower interest rates for loans in the cities where it faces competition from the second bank.

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.

[6] 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 5: Illustration with Linear Geography

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



5 Estimation

We quantify the model using data from Chile between 2002 and 2017.[7] For each city we observe wages, employment, and the total value of 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.

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.

[7] 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 2: 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		Geographic distribution of employment
$\{b_n\}_{n=1}^N$	Productivities		Geographic distribution of Wages
$\{\{\gamma_n^b\}_{b=1}^B\}_{n=1}^N$	Productivities		Internal capital flows

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. Table 2 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.[8]

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

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

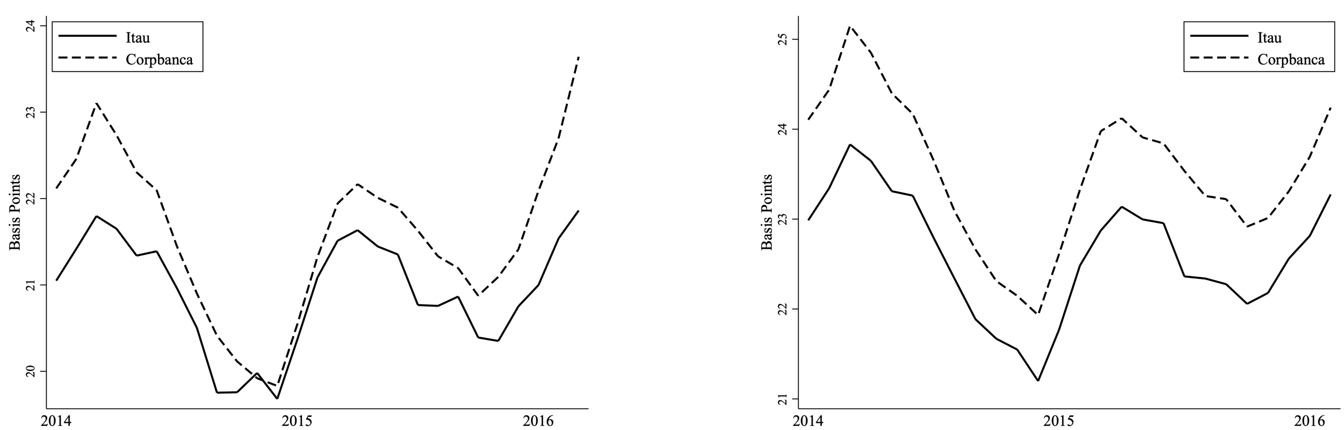
5.1 Reduced form evidence of substitutability between banks from the Itaú-Corpbanca merge

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.*[9] The merge was made effective in April 2016.[10]

Figure 6b 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.[11] 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.

Figure 6: Interest Rate Comparison between Itaú and Corpbanca before the Merge

(a) Interest Rate on Deposits (Imputed) (b) Interest Rate on Loans



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 (14).

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,

[9] 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.

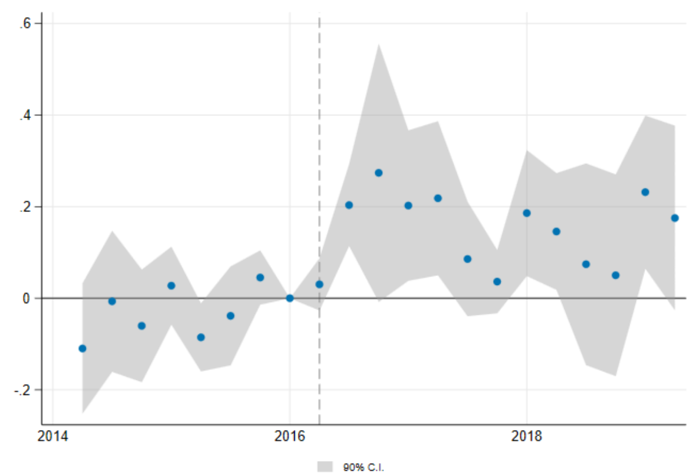
[10] https://citywire.com/americas/news/banco-itau-chile-and-corpbanca-complete-merger/a895936, access on April 25 2023.

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

$$l^b_{nt} = \gamma^b_t + \gamma^b_n + \sum_{\tilde{t}} \beta_{\tilde{t}} \mathbb{1}_{[n\in\mathcal{T}]} \mathbb{1}_{[t=\tilde{t}]} + \epsilon^b_{nt} \tag{26}$$

where l^b_{nt} is the log of loans issued by bank b in city n at quarter t. The fixed effects γ^b_t and γ^b_n capture shocks at the the month-bank and city-bank levels, respectively, and represent common shocks to r^b_t and the quality of the match γ^b_n (through equation (14)). We are interested in $\beta_{\tilde{t}}$ in equation (26) around April 2016, the date at which the merger became effective. Figure 7 below shows the results.

Figure 7: Estimates for $\beta_{\tilde{t}}$



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 6b).

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 city-bank specific characteristics, like the fit of a specific bank to the city's industry mix. Therefore, there would have to be city-bank-specific shocks happening at the same time as the Itau-Corpbanca merger for our identifying assumption to be violated.

If we map out estimated elasticity to σ, 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 Productivity, amenity, and city-bank complementarities

We can invert the model using data on wages, employment, loans, and interest rates on loans at the city-bank pair. For this part of the estimation, we use aggregate data. In the case of interest rates, we only observe the aggregate rate at the bank level so we assume they are the same in all cities. The inversion proceeds as follows.

1. Using data on new loans and the average interest rate we can calculate

$$\mathcal{C}(i_n) = \sum_{b \in \mathcal{B}^n} (1 + r_n^b) L_n^b.$$

2. Using that $\mathcal{C}(i_n) = i_n R_n P_n$ and that we have estimated σ, we can use equation (14) to write down a system of $\tilde{N}$ equations

$$L_n^b = \mathcal{C}(i_n) \frac{R_n^{\sigma-1}}{(1 + r_n^b)^{\sigma}} (\gamma_n^b)^{\sigma-1}$$

in $\tilde{N}$ unknowns, the vector of γ_n^b. The γ_n^b rationalize the observed level of loans perfectly.

3. Knowing γ_n^b we can use the definition of investment, equation (13), to calculate $P_n k_n$. We can then recover $\frac{P_n}{\hat{r}_n}$, since we know $\hat{r}_n k_n$ from firms' optimality conditions and our data on $w_n \ell_n$.

4. We estimate $\{z_n\}$ as the vector that guarantees the market clearing conditions hold and $\frac{P}{\hat{r}}$ equal the value we obtained before.

5. We back out amenities b that perfectly rationalize workers' location decisions.

We follow this approach using aggregate data on loans by city-bank pairs from the CMF, average rate on loans by bank from the CMF, average wage from the CASEN and employment from the census. These results are not necessarily representative of the country and only allow us to estimate the parameters for 88 cities out of the more than 300 cities in Chile. Therefore this empirical analysis is purely preliminary. We are currently in the process of estimating the model with more comprehensive data on wages, employments, and interest rates.

6 Integrating Local Capital Markets in Chile

We use the quantified model to measure the welfare and output effects of segmented capital markets. To do so, we consider a counterfactual in which savers and borrowers can access all banks in the economy. This could be achieved through banks opening actual branches in every city or, more plausibly, through decreasing the frictions that prevent people from using distant bank branches. In the counterfactual w impute the city-bank match quality γ_n^b for those city-bank pairs that were not observed in the data by taking the average γ_n^b in that city.

We focus on the effect on labor productivity and welfare. Welfare in the steady state is

$$V_n \propto \log(\tfrac{b_n w_n}{P_n})(1 + \beta) - \rho \ell_n. \tag{27}$$

The value of living in city n is the sum of flow utility and a continuation value. In equation (27) we have used properties of the extreme value distributions according to which the expected value of moving to other cities can be linked to the value conditional on choosing to stay in that city in the future. A correction term involving the probability that the worker actually chooses this action needs to be included. In our setting, the probability of choosing an action is the same as the share of people in that location, which explains the last term.

After the policy is implemented, welfare increases by 1.63% and aggregate labor productivity falls by 1.2%. To understand the drivers of these patterns we first look at how the policy affects different cities. In Figure 8 we sort cities according to either their level of welfare or labor productivity in the baseline. Labor productivity is jointly determined by exogenous productivity and the endogenous capital in each city,

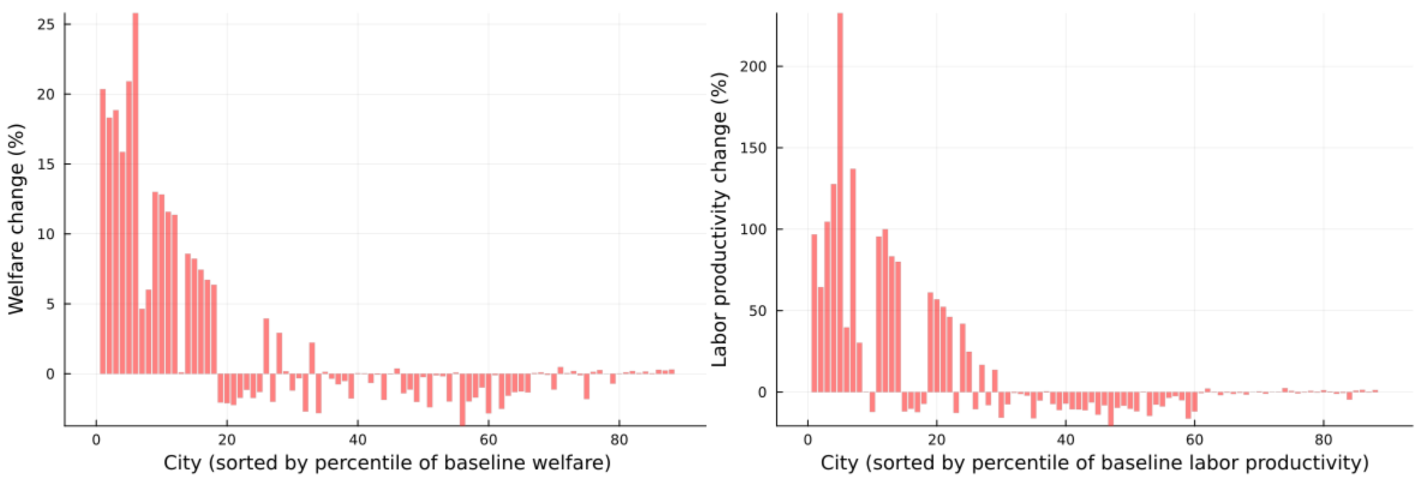
$$\frac{y_n}{\ell_n} \propto z_n \left(\frac{k_n}{\ell_n}\right)^{1-\mu}. \tag{28}$$

Figure 8 shows two clear and related patterns. Once local capital markets are integrated the cities that benefit the most are cities that were lagging behind in the baseline equilibrium, both in terms of welfare or labor productivity. As a consequence of these responses, spatial inequality decreases. The standard deviation of welfare across cities decreases by 29.32%, while the standard deviation of labor productivity decreases by 0.55%.

Figure 8: Heterogeneous effects of pro-competitive banking policy

(a) Welfare

(b) Labor Productivity



A key driver of these responses are heterogeneous changes in physical capital. Figure 9 shows changes in the capital stock by city. In this case we order cities in terms of the baseline marginal productivity in the baseline,

$$MPK_n \propto z_n \left(\frac{\ell_n}{k_n}\right)^{\mu} \tag{29}$$

Figure 9 shows the results. Although there is a clear investment surge in cities around the 60th percentile of MPK, there is also a reduction in cities with initially high levels of marginal productivity of capital. To understand this result we note that labor is also responding to changes in the economic environment, and workers take amenities into account when deciding where to reside. The results we observe are driven by high MPK cities losing population, and therefore attracting less capital after the policy.

Figure 9: Misallocation

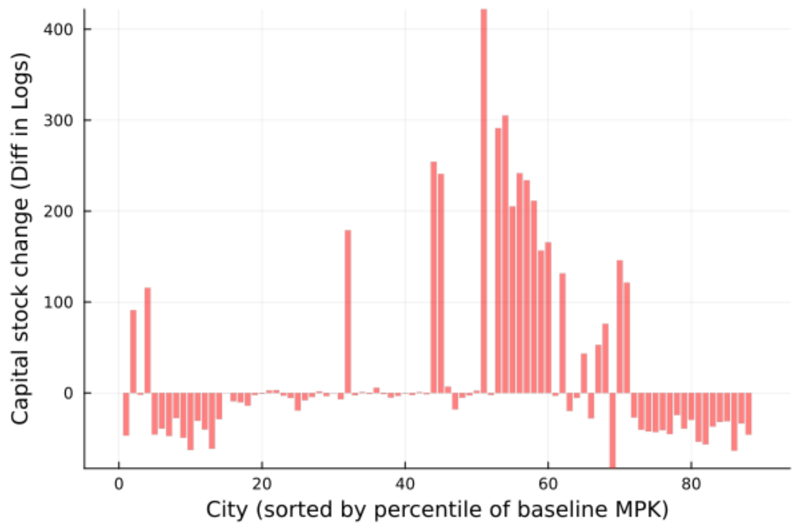


Table 3 shows the correlations between employment and capital and exogenous characteristics of the city, both in the baseline and in the counterfactual. Capital is slightly better allocated into exogenously productive cities, while labor is significantly worse allocated.

Table 3: Factor reallocation towards (away form) productive cities

Correlation between exogenous productivity and...	Baseline	Counterfactual
Employment	0.773	0.690
Capital	0.282	0.287

Our preliminary results — welfare goes up but productivty goes down — are the combination of capital increasing the standard of living in better cities, not necessarily the most productive. This brings an overall increase in aggregate welfare which is stronger in cities that were lagging behind before the policy. Interestingly, aggregate productivity does not increase in the economy. Although capital does go down in cities with low marginal productivity of capital, the correlation of investment growth and marginal productivity is not perfect for cities at the top of the distribution of marginal productivity of capital. Ongoing analysis will allow us to disentangle the quantitative importance of the distribution of amenities in driving these patterns.

7 Conclusion

There are substantial disparities in income between countries. In Latin America, for example, differences in labor income between cities are about double the size of those between countries (Acemoglu and Dell, 2010). In this paper we provided evidence of a novel mechanism, differences in investment cost across cities, by leveraging rich credit registry data from Chile. We show that difference in investment costs is substantial and cannot be explained by observable characteristics of the firm, the bank, or the loan. We highlight two drivers of interest rate differentials: local competition between banks and the identity of the banks present in that city. In line with other studies, we focus on the pool of deposits a bank can tap into as a determinant of the interest rate that a bank will charge for its loans in all the cities where it is present.

To understand the potential benefits in terms of income and welfare of policies that equalize the cost of capital across cities, we developed a quantitative model that includes banks, investment, trade and migration. Having estimated the model, we can study the effect of a policy that equalizes market power across cities by making all banks available to everyone in the country. A possible interpretation of this policy is a push to the use of internet banking that reduces reliance of local branches. We find positive effects on aggregate welfare and a substantial reduction in welfare spatial inequality. The model serves as a laboratory with which two study several policies beyond the one we analyze here. We are currently in the process of carrying out such an analysis.

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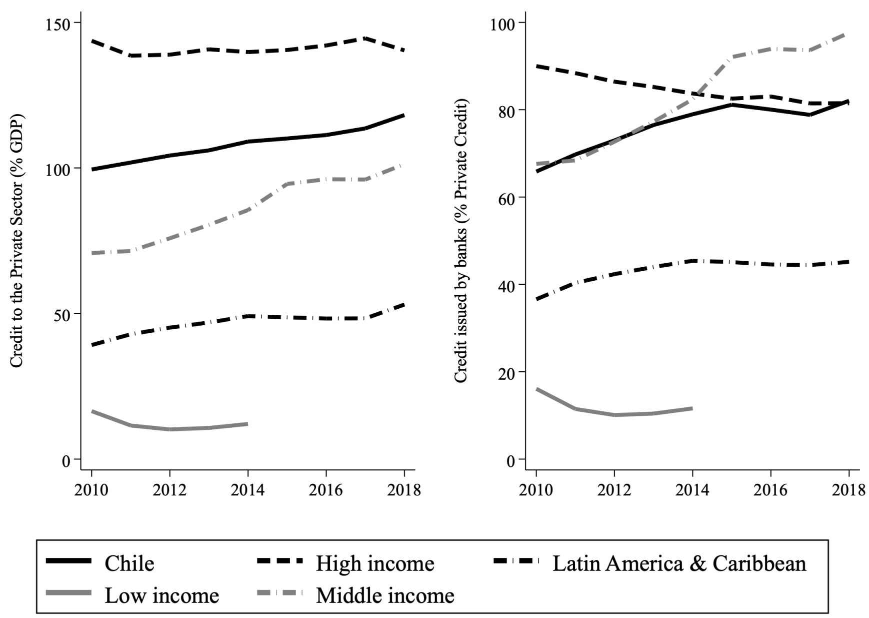
Appendix

A Empirical appendix

A.1 Chile's financial development

We use data publicly accessed from the World Banks' website on June 2024. Figure 10 below shows the two facts mentioned in the main text.

Figure 10: 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.[12] 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 4 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%).

[12]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 4: 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 5 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 5 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.

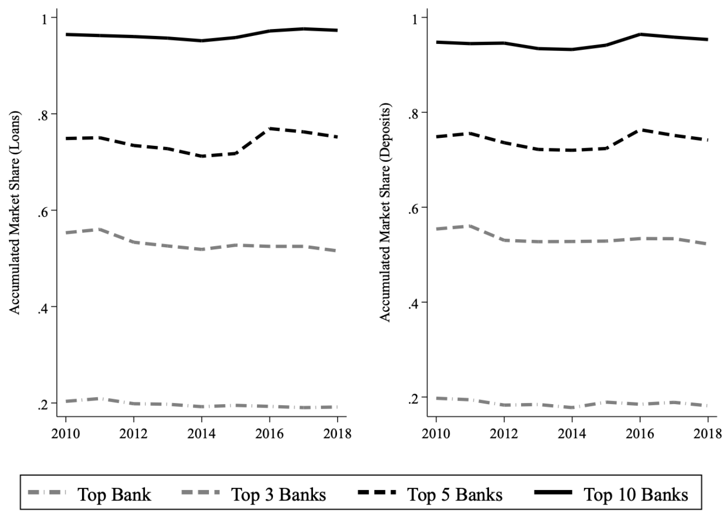
Table 5: Households' savings behavior

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	

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 11.

Figure 11: Concentration in the Banking Industry



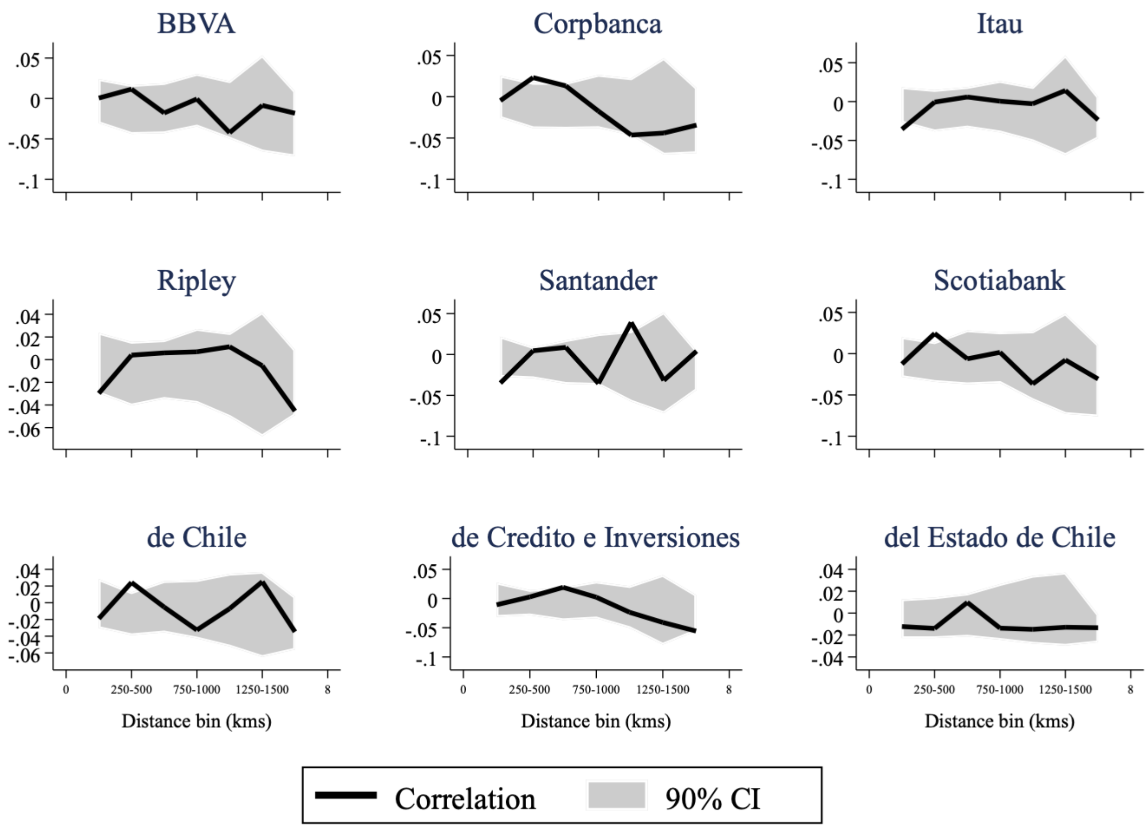
A.4 Spatial Clustering of Banks

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 12 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.

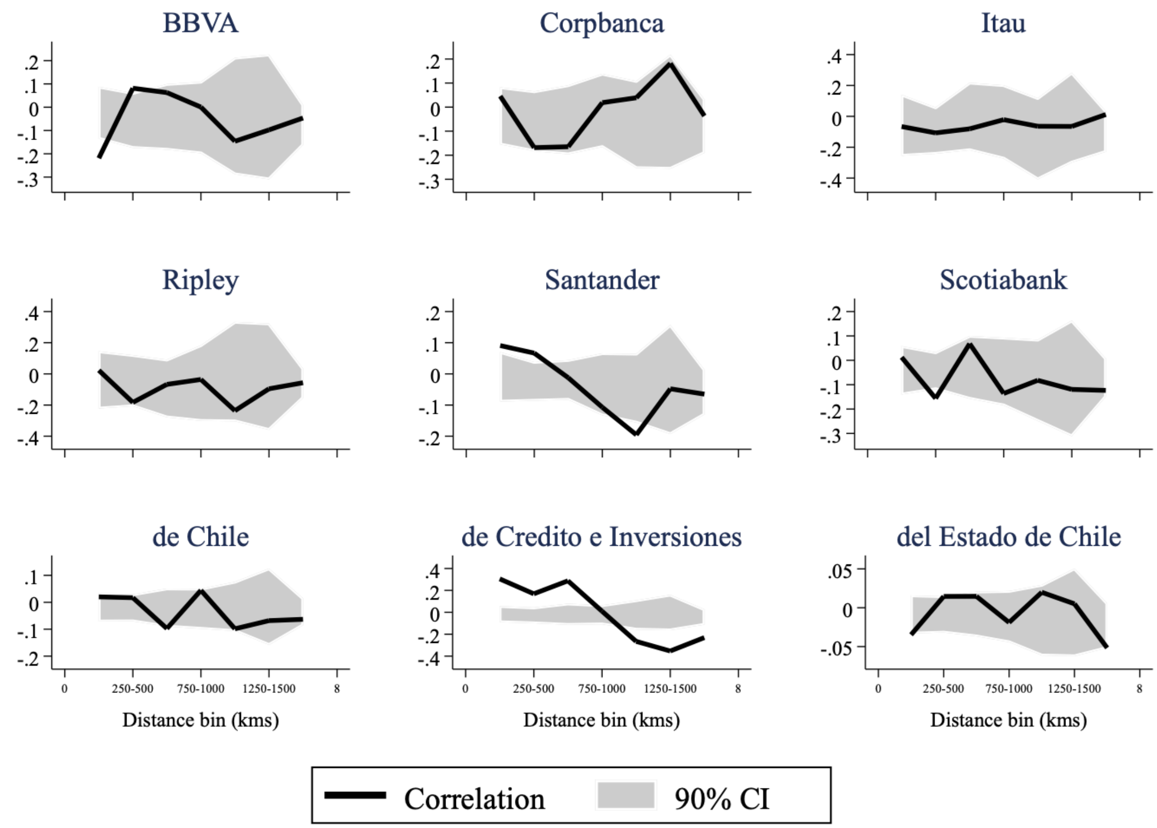
Figure 12: Spatial Correlation in Bank's Presence (Extensive Margin)



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 13 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.

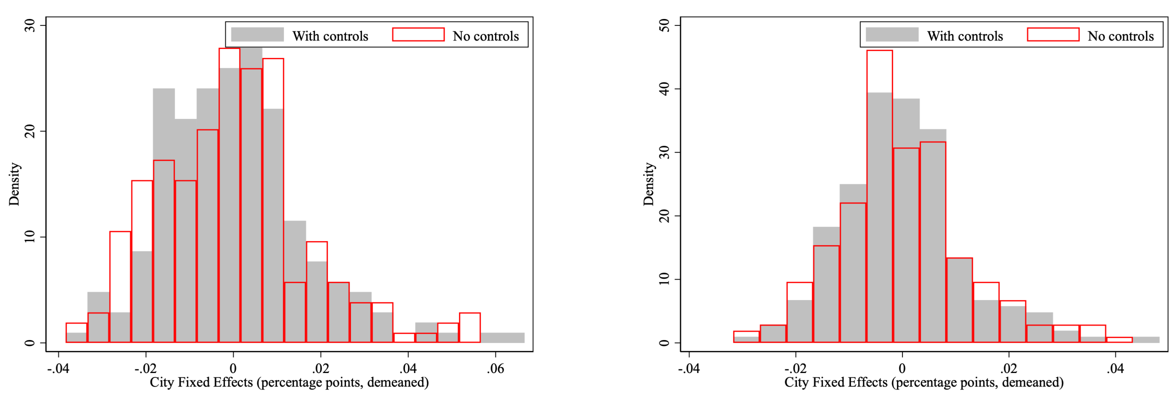
Figure 13: Spatial Correlation in Loan Market Shares (Intensive Margin)



A.5 Distribution of City Fixed Effects under different Regression Weights

Figure 3 in the main text shows the distribution of fixed effects when, in the regression, we weight each observation by the value of the loan. Figure 14 below shows equivalent results when we weigh each loan by the firm size and if all loans get equal weight.

Figure 14: Comparison of Geographical Differences in Interest Rates



(a) Geographical Differences in Interest Rates (Weighted by Firm Employment)

(b) Geographical Differences in Interest Rates (No Weights)

A.6 Variance Decomposition

x A limitation of comparing city-level fixed effects in Table **??** 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 6 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 **??**; 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.

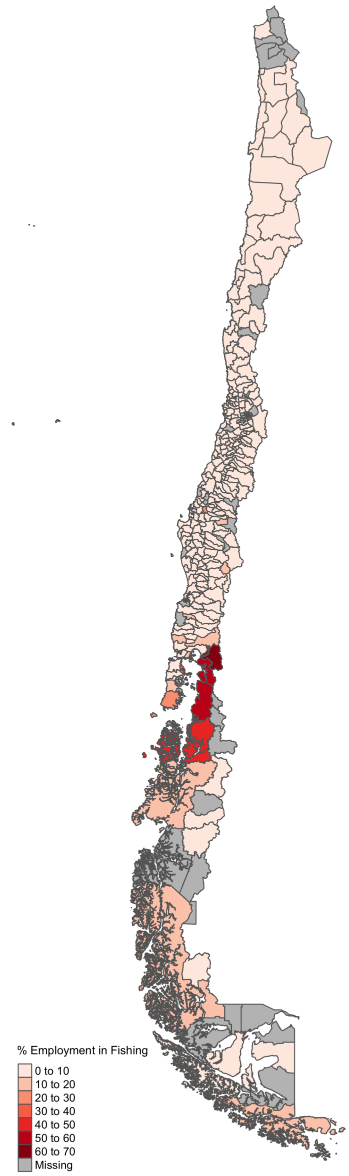
Table 6: Variance decomposition

	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

A.7 Details on the Shift-Share design

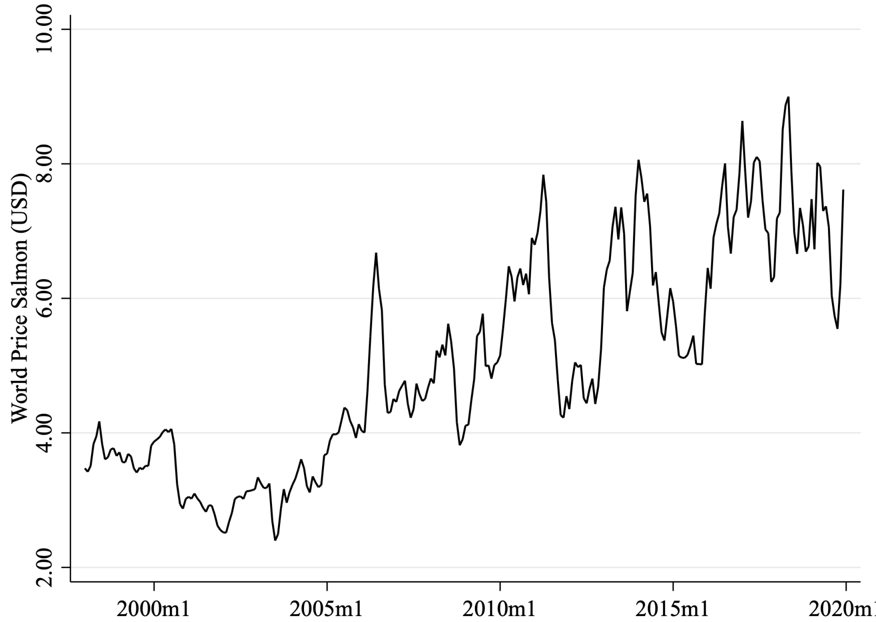
Figure 15 shows the share of local employment in the Fishing industry. The industry is mostly present in the Southern region.

Figure 15: Share of local employment in the fishing industry



The world price of salmon fluctuated during the period we analyzed. Figure 16 shows the world price of salmon.

Figure 16: World Price of Salmon



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

$$\max_{\{C_t^c, D_{t+1}^b, k_{t+1}\}} \sum_{t=0}^{\infty} \beta^t \Big[\log C_t^c + \log D_{t+1} \Big] \tag{30}$$

$$\underline{s.t:}\; C_t^c + \sum_b \frac{D_{t+1}^b}{P_t} + \frac{\mathcal{C}_t(i_{t-1})}{P_t} = \frac{\hat{r}_t}{P_t} k_t + \sum_b (1+\tilde{r}_t^b)\frac{D_t^b}{P_t} + \frac{T_{nt}}{P_{nt}} \tag{31}$$

$$k_t = k_{t-1}(1-\delta) + i_{t-1} \tag{32}$$

$$D_{t+1} = \Big[\sum_b {D_{t+1}^b}^{1-\frac{1}{\eta}} \Big]^{\frac{\eta}{\eta-1}} \tag{33}$$

$$k_0, \{D_0^b, L_0^b\}_b \tag{34}$$

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

$$\mathcal{C}_t(i_{t-1}) = \min_{\{L_t^b\}_b} \sum_{b\in\mathcal{B}} L_t^b (1 + r_{t-1}^b)$$

$$s.t: \Big[\sum_{b\in\mathcal{B}} (\gamma^b \tfrac{L_t^b}{P_{t-1}})^{\frac{\sigma-1}{\sigma}} \Big]^{\frac{\sigma}{\sigma-1}} = i_{t-1}. \tag{35}$$

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

$$\mu (\tfrac{\gamma^b}{P_{t-1}})^{\frac{\sigma-1}{\sigma}} \Big(\frac{i_{t-1}}{L_t^b} \Big)^{\frac{1}{\sigma}} = (1 + r_{t-1}^b), \tag{36}$$

where μ is the multiplier associated with the constraint in equation (35). Taking the ratio of equation (36) 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':

$$i_{t-1} = \Big(\sum_{b\in\mathcal{B}} (\gamma^b \tfrac{L_t^b}{P_{t-1}})^{\frac{\sigma-1}{\sigma}} \Big)^{\frac{\sigma}{\sigma-1}} = (1 + r_{t-1}^{b'})^{\sigma} (\gamma^{b'})^{1-\sigma} \tfrac{L_t^{b'}}{P_{t-1}} \Big[\sum_{b\in\mathcal{B}} (\tfrac{1+r_{t-1}^b}{\gamma^b})^{1-\sigma} \Big]^{-\frac{\sigma}{1-\sigma}}. \tag{37}$$

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

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

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

$$\frac{L_t^b}{P_{t-1}} = \Big(\frac{R_{t-1}}{1+r_{t-1}^b}\Big)^\sigma i_{t-1}(\gamma^b)^{\sigma-1}. \tag{39}$$

as in the main text. From equation (39) and the definition of $\mathcal{C}_t(i_{t-1})$,

$$\mathcal{C}_t(i_{t-1}) = \sum_{b\in\mathcal{B}} L_t^b(1+r_{t-1}^b) = i_{t-1}R_{t-1}P_{t-1}. \tag{40}$$

Plugging $\mathcal{C}_t(i_{t-1})$ into the budget constraint equation (31) and law of motion for capital equation (32), the problem of the capitalist becomes

$$\max_{\{C_t^c, D_{t+1}^b, k_{t+1}\}} \sum_{t=0}^\infty \beta^t \Big[\log C_t^c + \log D_{t+1}\Big] \tag{41}$$

$$\underline{s.t:}\; C_t^c + \sum_b \frac{D_{t+1}^b}{P_t} = (\frac{\hat{r}_t - R_{t-1}P_{t-1}}{P_t})k_t + \frac{(1-\delta)R_{t-1}P_{t-1}}{P_t}k_{t-1} + \sum_b R_t^b\frac{D_t^b}{P_t} + \frac{T_{nt}}{P_{nt}} \tag{42}$$

$$D_{t+1} = \Big[\sum_b {D_{t+1}^b}^{1-\frac{1}{\eta}}\Big]^{\frac{\eta}{\eta-1}} \tag{43}$$

$$k_0, \{D_0^b, L_0^b\}_b \tag{44}$$

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

$$\lambda_t\frac{\hat{r}_t}{P_t} + \lambda_{t+1}\frac{(1-\delta)R_tP_t}{P_{t+1}} = \lambda_t\frac{R_{t-1}P_{t-1}}{P_t} + \frac{T_{nt}}{P_{nt}} \tag{45}$$

$$\frac{\beta^t}{C_t^c} = \lambda_t \tag{46}$$

$$\beta^t D_{t+1}^{\frac{1-\eta}{\eta}}(D_{t+1}^b)^{-\frac{1}{\eta}} + \lambda_{t+1}\frac{1+\tilde{r}_t^b}{P_{t+1}} = \frac{\lambda_t}{P_t} \tag{47}$$

Equation (45) 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 (46), is standard. The first order condition with respect to deposits in a specific bank, equation (47), 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 (45) and equation (46) we derive the following Euler equation,

$$\frac{P_{t+1}C_{t+1}}{P_tC_t} = \beta(1-\delta)\frac{R_tP_t}{R_{t-1}P_{t-1} - \hat{r}_t}. \tag{48}$$

Replacing equation (46) into equation (47), 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

$$\frac{D_{t+1}^b}{D_{t+1}^{b'}} = \left(\frac{q_t^b}{q_t^{b'}}\right)^{-\eta}, \tag{49}$$

where we defined q_t^b as

$$q_t^b \equiv 1 - \left(1 + \tilde{r}_t^b\right) / \left(\frac{(1-\delta)R_t P_t}{R_{t-1}P_{t-1} - \hat{r}_t}\right). \tag{50}$$

Let us define the deposit price index as

$$Q_t \equiv \left(\sum_b (q_t^b)^{1-\eta}\right)^{\frac{1}{1-\eta}}. \tag{51}$$

It follows from equation (49) and the definition of D_{t+1} that the supply of deposits to bank b is given by

$$D_{t+1}^b = D_{t+1}\left(\frac{Q_t}{q_t^b}\right)^\eta. \tag{52}$$

Replacing this back into equation (47) we get the usual equalization of expenditure on the two 'goods' available to the consumer

$$D_{t+1}Q_t = P_t C_t. \tag{53}$$

The nominal value invested on deposits at t is given by

$$\sum_b D_{t+1}^b = \sum_b D_{t+1}(\tfrac{Q_t}{q_t^b})^\eta = D_{t+1}Q_t^\eta \overbrace{\sum_b (q_t^b)^{-\eta}}^{\equiv \tilde{Q}_t}. \tag{54}$$

Then, plugging this into the budget constraint equation (42) and using equation (53), we get

$$Q_t D_{t+1} + D_{t+1}Q_t^\eta \tilde{Q}_t = M_t \rightarrow D_{t+1} = \frac{M_t}{Q_t + Q_t^\eta \tilde{Q}_t} \tag{55}$$

$$\text{and } P_t C_t^c = \frac{Q_t M_t}{Q_t + Q_t^\eta \tilde{Q}_t}. \tag{56}$$

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

$$\begin{aligned} A_{t+1} &\equiv \sum_b D_{t+1}^b(1+r_t^b) \\ &= \sum_b D_{t+1}(\tfrac{Q_t}{q_t^b})^\eta(1+r_t^b) \\ &= D_{t+1}\, \overbrace{Q_t^\eta[\sum_b \frac{(1+r_t^b)}{(q_t^b)^\eta}]}^{\equiv Q^A} \end{aligned} \tag{57}$$

From equation (57), equation (56) evaluated at $t+1$ and equation (55)

$$P_{t+1}C_{t+1} = \frac{1}{1+Q_{t+1}^{\eta-1}\tilde{Q}_t}\left[k_{t+1}(\hat{r}_{t+1} - R_t P_t) + M_t \tfrac{Q_t^A}{Q_t + Q_t^\eta \tilde{Q}_t} + k_t(1-\delta)R_t P_t\right] \tag{58}$$

Plugging this and equation (56) into equation (48) we end up with an equation that implicitly defines a policy function of k_{t+1},

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

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

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

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

$$\frac{\partial k_{t+1}}{\partial R_t} = -\frac{k_{t+1}P_t}{R_tP_t-\hat{r}_{t+1}} + \frac{1}{R_tP_t-\hat{r}_{t+1}}\left[(1-\delta)P_tk_t - \beta(1-\delta)\frac{P_tM_t}{R_{t-1}P_{t-1}-\hat{r}_t}\frac{1+Q_{t+1}^{\eta-1}\tilde{Q}_{t+1}}{1+Q_t^{\eta-1}\tilde{Q}_t}\right] \tag{59}$$

$$= -\frac{P_t}{R_tP_t-\hat{r}_{t+1}}\left[i_t + \beta(1-\delta)\frac{M_t}{R_{t-1}P_{t-1}-\hat{r}_t}\frac{1+Q_{t+1}^{\eta-1}\tilde{Q}_{t+1}}{1+Q_t^{\eta-1}\tilde{Q}_t}\right] \tag{60}$$

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

$$\frac{\partial Q_t}{\partial q_t^b} = \left(\frac{Q_t}{q_t^b}\right)^{\eta} \text{ and } \frac{\partial \tilde{Q}_t}{\partial q_t^b} = -\eta(q_t^b)^{-(1+\eta)}. \tag{61}$$

Then, the derivative of D_n^b with respect to the cost becomes

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

And we can recover the derivative with respect to interest rates from $\frac{\partial q_t^b}{\partial r_t^b} = -\frac{R_{t-1}P_{t-1}-\hat{r}_t}{(1-\delta)R_tP_t}$ and the chain rule.

And then, we know that:

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

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

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

which follows from $\frac{\partial R_n}{\partial r_n} = \frac{L_n^b}{i_n P_n}$ and $\frac{\partial i_n}{\partial R_n}$ is given byequation (60).

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

$$\frac{1}{\epsilon^L} + (1+r_n) - \frac{1}{\beta} = \mu \tag{62}$$

$$\frac{1}{\epsilon^D} + (1+\tilde{r}_n) - \frac{1}{\beta} = \mu \tag{63}$$

$$\mu \leq (1+r^w) - \frac{1}{\beta} \tag{64}$$

$$\mu \geq (1+r^w)(1+\tau) - \frac{1}{\beta} \tag{65}$$

$$\bar{W}(\mu - [(1+r^w) - \frac{1}{\beta}]) = 0 \tag{66}$$

$$\underline{W}[\mu - ((1+r^w)(1+\tau) - \frac{1}{\beta})] = 0 \tag{67}$$

$$\bar{W} \geq 0 \tag{68}$$

$$\underline{W} \geq 0 \tag{69}$$

Where ϵ^L, ϵ^D are the elasticities of loan and deposits with respect to interest rates. It follows from equation (65) and equation (66) that banks would either lend or borrow in the inter-bank market, but not both.

B.3 Bank's problem - Wholesale funding

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

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

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 wholesale cost is the equilibrium interest rate on repayments (that clear the wholesale market), and in addition, there is an increasing function, $\tau(\cdot)$, of the ratio of wholesale funding to deposits. This function τ captures that the more reliable on wholesale funding a bank is, the more risky their operations (?) The first-order conditions with respect to active and passive interest rates are, respectively,

$$
\begin{aligned}
\frac{\partial L_{nt+1}}{\partial r_{nt}}[-\beta^t + \beta^{t+1}(1+r_{nt}) - \lambda_t] + L_{nt+1}\beta^{t+1} &= 0, \\
\frac{\partial D_{nt+1}}{\partial \tilde{r}_{nt}}[-\beta^t + \beta^{t+1}(1+\tilde{r}_{nt}) - \beta^{t+1}\tau'\left(\frac{W_{t+1}}{D_{t+1}}\right)(1+r^W_t)\frac{W^2_{t+1}}{D_{t+1}} - \lambda_t] + D_{nt+1}\beta^{t+1} &= 0, \\
\beta^{t+1}\tau\left(\frac{W_{t+1}}{D_{t+1}}\right)(1+r^W_t) + \beta^{t+1}\tau'\left(\frac{W_{t+1}}{D_{t+1}}\right)(1+r^W_t)\frac{W_{t+1}}{D_{t+1}} - \lambda_t &= 0.
\end{aligned}
$$

where $D_t \equiv \sum_n D_{nt}$

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

$$
\frac{\partial L_{nt+1}}{\partial r_{nt}}\left[\frac{1}{\beta} - (1+r_{nt}) + \mu_t\right] = L_{nt+1}, \tag{70}
$$

$$
\frac{\partial D_{nt+1}}{\partial \tilde{r}_{nt}}\left[\frac{1}{\beta} - (1+\tilde{r}_{nt}) + \tau'\left(\frac{W_{t+1}}{D_{t+1}}\right)(1+r^W_t)\frac{W^2_{t+1}}{D_{t+1}} + \mu_t\right] = D_{nt+1}, \tag{71}
$$

$$
\tau\left(\frac{W_{t+1}}{D_{t+1}}\right)(1+r^W_t) + \tau'\left(\frac{W_{t+1}}{D_{t+1}}\right)(1+r^W_t)\frac{W_{t+1}}{D_{t+1}} = \mu_t \tag{72}
$$

B.3.1 Wholesale market clearing

The interest rate r^W_t is such that:

$$
\sum_b W_b = \tau_{\text{AFP}} \sum_n w_n \ell_n
$$

Let us give the gains of the wholesale market back to the residents. Maybe we can give them back to residents as a subsidy:

$$
\sum_b (1+r^W)W_b = \pi(1-\tau_{\text{AFP}})\sum_n w_n \ell_n
$$

$$
\implies \pi = \frac{1}{1-\tau_{\text{AFP}}}\frac{\sum_b(1+r^W)W_b}{\sum_n w_n \ell_n} = (1+r^W)\tau_{AFP}
$$

So, for market clearing, we have that the real income in a location is given by:

$$(1+\pi)(1-\tau_{\text{AFP}}) = \underbrace{\left[1+(1+r^W)\tau_{\text{AFP}}\right](1-\tau_{\text{AFP}})}_{\text{Multiplier}} w_n\ell_n$$

B.4 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 (55). Individual deposits in each city-bank pair follow from equation (20).