Banks, Market Segmentation, and Local Development*

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Abstract

We analyze how banks' local market power in interest rate setting, cost differences across banks, and asymmetric bank presence across cities contribute to the spatial misallocation of investment in Chile. Using a novel loan-level dataset, we document substantial variation in interest rates charged by the same bank across cities and across banks within the same city. To quantify the economic implications of these distortions, we develop a quantitative spatial model that integrates bank competition with local investment and migration decisions. Our preliminary findings suggest that pro-competitive reforms in the banking sector could increase aggregate welfare by % and reduce spatial inequality.

Key words: capital misallocation, banks, spatial inequality.

JEL codes: G21, O16, R12.

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1 Introduction

Understanding the drivers of income inequality between regions 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 assess the costs of interest rate disparities in terms of productivity and welfare, we embed banks into a quantitative spatial model with investment, trade and migration and use it to quantify the effect of policies aimed at reducing geographic dispersion in interest rates. A pro-competitive policy in the banking sector would lead to an increase of 7% in aggregate welfare and a reduction in the dispersion of welfare across cities by 29%.

The first contribution of this paper is to show that, all else equal, the interest rate that firms pay for their loans vary based on their location. Using detailed loan-level data from Chile where we can control for borrower, loan, and bank characteristics, we find that interest rates in cities at the 10th percentile of the distribution are approximately 300 basis points lower than those at the 90th percentile. We then investigate the driver of these differences. Our first result is that local bank competition plays a role — 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 the benefits of policies aimed at reducing interest rate 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 every bank in the economy. Preliminary results show that this policy increases aggregate welfare by 7% 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%.

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 yields a difference between cities at the 10-90th percentiles of the interest rate distribution of around 600 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 approxiamtely 300 basis points between cities at the 10-90th percentiles of the interest rate distribution. In our more demanding specification we include firm fixed effects, and geographic differences in interest rates remain substantial. These results imply 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 in the wholesale market 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, 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 associated to banks' borrowing funds in the wholesale 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 local bank competition in cities where the bank's identity changed around the merge date. We exploit this event to estimate how firms substitute loans from different banks. After the merger, interest rates went down in cities that used to have Corpbanca branches (and no Itaú), which suddenly became 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. For the other parameters of the model, we follow a standard approach in spatial economics and invert the model from observed data on city-bank loans, local wages and employment, and interest rates (Redding and Rossi-Hansberg, 2017).

We use the quantified model to study the welfare effects of a pro-competitive policy in which borrowers and deposit makers can access *every* bank in the country. This policy does not eliminate market power but equalizes it across cities. Our preferred way to interpreting this policy is as facilitating the use of the internet to borrow and start relationships with banks, in such a way that eliminates reliance on local branches. Through the lens of our model, such policy would generate an increase in aggregate welfare of 7%.

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 to the literature on spatial inequality and factor misallocation within countries. By highlighting the importance of bank branches at the local level, we relate to studies in finance on the economic effects of bank branches and in industrial organization on local credit markets.

Studies on the frictions preventing capital to flow from rich to poor countries, where capital is scarcer, include Lucas (1990) and follow up empirical work in Alfaro et al. (2008). In Acemoglu and Dell (2010), the authors study the determinants of within-country inequality and discard frictions to capital mobility arguing that formal impediments for capital mobility between regions are low. However, subsequent studies have pointed out that banks' internal capital markets could be a source of frictions (Gilje et al., 2016; Bustos et al., 2020). Our empirical results using Chilean data provide additional support for the view that even in the absence of formal restrictions to within-country capital flows, geographically segmented markets — firms borrow and households save using local branches — result in spatial differences in the marginal product of capital. Dispersion in the marginal product of capital has been the focus of the misallocation literature (Hsieh and Klenow, 2009; Midrigan and Xu, 2014). The focus of this literature has been misallocation across firms, not across space, which is our focus.

As mentioned above, two related papers are Bustos et al. (2020) and Gilje et al. (2016). Bustos et al. (2020) exploit a shock to savings in agricultural areas in Brazil. Following the shock, they compare urban areas integrated with the agricultural areas through the bank network with those unconnected to it. 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, which we do.

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 framework. 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 allows us to endogeneize the marginal cost of raising funds for every bank, depending on its geographical footprint. Secondly, our model allows for inter-regional trade and migration, while Manigi (2023) ignores the latter. A key difference between Manigi (2023) and Kleinman et al. (2023) is the focus on misallocation of capital across regions.

Oberfield et al. (2024) focus on the endogenous entry decision of heterogeneous banks across locations in the context of the passage of the Riegle-Neal Act in the United States. In Oberfield et al. (2024), the authors focus on banks decisions to open branches taking the level of investment demand and supply of deposits as given. Instead, we focus on how the demand for investment varies across cities with different banks, whose location we take as given. As we allow for migration in the model, local population responds indirectly too. The assumption of a fixed network is plausible in Chile during the time period we consider, when there was no change in regulation comparable to the passage of the Riegle-Act. Below, we also show that entry and exit of banks from location was small during our sample.

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). Aguirregabiria et al. (2020) analyze the bank network in the United States and highlight the role of local competition between banks. 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 and firms' demand for loans.

At the heart of our analysis and most of the papers discussed above is the idea that agents 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. Ji et al. (2023) and Fonseca and Matray (2024) study the local economic effects of branch openings in small villages Thailand and Brazil respectively. Burgess and Pande (2005) study the expansion of banks into rural areas in India. These papers focus on what happens when unbanked populations get access to banks, a priority in developing countries. By focusing on Chile, a financially developed country, our study is concerned with countries higher up in the development ladder where the main problem is not to reach unbanked populations but fostering local competition between banks.

2 Context and Data

2.1 The banking industry and its geographic footprint in Chile

Chile stands out in Latin America for its advanced financial development and the role of banks as providers of credit. Between 2010 and 2018, the level of credit to the private sector were comparable to that 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] This makes Chile a well-suited application to study the economic effects of the spatial network of banks.

The banking industry is very concentrated. Between 2010 and 2018, the largest bank held a market share of approximately 20% in loans, the top three banks accounted for just under 60%, and the top five banks controlled around 80%. Collectively, the ten largest banks nearly dominated the entire Chilean loan market. The market for deposits exhibits a similar level of concentration.[2] Moreover, as pointed out by Oberfield et al. (2024), given that savers and borrowers rely on local bank branches, national numbers may underestimate the relevant level of concentration. This is indeed the case in Chile. Table 1 reports our main summary statistics on the bank network using aggregate data at the city-bank level from the CMF, described in more detail in the next section. In the second panel we compare the national Herfindahl-Hirschmann with the average across indices. Credit markets are significantly more concentrated once we define markets locally.

Despite the high degree of local market concentration, the spatial network of banks remained fairly stable throughout the period. In the third panel of Table 1 we report summary statistics on the number of banks per city for different years. We exclude the metropolitan region which includes Santiago de Chile. The average number of banks per city fluctuated around 3l The main reason why it decreased slightly are two mergers: Itaú-Corpbanca in 2014, and Scotiabank-BBVA in 2018. In the last panel of Table 1 we show how many new city-bank pairs are born or disappear excluding those attributable to the mergers. Given this stability, in our analysis we take the bank network as given and do not incorporate branch location decisions.

One distinctive feature of the banking sector in Chile is that all bank headquarters are located in Santiago, with their presence outside the capital dispersed rather than concentrated in specific regions. Following

[1] See Appendix Section A.1 and Section A.2 for a discussion of the empirical results in this paragraph.
[2] See Figure 7 in the Appendix Section A.3.

Table 1: Bank Network outside the Metropolitan Region

	2013	2015	2017	2019
Herfindahl–Hirschman Index				
National	0.16	0.16	0.17	0.17
Average across local indices	0.67	0.69	0.71	0.73
Banks per City				
Mean	3.2	3.0	2.7	2.5
Standard Deviation	3.3	3.1	2.7	2.4
Min	1	1	1	1
25th percentile	1	1	1	1
50th percentile	1	1	1	1
75th percentile	4	4	4	3
Max	13	12	11	10
City-Bank Pairs	558	544	540	510
Cities	172	180	196	203
Annualized change between columns				
New city-bank pairs		5	9	10
Disappearing city-bank pairs		10.5	1.5	-

Source and notes: CMF. We count city-bank pairs in which bank branches had outstanding loans. We exclude mergers from the new and disappearing calculations in the last rows of the table.

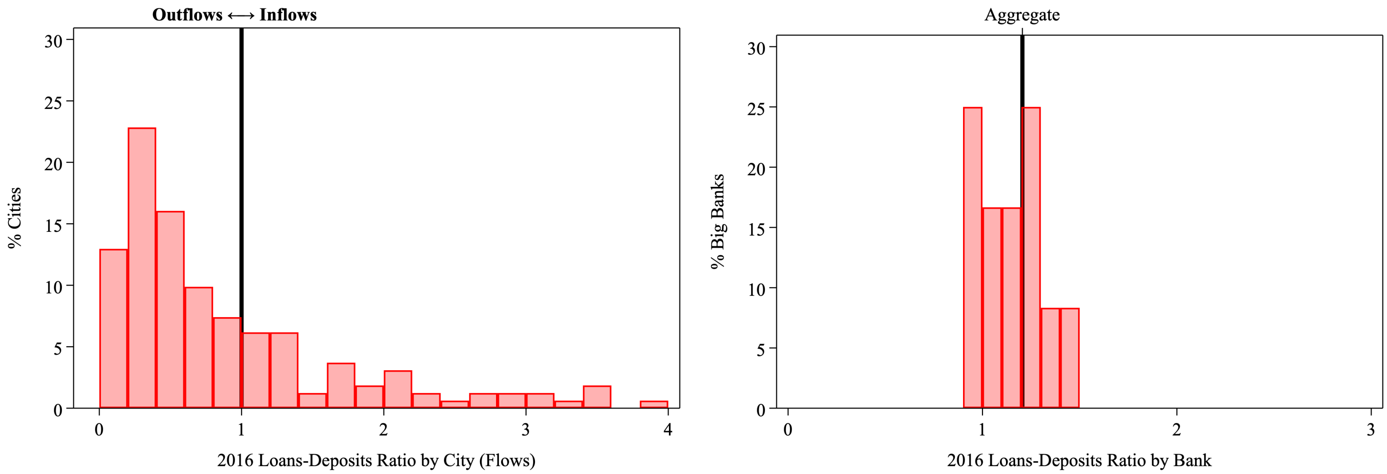
the approach in Conley and Topa (2002), we find no statistically significant geographical correlation between bank presence and market share at various distances.[3] This stands in contrast, for example, to the United States, where banks do cluster geographically because of a history of regulation in banks' geographic expansion (Oberfield et al., 2024). It also underscores one of the paper's contributions: financial linkages between cities via the bank network are, when branches are not geographically clustered, independent of other geographically driven linkages such as trade and migration connections.

By operating in many cities, banks can fund loans in one city with deposits from another. 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 can fund loans, they are the main one. The right panel in Figure 2 displays the loan-deposit ratio for the biggest banks. Most banks rely partly on other sources of funding sources to issue loans. In our analysis we will model a wholesale market in which banks can borrow from each other and households that works differently than the deposit market to match this aggregate fact.

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

Figure 1: Banks and Capital Flows Across Cities

(a) By City (b) By Bank



Source: CMF. Figure 1a computes the new loans and new deposits in each city between August 2016 and August 2017 and shows the ratio of the two. Figure 1b shows the ratio of the stock of loans and deposits per bank in August 2017. For 1b we keep banks with a stock of loans above one billion Chilean pesos, the 11 biggest in 2017.

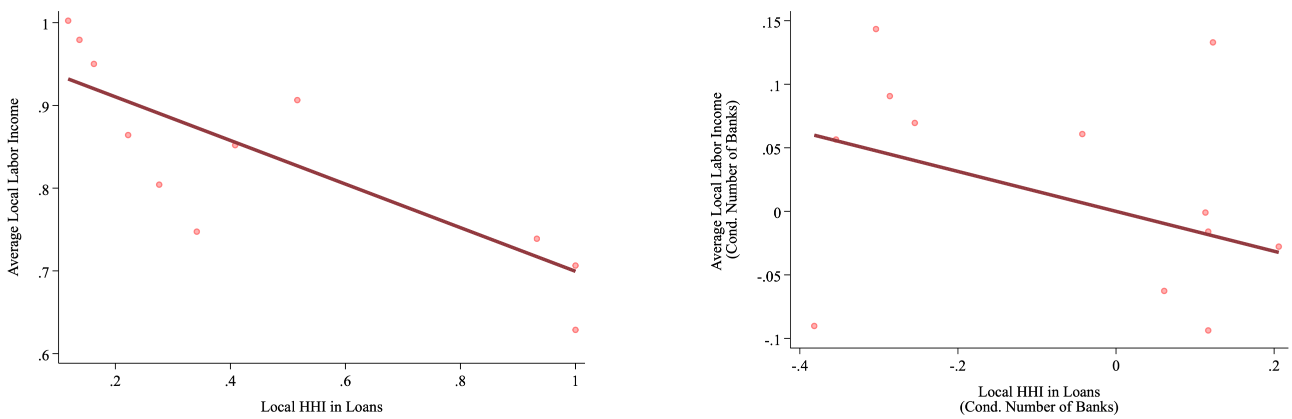
Lastly, another feature of the Chilean context that makes it a well-suited application for our study is that Chile is one of the most unequal countries in Latin America and with high levels of spatial inequality. Leveraging data on the universe of workers in the formal private sector we compute the average local labor income and normalize it by the national average.[4] There is substantial inequality in labor income across cities: income at the first decile of cities is below half the national average, while incomes at the median is around 70% of the national average.

The relationship between local bank competition and local prosperity is a first-order feature of the data. In the two bin-scatters in Figure 2 we compare the local HHI in the loan market in 2017 with the average local labor income in that same year. The first plot shows a strong and statistically significant relationship between the two variables. Reverse causality is a concern: it could be that banks decide not to enter to poor cities, driving local concentration up. The right figure shows the same exercise but conditioning on the number of banks in the city. The statistical relationship is still present and strong. In the rest of the paper we will analyze the strength of the mechanism going from loan market concentration to local development and analyze policies aimed at making the banking industry more competitive.

[4]For this exercise group together all the municipalities that belong Santiago, the capital city, as one.

Figure 2: Local Bank Competition and Local Income

(a) Unconditional (b) Conditional on the Number of Banks Locally



Sources: Average local labor income from AFC local HHI index from CMF. All data is from 2017.

2.2 Data sources

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. We also show that interest rates are higher in more concentrated local credit markets. 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 indirect evidence 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

$$i_{\ell ft} = \delta_0 + \delta_t + \delta_{c(f)} + \gamma_1 \times X_{ft} + \gamma_2 \times X_{\ell t} + \delta_{b(\ell)} + \epsilon_{\ell ft} \tag{1}$$

using micro-data on the universe of loans extended to firms during 2015-2018. 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 quarter fixed effects δ_t which will absorb variation in credit conditions at the national level. Our second and main fixed of interest, $\delta_c(f)$, is a fixed effect of the municipality of the firm. In our baseline specification we keep only firms that are present in one city in order to make this link between firm and city unambiguously. In the Appendix we do the analysis including multi-city firms and matching a firm to the city in which it has the highest employment.

The composition of firms varies geographically. To address this, we control for characteristics of the firm X_{ft} including the sector of the firm, its size in terms employment decile, and two measures of risk. The first risk measure is constructed by the bank when a firm borrows from them, based on their own assessment of the borrowing firm. When the borrower is sufficiently large, the bank assesses each firm individually. It assigns the firm to one of 16 categories: A1-A6 for normal risk levels and B1-B4 and C1-C6 for riskier borrowers. When the borrowing firm is small, the risk assessment is done by pooling firms with similar characteristics into the same risk bin. We include one fixed effect for each of the 16 categories. The second risk measure that we include is an indicator variable that takes value one if the firm is behind with its payments by at least 90 days. In our more demanding specification we include firm fixed effects, which are estimated from the special pool of firms borrowing from many banks. We also include characteristics of the loan $X_{\ell t}$, including the amount lent, maturity and bank fixed effects.

Table 2 shows our results on the geographic dispersion of interest rates in our baseline subsample with single-city firms, as we progressively add more controls. In the first column we only include time and space fixed effects. The interest rate differential between a city in the 10^{th} and 90^{th} percentile in this specification captures differences in average interest rate within periods and is approximately 600 basis points. As expected, geographic dispersion narrows as we add controls because the composition of firms and loans varies geographically. The interest rate differential between a city in the 10^{th} and 90^{th} percentile narrows to approximately 300 basis points in the third column, half of what a crude comparison of geographic averages would yield.

In the fourth column we include a measure of local competition between banks. Using $\mathcal{B}^c$ 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

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

The fourth column reports a positive and statistically significant effect of local concentration on interest rates. This empirical result informs our model, in which banks compete oligopolistically within a local credit market.

The last column shows the results with our most demanding specification in which we include firm fixed effects. Notice that this comes with some attrition, as firm fixed effects are estimated from firms that borrow from more than one bank during 2015-2018.

Table 2: Geographic dispersion in interest rates (basis points)

	Interest Rate	**Interest Rate**	**Interest Rate**	**Interest Rate**	**Interest Rate**
City Fixed Effects, normalized percentile					
10-th	-219.2	-123.6	-112.2	-114.2	-210.1
25-th	-128.2	-63.8	-55.7	-57.5	-116.4
50-th	0	0	0	0	0
75-th	159.4	78.3	68.1	71.5	159.4
90-th	416.3	208.3	205.9	206.4	413.3
Local HHI				41.7***	11.6***
				(3.1)	(4.1)
Quarter FE	Yes	Yes	Yes	Yes	Yes
Sector and Size of the Firm	No	Yes	Yes	Yes	Yes
Firm Risk	No	Yes	Yes	Yes	Yes
Loan Characteristics	No	Yes	Yes	Yes	Yes
Bank FE	No	No	Yes	Yes	Yes
Firm FE	No	No	No	No	Yes
R^2	0.216	0.609	0.661	0.661	0.869
Observations	935,834	934,242	934,242	934,242	921,296
Number of Banks	19	19	19	19	19
Number of Firms	38,718	38,609	38,609	38,609	25,663
Number of Cities	294	294	294	294	292

Outcome variable in basis points. Statistical significance denoted as *p < 0.10, **p < 0.05, ***p < 0.01.

3.2 Deposits are a key source of funding, shaped by bank branches' geographic reach

It is standard to view deposits as the preferred source of banks' funding. Compared to issuing bonds or taking loans, deposits are cheaper and more stable, as they provide liquidity services to depositors. In Chile as in many other countries, deposits are insured by the government. Therefore, banks with better access to deposits have a cheaper source of funding available when deciding to issue loans.

To gauge the strength of banks' preference for deposits as a source of funding empirically, we exploit banks' differential exposure to deposit shocks and study the effect on their lending. If deposits were not a better source of funding on the margin, banks should not increase their loan issuance (as the ability to raise wholesale funding did not change). Building on Gilje et al. (2016), we instrument for deposit shocks using movements in the world price of salmon, a large industry in certain regions of Chile to which banks are differentially exposed. We find a positive effect of deposit growth on loan growth at the bank level, which provides indirect evidence that internal capital markets are important for these banks. These results, which echo the findings in Gilje et al. (2016) and Bustos et al. (2020), highlight the importance of studying the bank network both as a source of deposits and loans jointly.

We instrument for deposits shocks at the city-bank level by combining shocks to the world price of salmon and banks' exposure to cities that produce salmon. This shock has several advantages in the Chilean context. First, the price of salmon moved significantly during our sample. Using data from the IMF Commodity Price series, figure 12 in the Appendix A.8 shows the evolution of the world price of salmon throughout the 2005-2019 period. Second, salmon is an important industry in Chile, accounting for 7.8% of non-copper exports between 2005 and 2019 (12.8% in 2019). Finally, not only is the industry geographically clustered but also most of the salmon firms are headquartered locally. This means that increased profits would be deposits into local bank branches, not shifted to headquarters in the Santiago (which would be a concern exploiting other shocks, like shocks to mining prices).

To identify which cities specialize in salmon, we calculate employment in the fishing industry as a percentage of local employment using AFC data from AFC 2015. The results, shown in Figure 11 in the Appendix A.8, indicate that cities specializing in fishing cluster in the country's South. We construct an indicator dummy that equals one if the local percentage of employment in the fishing industry is above 4.33% (the 90^{th} percentile). We label these as 'fishing cities' and, below, use $\mathcal{F}$ to denote this set.

To measure banks' exposure to movements in the price of salmon, we compute the share of deposits that each bank received from 'fishing cities' during 1998-2001. We measure banks' presence in these cities before the price started to pick up (as seen in Figure 12 in the Appendix A.8) to avoid endogeneity in banks' entry to these regions as a response of increasing salmon prices.

Then, our instrument Z_{bt} is

$$Z_{bt} = p_{t-1}^{salmon} \times \frac{\sum_{c \in \mathcal{F}} D_{bc1998-2001}}{\sum_c D_{bc1998-2001}}. \tag{2}$$

Notice that we lag the price of salmon, allowing for a lag between the increase in prices, wages, and profits, and deposits of one semester.

In our first stage we estimate

$$Deposits_t^b = \beta_0 + \beta_1 Deposits_{t-1}^b + \beta_2 p_t^{salmon} + \beta_3 Z_{bt} + \gamma X_t^b + \epsilon_t^b. \tag{3}$$

The analysis in this section is done at the semester level because the outstanding stock of deposits or loans was reported every February and August throughout 2005-2019 and only started to be reported monthly in 2012. 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 effects of the Global Financial Crisis (GFC). The results are shown in the first column of Table 3. 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 4.62% 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%).

For the second stage we use aggregate loan data at the city-bank level, which we denote by n and b, respectively. To avoid reverse causality concerns related to to investment in the fishing industry responding to the price of salmon, we exclude 'fishing cities' from the sample. We estimate

$$Loans_{nt}^b = \beta_0 + \beta_1 Deposits_t^b + \beta_2 Deposits_{t-1}^b + \beta_3 Loans_{nt-1}^b + \gamma X_{nt}^b + \epsilon_t^b \quad \forall n \notin \mathcal{F}. \tag{4}$$

Our control variables include the lagged value of loans in the city-bank pair, city-bank fixed effects, city-

Table 3: Deposit Shocks and Loan Growth

	Bank Deposits (Logs) OLS	**City-Bank Loans (Logs)** OLS	**City-Bank Loans (Logs)** IV
Log Deposits$_t$		-0.056	2.825*
		(0.070)	(1.459)
Log Deposits$_{t-1}$	0.255***	0.044	-1.449**
	(0.034)	(0.037)	(0.626)
Log Loans$_{t-1}$		0.041	-0.006
		(0.043)	(0.040)
Log Price of Salmon$_{t-1}$	1.163***		
	(0.319)		
Z_{bt}	4.629***		
	(1.245)		
Controls included			
Bank FE	Yes	-	-
Bank FE × GFC Dummy	Yes	Yes	Yes
Bank × City FE	-	Yes	Yes
Semester × City FE	-	Yes	Yes
Within R-squared	0.669	0.069	-
Cragg-Donald Wald F-statistic	-	-	32.2
Observations	222	12102	9643
Number of Banks	10	14	10

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

semester fixed effects, and an interaction between the bank fixed effects and the GFC period. The second column in Table 3 shows the results of the OLS estimation, and the third column the results when instrumenting contemporaneous deposits with our instrument Z_{bt}. We find a strong and statistically significant effect on loans when we instrument for deposits. A bank with a reliance on fishing cities of 0.25 would have issued around 0.7% 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%).

4 Model

Our empirical analysis has shown that interest rates vary geographically, but how do interest rate differentials translate into differences in wages, population, and welfare across cities? The general equilibrium model we build in this section allows us to analyze these linkages quantitatively. Our modeling choices capture features described in the previous two sections: firms' and households' reliance on local branches, local competition between banks, and banks' preference for deposits as a source of funding. Our setup includes endogenous investment decisions by local firms, endogenous deposit supply by capitalists, trade, and migration.

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 with branches in city n as $\mathcal{B}^n$.

The economy has B banks. Each bank operates in a set of cities $\mathcal{C}^b$. The bank network is assumed to be fixed.[5] Every period banks set city-specific nominal interest rates for deposits and loans, r_{nt}^b and $\tilde{r}_{nt}^b$, respectively, to maximize total profits. Banks face city-specific demand for loans and city-specific supply of savings and compete oilgopolistically with other banks in the 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 wholesale market. However, the wholesale 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 must be shipped from location i. In this framework, 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

There is a unit mass of identical and infinitely-lived workers. They 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,

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

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

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

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

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

The budget constraint of a worker is given by

$$P_{nt} C^w_{nt} = w_{nt}(1 - \tau^{ss}) + T^w_{nt} \tag{8}$$

where τ^{ss} is the social security tax, which is equal across locations, and T^w_t is a transfer that the worker receives from the government and we describe in detail later.

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 an amenity value b_n, the utility coming from consumption, and the continuation value after moving

$$V^w_{nt} = \log(b_n C^w_{nt}) + \max_d \{\beta \mathbb{E}_t [V^w_{dt+1}] + \rho \epsilon_{dt}\}. \tag{9}$$

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 capitalists derive utility from consumption and deposits, where α controls the utility derived from deposits relative to consumption. Using C^c_{nt} to denote a consumption basket for capitalists, analogous to the one for workers in equation (5), the problem of a capitalist at the second stage can be written as

$$\max_{\{C^c_{nt}, D^b_{nt+1}, k_{nt+1}\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t \Big[\log C^c_t + \alpha \log D_{nt+1} \Big] \tag{10}$$

$$\underline{s.t:}\; C^c_{nt} + \sum_b \frac{D^b_{nt+1}}{P_{nt}} + \frac{\mathcal{C}_{nt}(i_{nt-1})}{P_{nt}} = \frac{\hat{r}_{nt}}{P_{nt}} k_{nt} + \sum_b (1+\tilde{r}^b_{nt}) \frac{D^b_{nt}}{P_{nt}} + T_{nt} \tag{11}$$

$$k_{nt} = k_{nt-1}(1-\delta) + i_{nt-1} \tag{12}$$

$$D_{nt+1} = \Big[\sum_b {D^b_{nt+1}}^{1-\frac{1}{\eta}} \Big]^{\frac{\eta}{\eta-1}} \tag{13}$$

$$k_{n0}, \{D^b_{n0}, L^b_{n0}\}_b \tag{14}$$

where the budget constraint equation (11) 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 from the governmnet T_{nt} (which we specify below) 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

$$\begin{aligned} \mathcal{C}_{nt}(i_{nt-1}) = \min_{\{L^b_{nt}\}_b} \sum_{b\in\mathcal{B}} L^b_{nt}(1+r^b_{nt-1}) \\ s.t: \Big[\sum_{b\in\mathcal{B}} (\gamma^b \tfrac{L^b_{nt}}{P_{nt-1}})^{\frac{\sigma-1}{\sigma}} \Big]^{\frac{\sigma}{\sigma-1}} = i_{nt-1} \end{aligned} \tag{15}$$

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

$$\frac{L^b_t}{P_{t-1}} = \Big(\frac{R_{t-1}}{1+r^b_{t-1}} \Big)^{\sigma} i_{t-1} (\gamma^b)^{\sigma-1}. \tag{16}$$

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 (15) and equation (16) it follows that

$$\mathcal{C}_t(i_{t-1}) = \sum_{b\in\mathcal{B}} L^b_t(1+r^b_{t-1}) = i_{t-1} R_{t-1} P_{t-1}. \tag{17}$$

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

$$D^b_{t+1} = D_{t+1} \left(\frac{Q_t}{q^b_t} \right)^{\eta}, \tag{18}$$

where

$$q^b_t \equiv 1 - \underbrace{\Big(1+\tilde{r}^b_t\Big)}_{\text{Return on deposits}} \Big/ \underbrace{\left(\frac{(1-\delta) R_t P_t}{R_{t-1}P_{t-1} - \hat{r}_t} \right)}_{\text{Return on investment}} \;\text{ and }\; Q_t \equiv \left(\sum_b (q^b_t)^{1-\eta} \right)^{\frac{1}{1-\eta}}. \tag{19}$$

The key price of a deposit with bank b is q_t^b. This cost captures the dollar that the capitalists gives up in the present 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. Therefore, the return on investment deflates the pecuniary benefit of a deposits in the definition of q_t^b.

The total demand for deposits and consumption is given by

$$D_{t+1} = \frac{\alpha M_t}{Q_t + \alpha Q_t^\eta \tilde{Q}_t} \tag{20}$$

$$\text{and } P_t C_t^c = \frac{Q_t M_t}{Q_t + \alpha Q_t^\eta \tilde{Q}_t} \tag{21}$$

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 index of q_t^b, defined in the appendix.

From equation (16), equation (18) and equation (20) the bank-specific demand for deposits and loans are described by

$$D_{t+1}^b = \frac{\alpha M_t}{Q_t + \alpha Q_t^\eta \tilde{Q}_t} \left(\frac{Q_t}{q_t^b} \right)^\eta \tag{22}$$

$$\text{and } L_{t+1}^b = i_t P_t \Big(\frac{R_t}{1 + r_t^b} \Big)^\sigma (\gamma^b)^{\sigma - 1}. \tag{23}$$

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 setting interest rates by banks, who take these two functions as given.

4.1.4 Banks

Banks set active and passive interest rates in each city where they operate to maximize profits. They take the supply of deposits and demand for loans from local capitalists, equation (22) and equation (23), as given. To issue loans while meeting balance sheet requirements, banks can attract deposits and use wholesale funding. They can either borrow from or lend to the wholesale market, but this market faces frictions. These frictions are an increasing function of the ratio of wholesale funding to deposits, as in (Oberfield et al., 2024). Among other forces, this captures that banks that are more reliant on external funding seen as riskier by other banks or regulators since wholesale funds lack government insurance. Omitting super-script b for clarity in this section, the problem of a bank at $t = 0$ is

$$\max_{\{\{r_{nt}, \tilde{r}_{nt}\}, F_t\}_{t=0}^\infty} \quad \sum_{t=0}^\infty \beta^t \sum_n L_{nt}(1 + r_{nt-1}) + D_{nt+1} - L_{nt+1} - D_{nt}(1 + \tilde{r}_{nt-1}) - \tau \left(\frac{F_t}{\sum_n D_{nt}} \right) (1 + r_{t-1}^F) F_t$$

$$\underline{s.t:}\ [\lambda_t] \quad \sum_n L_{nt+1} = \sum_n D_{nt+1} + F_{t+1} \quad \forall t.$$

The value of the bank is the maximized discounted sum of per-period cash flows. The amount of wholesale funding is represented by F_t. At each t, inflows come from maturing loans either from firms or the wholesale market (if $F_t < 0$), and new deposits captures. Outflows consist of new loans extended to firms or other banks and maturing deposits that need to be repaid.

A positive F_t indicates that the bank is borrowing in the wholesale market, while a negative F_t means the bank is lending in the wholesale market. The wholesale equilibrium interest rate is denoted by r_t^F, and the friction function $\tau(\cdot)$ satisfies $\tau' > 0$ and $\tau(0) = 1$. These conditions imply that for banks borrowing from the wholesale market, the total cost is higher than the pecuniary cost while for those lending to the wholesale market, the total benefit is lower than the pecuniary benefit. In what follows, we assume

$$\tau\Big(\frac{F_{t+1}}{D_{t+1}}\Big) = exp\Big(\frac{\phi F_{t+1}}{D_{t+1}}\Big), \tag{24}$$

where ϕ measures how costly it is to access wholesale funding. Manipulating the first-order conditions with respect to active and passive interest rates, and wholesale funding, we get

$$(1 + r_{nt}^*) = \frac{\varepsilon_n^L}{\varepsilon_n^L - 1}\left[\frac{1}{\beta} + \mu_t\right], \tag{25}$$

$$(1 + \tilde{r}_{nt}^*) = \frac{\varepsilon_n^D}{\varepsilon_n^D + 1}\left[\frac{1}{\beta} + \mu_t + \frac{\partial\tau(F_{t+1}/D_{t+1})}{\partial D_{t+1}}(1 + r_t^F)F_{t+1}\right] \tag{26}$$

Where $\varepsilon_n^L = -\frac{\partial L_n^b}{\partial r_n^b}\frac{1+r_n^b}{L_n^b}$ and $\epsilon_n^D = \frac{\partial D_n^b}{\partial \tilde{r}_n^b}\frac{1+\tilde{r}_n^b}{D_n^b}$ denote the city-specific elasticities of loan demand and deposits supply with respect to an individual bank's interest rates. Optimal loan interest rates are a city-specific markup over the bank's marginal cost of raising funds.

The marginal cost is given by $\frac{1}{\beta} + \mu_t$, where μ_t represents the marginal cost of wholesale funding,

$$\mu_t = \tau\left(\frac{F_{t+1}}{D_{t+1}}\right)(1 + r^F) + \frac{\partial\tau(F_{t+1}/D_{t+1})}{\partial F_{t+1}}(1 + r_t^F)F_{t+1}. \tag{27}$$

Similarly, the optimal deposit interest rate is a city-specific markdown determined by the local elasticity of deposit supply and the bank's marginal cost of funds. Deposits include an additional marginal cost compared to loans, as expanding the deposit base reduces wholesale funding frictions.

City-specific elasticities are given by

$$\varepsilon_n^L = \sigma - \underbrace{\sigma\frac{L_n^b(1 + r_n^b)}{i_n R_n P_n}}_{\text{Effect on agg. } R} - \underbrace{\frac{L_n^b}{i_n^2}\frac{1 + r_n^b}{P_n}\frac{\partial i_n}{\partial R_n}}_{\text{Effect on agg. investment}},$$

$$\varepsilon_n^D = -\eta + \underbrace{\eta\left(\frac{Q_n}{q_n^b}\right)^{\eta-1}}_{\text{Effect on agg. } Q} + \underbrace{\frac{q_n^b}{D_n}\frac{\partial D_n}{\partial q_n^b}}_{\text{Effect on agg. deposits}}.$$

In this framework, banks do not set uniform markups and markdowns across cities because they internalize their influence on local price indices, aggregate investment, and deposits at the city level. This mechanism allows us to capture the importance of local banking market structures: cities with more competition will experience lower markups and markdowns on interest rates. Moreover, our framework also captures cost differences across banks as a source of differences in the cost of capital across cities. As seen in **?**, banks that need to rely on wholesale funding have higher costs.

4.1.5 Government

The government plays two roles in the model. First, it taxes workers at rate τ^{ss} and invests the funds in the wholesale market, from which banks are allowed to borrow. This assumption is intended to capture the quantitatively important role of social security as a domestic investor. Therefore, transfers to workers are given by

$$T_{nt}^{w} = w_{nt-1}\tau^{ss}(1 + r_{t-1}^{F}). \tag{28}$$

The second role of the government is to tax banks and rebate the profits back to capitalists in a way that completely undoes city specific profits made by the banking industry. We assume

$$T_{nt} = \sum_{b \in \mathcal{B}^{n}} L_{nt}^{b} r_{nt-1}^{b} - D_{nt}^{b} \tilde{r}_{nt-1}^{b}. \tag{29}$$

This assumption means that banks make no profits in the aggregate and takes care of where to locate the profits of the banking industry.

4.2 Steady State

Our analysis will focus on comparing steady state outcomes. In each steady state the 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 a vector of quantities $\{\ell_n, k_n, y_n, C_n, C_n^{c}, k_n\{L_n^{b}, D_n^{b}\}_{b \in B}\}_{n \in N}, \{F^{b}\}_{b \in B}, r_t^{F}$ and prices $\{\{w_n, p_n, \{r_n^{b}, \tilde{r}_n^{b}\}_{b \in B}\}_{n \in N}$ such that

- Workers' consumption and migration decisions maximize their lifetime utility, equation (7)-equation (9). From optimal migration decisions it follows that teady-state labor shares reflect flow utility,

$$\ell_n = \frac{\left(\frac{b_n w_n}{P_n}\right)^{\frac{\beta}{\rho}}}{\sum_{i=1}^{N}\left(\frac{b_i w_i}{P_i}\right)^{\frac{\beta}{\rho}}}. \tag{30}$$

- Capitalists' consumption, saving and borrowing decisions maximize their lifetime utility, equation (21)-equation (22)-equation (23).

- Bank-specific interest rates set optimally, equation (79)-equation (77) in the Appendix.

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

$$\sum_{b} F^{b} = \tau \sum_{n} \ell_n w_n \text{ and } T_n = \sum_{b \in \mathcal{B}^{n}} L_n^{b} r_n^{b} - D_n^{b} \tilde{r}_n^{b}. \tag{31}$$

- Labor markets clear at the national level

$$\sum_n \ell_n = 1. \tag{32}$$

- 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:

$$w_n \ell_n + \hat{r} k_n = \sum_{i=1}^{N} \pi_{ni} (P_i C_i^w + P_i C_i^c + \sum_{b \in \mathcal{B}^i} L_i^b) \tag{33}$$

4.3 Illustrative example: linear geography

To illustrate the effects of segmented capital markets in our model we consider the case of linear geography, a well-studied benchmark in the spatial literature. We index cities by their location in a line, $n \in \{1, .., N\}$, and parametrize transport costs from city n to city i as $\tau_{ni} = \tau e^{\alpha|i-n|}$. We assume no differences in productivities or amenities. Therefore, the only heterogeneity across cities comes from their proximity to other cities. Cities at the middle of the line have better market access to other consumption goods than cities at the extremes of the line, and their producers capture larger market shares in other markets. Finally, we assume there are two banks in the country.[6]

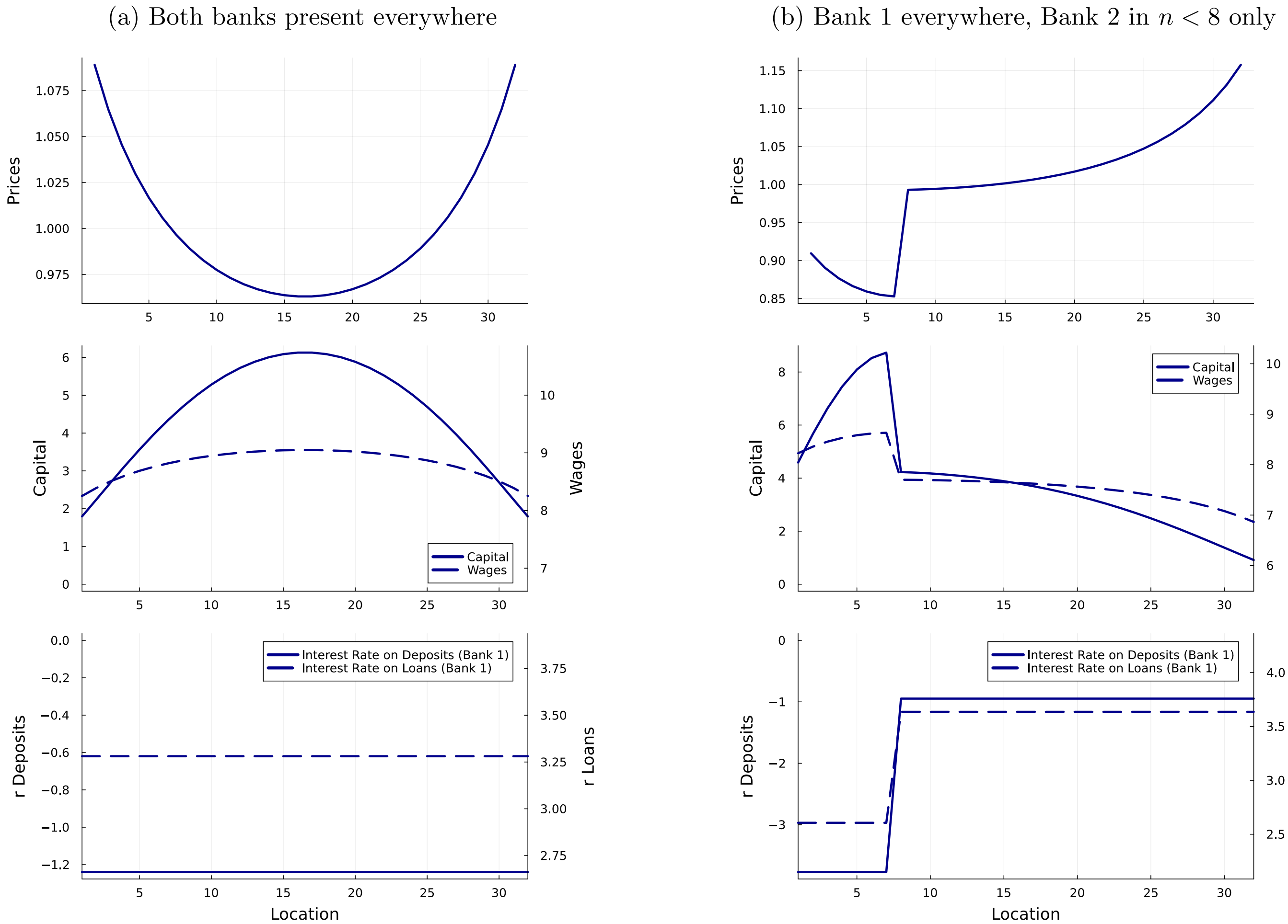
Figure 3a describes the equilibrium outcomes in our benchmark scenario when both banks have branches in every city. The top panel describes the price of the final good in different locations. The middle panel shows the distribution of capital and wages in equilibrium. Cities in the center have higher market access, which leads to higher investment. Capital deepening leads to higher labor productivity and wages in equilibrium, even though exogenous productivity is constant in space. Banks equalize the interest rate they charge across cities for this particular parametrization, as shown in the bottom panel.

How would a segmented 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, $n < 8$. Figure 3b describes the equilibrium in this case.

Once markets are segmented, outcomes around $n = 8$ look sharply different. The top panel 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 shown in the mid-panel. The bottom panel shows interest rate differential arising in equilibrium. Facing less competition from Bank 2 in the cities to the right of the line, Bank 1 charges higher interest rate on loans in these cities. Bank 1 exploits its market power in cities with little competition between banks, which affects differences in labor productivity and real incomes across cities. In the rest of the paper, we empirically explore the extent of these effects by estimating our model using Chilean data.

[6] We set the values of the main parameters as $\mu = 0.3, \sigma_c = 4, \eta = 2, \sigma = 25, \beta = 0.63, \delta = 0.1, \rho = 1.9, \gamma_0 = 1, \gamma = 3, \alpha = 1.05$. See Appendix for a complete list of the parameters in this numerical example.

Figure 3: Illustration with Linear Geography



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 issued by each bank. Once we clean the data and keep cities for which we observe all variables, we are left with around 90 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 $\tau_{ni} = t_{ni}^{0.375}$.

Among targeted data moments 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 target the value of loans issued

[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.

in each city-bank pair to estimate our values of bank-city fit γ_n^b. Two important parameters in the model are σ and η, as they govern the markups and markdowns on interest rates. To estimate these parameters we exploit exogenous changes in bank-specific interest rates after the merger between Itaú and Corpbanca in 2016. We can only observe loans at the bank-city level, not deposits. Therefore, we assume that both elasticities are equal $\eta = \sigma$.

Table 4 shows a complete list of the parameters in our model divided between those externally calibrated and those estimated from the data. Parameters μ, β and δ are standard in the macro literature, while we borrow σ_c from the trade literature.

Table 4: Estimation

	Description	Value	Source or Objective
	Externally calibrated		
μ	Capital share	0.30	Standard
δ	Rate of depreciation	0.04	Standard
β	Discount factor	0.96	Standard
α	Deposits in the utility function	0.2	-
η	Elasticity of substitution (deposits)	$=\sigma$	Preliminary
σ_c	Elasticity of substitution (consumption)	4	Redding and Rossi-Hansberg (2017)
ϕ	Cost of wholesale funding	1.5	-
$\{\tau_{nj}\}_{n,j=1,..,N}$	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)	27	Corpbanca-Itau merge
$\{z_n\}_{n=1}^N$	Productivities		Geographic distribution of employment
$\{b_n\}_{n=1}^N$	Amenities		Geographic distribution of wages
$\{\{\gamma_n^b\}_{b=1}^B\}_{n=1}^N$	Bank-city match		Bank-City Loans

5.1 Itaú-Corpbanca merger: reduced-form evidence of substitution between banks

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

Figure 4a below compares the average interest rate that the two banks were charging for commercial loans to big firms in the period leading up to the merger. These are calculated from aggregate data, so differences in the type of firms taking these loans can't be ruled out.[10] Keeping only loans to big firms alleviates this

[8] 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.

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

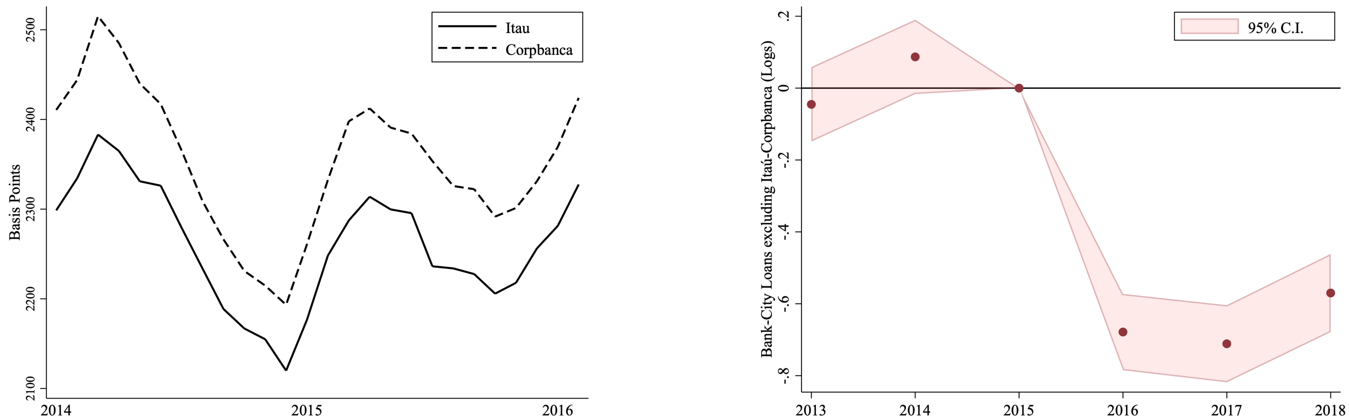
[10] The estimation using the credit registry data, where we can rule out these concerns, is in progress.

concern.

Figure 4: Itaú-Corpbanca Merger as an Exogenous Shock to Interest Rates

(a) Interest Rate on Loans before the merger

(b) Event Study Results



The merger between these two banks induced exogenous variation in interest rates at the city level, as cities that had some Corpbanca branches but no Itaú branches should have seen a decrease in interest rates.[11] 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. To see this, take logs in both sides of equation (23) leads to

$$\log(L^b_{nt+1}) = log(i_{nt}P_{nt}) + (\sigma - 1)\log(\gamma^b_n) + \sigma\log(R_{nt}) - \sigma\log(1 + r^b_{nt}) \tag{34}$$

Taking the derivative with respect to $r^{b'}_{nt}$ keeping all other interest rates in the city fixed,

$$\frac{\partial \log(L^b_{nt+1})}{\partial r^{b'}_{nt}} = \sigma\frac{\partial \log(R_{nt})}{\partial r^{b'}_{nt}} = \sigma(1 + r^{b'}_{nt+1})^{-\sigma}(R_{nt}\gamma^b_n)^{\sigma-1} \tag{35}$$

Equation (35) links the response of firms in cities affected by the merger to our parameter of interest, σ. To estimate the left-hand side of equation (35) we use quarterly data on the new loans issued at the city-bank level from the CMF. Our empirical strategy is an event-study design. In the subsmaple of cities in which Corpbanca was present before the merger but Itaú was not we estimate

$$\log(L^b_{nt}) = \gamma^b_n + \sum_{\tilde{y}} \beta_{\tilde{y}(t)}\mathbb{1}_{[y(t)=\tilde{y}]} + \epsilon^b_{nt} \tag{36}$$

The fixed effect γ^b_n captures time-invariant characteristic of the city-bank pair, as in equation (34). The main identifying assumption for the causal intepretation to be valid is that, absent the merger, loans given by branches in treated cities would have evolved similarly as they had been doing before. We are interested in $\beta_{\bar{t}}$ in equation (36) for years after 2016, when the merger became effective. Figure 4b shows the results.

The estimated coefficients are negative and statistically significant starting in 2016, indicating that firms substituted to Itaú-Corpbanca from other banks around the date of the merge when interest rates decreased.

[11] We could in principle also look at cities in the opposite situation and had some Itaú branches and none Corpbanca branches. However, there are only 6 cities in circumstance.

To map our estimated effect we look for the fixed point in σ of equation (35) where we substitute the left-hand side for -0.67, the estimated effect on 2016. We choose to target the effect on this year as it alleviates the concerns for other banks re-optimizing their interest rates after Itaú-Corpabanca changed theirs. We target this moment in the estimation strategy below.

5.2 Productivity, amenity, and bank-city 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 we can use equation (16) to write down a system of $\tilde{N} + 1$ equations

$$\begin{aligned} L_n^b &= \mathcal{C}(i_n) \frac{R_n^{\sigma-1}}{(1 + r_n^b)^\sigma} (\gamma_n^b)^{\sigma-1} \\ \frac{0.67}{0.03} &= \sigma (1 + r_{nt}^{b'})^{-\sigma} (R_{nt} \gamma_n^{b}{'})^{1-\sigma} \end{aligned}$$

   in $\tilde{N} + 1$ unknowns, the vector of γ_n^b and σ. These parameters rationalize the observed level of loans perfectly.

3. Having estimated γ_n^b we can use the definition of investment, equation (15), to calculate $P_n k_n$. We can then recover $\frac{P_n}{\hat{r}_n}$ from $\hat{r}_n k_n$, which appears in firms' optimality conditions, and using that$w_n \ell_n$ is data.

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.

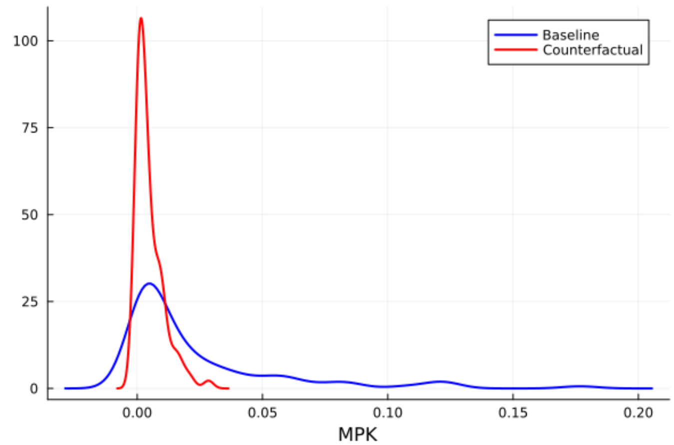
5. We back out amenities b that perfectly rationalize workers' location decisions.

We estimate the model using aggregate data on loans by city-bank pairs from the CMF, average rate on loans by bank from the CMF, average wage and total employment from AFC.

6 Pro-Competitive Policy

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. A possibility is that digital

Figure 5: Spatial Misallocation of Capital



banking allows such relationships to form. 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

$$V_n \propto \log(\tfrac{b_n w_n}{P_n})(1+\beta) - \rho \ell_n. \tag{37}$$

The value of living in city n is the sum of flow utility and a continuation value. In equation (37) 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.

Our preliminary results indicate that welfare, total capital, and labor productivity go up in the counterfactual economy. Population weighted welfare across cities increases by 7%, driven both by a higher capital stock and a better allocation of it. Figure 5 compares the distribution of the MPK in the baseline and in the counterfactual economy, showing that misallocation gets substantially reduced.

7 Conclusion

There are substantial disparities in income within 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 underlying spatial inequality: differences in investment cost across cities. 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. We used the estimated model to study 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 as a push to the use of internet banking that reduces reliance of local branches. In the quantification, preliminary for reasons discussed in the main text, 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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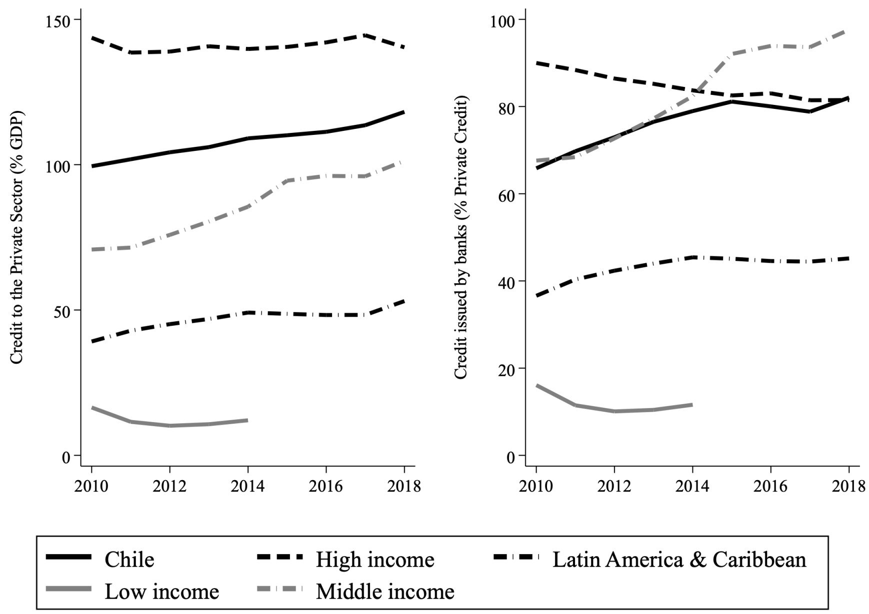
Appendix

A Empirical appendix

A.1 Chile's financial development

We use data publicly accessed from the World Banks' website on June 2024. Figure 6 below shows the two facts mentioned in the main text.

Figure 6: Financial development



The importance of banks in other developing regions during 2007-2017 was even higher: 93% in Latin America and the Caribbean, 95.6% in Middle-Income countries, and 97.1% among Lower-Middle income countries.

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

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

In the EFH we separately observe the total amount invested by an individual household in stocks, mutual funds, fixed income, saving accounts, and other instruments. The survey contains information on the financial institution through which these assets were purchased. Panel A in Table 6 shows — for the sub-sample of

Table 5: Credit sources for firms (excluding Santiago)

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

respondents with positive financial assets — what percentage of savings were allocated to each asset and the percentage of respondents who used banks to purchase that asset. Banks are the primary institutions used by households to invest in mutual funds and fixed-income assets and to open savings accounts. These represent around half the total investment in financial assets in 2007 and 2017.

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

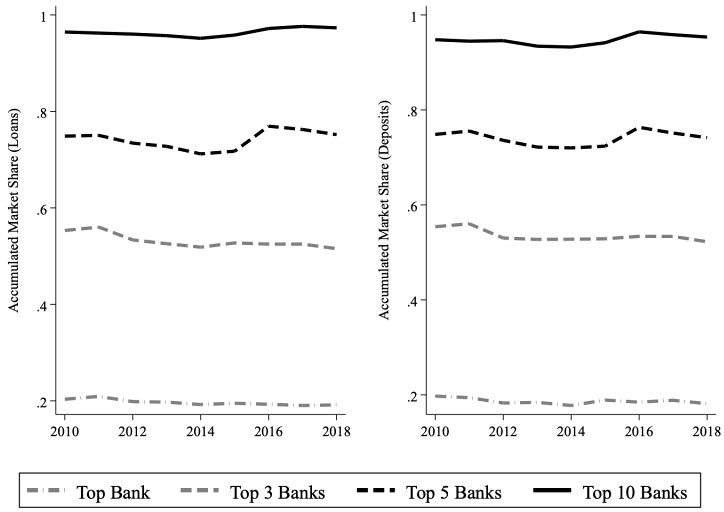
Table 6: Households' savings behavior

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

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 7.

Figure 7: Concentration in the Banking Industry



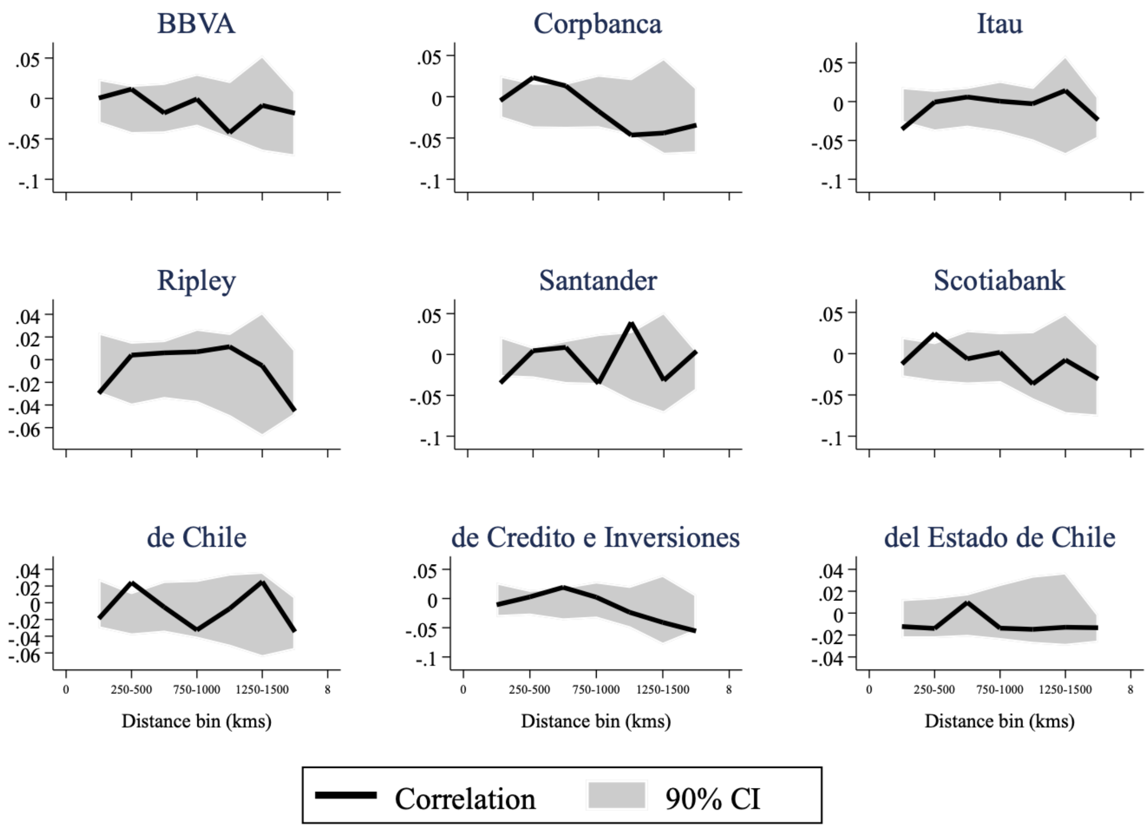
A.4 Spatial Clustering of Banks

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 8 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.

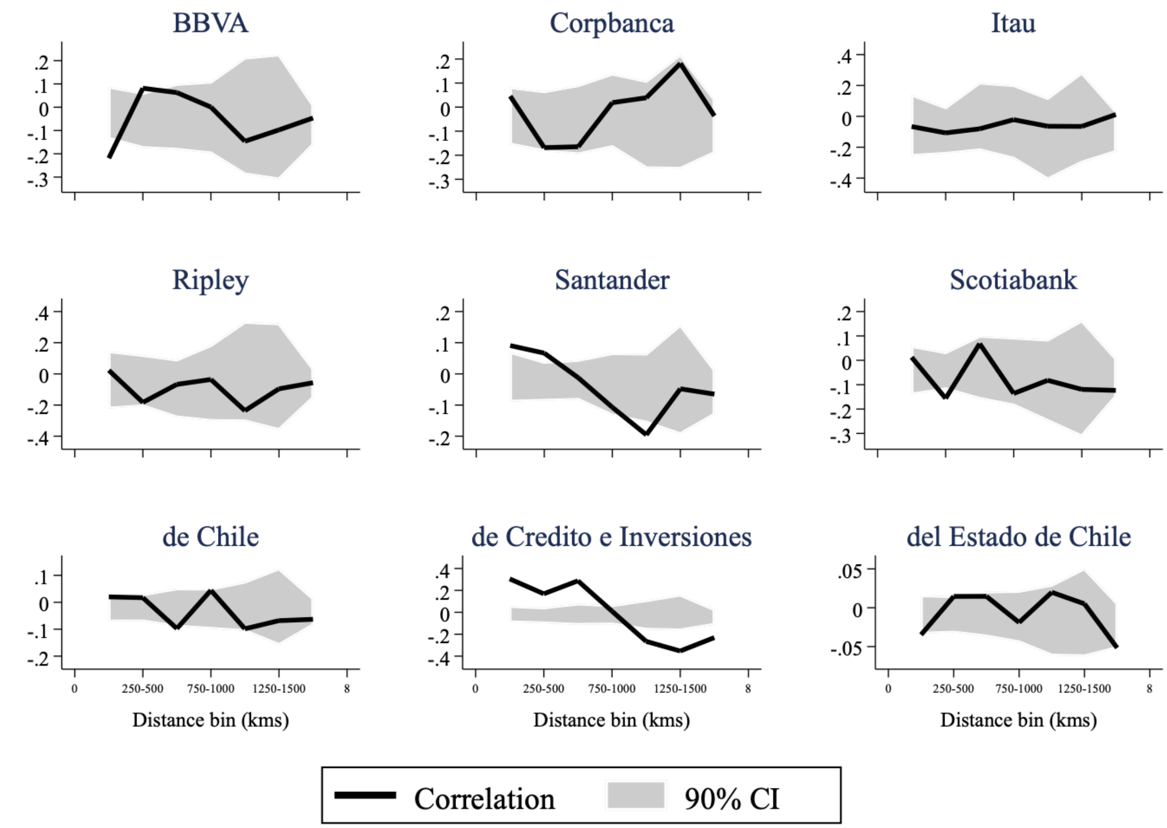
Figure 8: Spatial Correlation in Bank's Presence (Extensive Margin)



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 9 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.

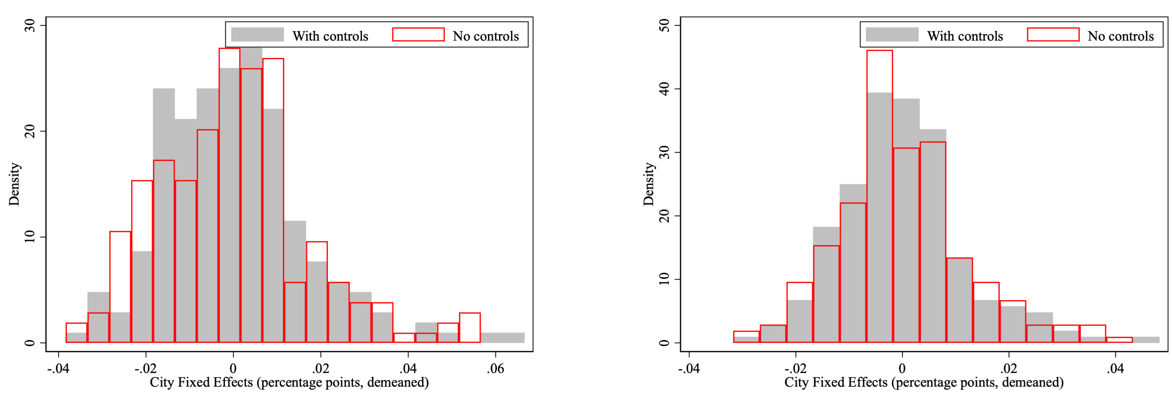
Figure 9: Spatial Correlation in Loan Market Shares (Intensive Margin)



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

Figure ?? 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 10 below shows equivalent results when we weigh each loan by the firm size and if all loans get equal weight.

Figure 10: 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 **??** 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.

A.7 Robustness: Geographic dispersion in interest rates

Table 7: Geographic dispersion in interest rates including firms with some banks' risk assesement (basis points)

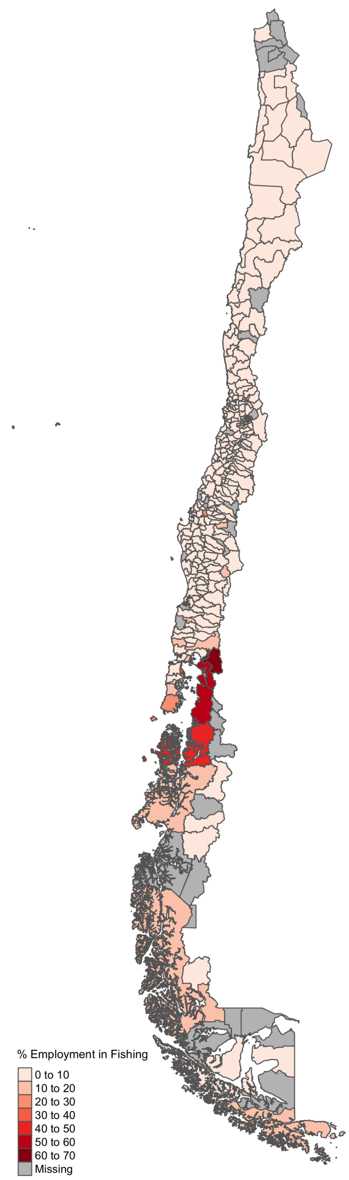
	Interest Rate	**Interest Rate**	**Interest Rate**	**Interest Rate**	**Interest Rate**
City Fixed Effects, normalized percentile					
10-th	-173.668	-121.399	-116.804	-113.319	-175.802
25-th	-79.844	-62.582	-57.951	-56.824	-97.311
50-th	0.000	0.000	0.000	0.000	0.000
75-th	102.44	75.132	86.686	82.236	104.074
90-th	262.316	213.654	198.205	193.482	249.612
Local HHI				41.7	11.6
				(3.1)	(4.1)
Quarter FE	Yes	Yes	Yes	Yes	Yes
Sector and Size of the Firm	No	Yes	Yes	Yes	Yes
Firm Risk	No	Yes	Yes	Yes	Yes
Loan Characteristics	No	Yes	Yes	Yes	Yes
Bank FE	No	No	Yes	Yes	Yes
Firm FE	No	No	No	No	Yes
R^2	0.205	0.542	0.622	0.622	0.849
Observations	673,844	673,844	673,844	673,844	670,882
Number of Banks	19	19	19	19	19
Number of Firms	13,203	13,203	13,203	13,203	10,241
Number of Cities	262	262	262	262	259

Outcome variable in basis points. Statistical significance denoted as *p < 0.10, **p < 0.05, ***p < 0.01.

A.8 Details on the Shift-Share design

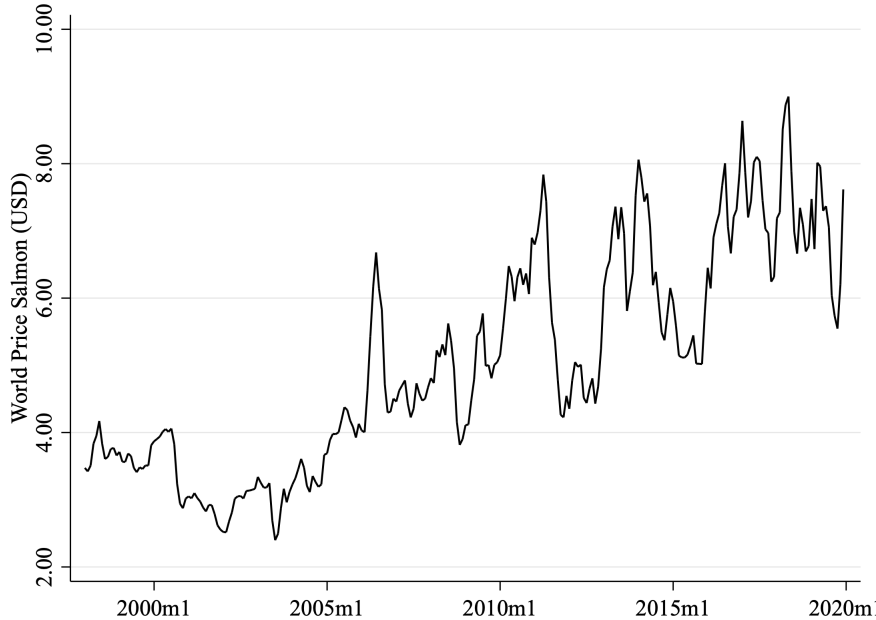
Figure 11 shows the share of local employment in the Fishing industry. The industry is mostly present in the Southern region.

Figure 11: Share of local employment in the fishing industry



The world price of salmon fluctuated during the period we analyzed. Figure 12 shows the world price of salmon.

Figure 12: 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

$$\max_{\{C_t^c, D_{t+1}^b, k_{t+1}\}} \sum_{t=0}^{\infty} \beta^t \Big[\log C_t^c + \alpha \log D_{t+1} \Big] \tag{38}$$

$$\underline{s.t:}\; C_t^c + \sum_b \frac{D_{t+1}^b}{P_t} + \frac{\mathcal{C}_t(i_{t-1})}{P_t} = \frac{\hat{r}_t}{P_t} k_t + \sum_b (1+\tilde{r}_t^b) \frac{D_t^b}{P_t} + \frac{T_{nt}}{P_{nt}} \tag{39}$$

$$k_t = k_{t-1}(1-\delta) + i_{t-1} \tag{40}$$

$$D_{t+1} = \Big[\sum_b {D_{t+1}^b}^{1-\frac{1}{\eta}} \Big]^{\frac{\eta}{\eta-1}} \tag{41}$$

$$k_0, \{D_0^b, L_0^b\}_b \tag{42}$$

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

$$\mathcal{C}_t(i_{t-1}) = \min_{\{L_t^b\}_b} \sum_{b\in\mathcal{B}} L_t^b (1 + r_{t-1}^b)$$
$$s.t: \Big[\sum_{b\in\mathcal{B}} (\gamma^b \tfrac{L_t^b}{P_{t-1}})^{\frac{\sigma-1}{\sigma}} \Big]^{\frac{\sigma}{\sigma-1}} = i_{t-1}. \tag{43}$$

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

$$\mu(\tfrac{\gamma^b}{P_{t-1}})^{\frac{\sigma-1}{\sigma}} \Big(\frac{i_{t-1}}{L_t^b} \Big)^{\frac{1}{\sigma}} = (1 + r_{t-1}^b), \tag{44}$$

where μ is the multiplier associated with the constraint in equation (43). Taking the ratio of equation (44) for two banks b, b'

$$\frac{L_t^{b'}}{L_t^b} = \Big[\frac{(1 + r_{t-1}^b)}{(1 + r_{t-1}^{b'})} \Big]^\sigma \Big[\frac{\gamma^{b'}}{\gamma^b} \Big]^{\sigma-1}. \tag{45}$$

From here, picking an arbitrary b':

$$i_{t-1} = \Big(\sum_{b\in\mathcal{B}} (\gamma^b \tfrac{L_t^b}{P_{t-1}})^{\frac{\sigma-1}{\sigma}} \Big)^{\frac{\sigma}{\sigma-1}} = (1 + r_{t-1}^{b'})^\sigma (\gamma^{b'})^{1-\sigma} \tfrac{L_t^{b'}}{P_{t-1}} \Big[\sum_{b\in\mathcal{B}} (\tfrac{1+r_{t-1}^b}{\gamma^b})^{1-\sigma} \Big]^{-\frac{\sigma}{1-\sigma}}. \tag{46}$$

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

$$i_{t-1} R_{t-1}^\sigma = (1 + r_{t-1}^b)^\sigma (\gamma^b)^{1-\sigma} \tfrac{L_t^b}{P_{t-1}} \tag{47}$$

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

$$\frac{L_t^b}{P_{t-1}} = \Big(\frac{R_{t-1}}{1+r_{t-1}^b}\Big)^{\sigma} i_{t-1}(\gamma^b)^{\sigma-1}. \tag{48}$$

as in the main text. From equation (48) and the definition of $\mathcal{C}_t(i_{t-1})$,

$$\mathcal{C}_t(i_{t-1}) = \sum_{b\in\mathcal{B}} L_t^b(1+r_{t-1}^b) = i_{t-1}R_{t-1}P_{t-1}. \tag{49}$$

Plugging $\mathcal{C}_t(i_{t-1})$ into the budget constraint equation (39) and law of motion for capital equation (40), the problem of the capitalist becomes

$$\max_{\{C_t^c, D_{t+1}^b, k_{t+1}\}} \sum_{t=0}^{\infty} \beta^t \Big[\log C_t^c + \alpha \log D_{t+1}\Big] \tag{50}$$

$$\underline{s.t:} \; C_t^c + \sum_b \frac{D_{t+1}^b}{P_t} = (\frac{\hat{r}_t - R_{t-1}P_{t-1}}{P_t})k_t + \frac{(1-\delta)R_{t-1}P_{t-1}}{P_t}k_{t-1} + \sum_b R_t^b\frac{D_t^b}{P_t} + \frac{T_{nt}}{P_{nt}} \tag{51}$$

$$D_{t+1} = \Big[\sum_b {D_{t+1}^b}^{1-\frac{1}{\eta}}\Big]^{\frac{\eta}{\eta-1}} \tag{52}$$

$$k_0, \{D_0^b, L_0^b\}_b \tag{53}$$

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

$$\lambda_t\frac{\hat{r}_t}{P_t} + \lambda_{t+1}\frac{(1-\delta)R_tP_t}{P_{t+1}} = \lambda_t\frac{R_{t-1}P_{t-1}}{P_t} + \frac{T_{nt}}{P_{nt}} \tag{54}$$

$$\frac{\beta^t}{C_t^c} = \lambda_t \tag{55}$$

$$\beta^t\alpha D_{t+1}^{\frac{1-\eta}{\eta}}(D_{t+1}^b)^{-\frac{1}{\eta}} + \lambda_{t+1}\frac{1+\tilde{r}_t^b}{P_{t+1}} = \frac{\lambda_t}{P_t} \tag{56}$$

Equation (54) 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 (55), is standard. The first order condition with respect to deposits in a specific bank, equation (56), 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 (54) and equation (55) we derive the following Euler equation,

$$\frac{P_{t+1}C_{t+1}}{P_tC_t} = \beta(1-\delta)\frac{R_tP_t}{R_{t-1}P_{t-1} - \hat{r}_t}. \tag{57}$$

Replacing equation (55) into equation (56), and then replacing $C_{t+1}P_{t+1}$ from the Euler equation above, we get

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

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

$$\frac{D_{t+1}^b}{D_{t+1}^{b'}} = \left(\frac{q_t^b}{q_t^{b'}}\right)^{-\eta}, \tag{58}$$

where we defined q_t^b as

$$q_t^b \equiv 1 - \left(1 + \tilde{r}_t^b\right) / \left(\frac{(1-\delta)R_t P_t}{R_{t-1}P_{t-1} - \hat{r}_t}\right). \tag{59}$$

Let us define the deposit price index as

$$Q_t \equiv \left(\sum_b (q_t^b)^{1-\eta}\right)^{\frac{1}{1-\eta}}. \tag{60}$$

It follows from equation (58) and the definition of D_{t+1} that the supply of deposits to bank b is given by

$$D_{t+1}^b = D_{t+1}\left(\frac{Q_t}{q_t^b}\right)^{\eta}. \tag{61}$$

Replacing this back into equation (56) we get the usual equalization of expenditure on the two 'goods' available to the consumer

$$D_{t+1}Q_t = \alpha P_t C_t. \tag{62}$$

The nominal value invested on deposits at t is given by

$$\sum_b D_{t+1}^b = \sum_b D_{t+1}(\tfrac{Q_t}{q_t^b})^{\eta} = D_{t+1}Q_t^{\eta}\overbrace{\sum_b (q_t^b)^{-\eta}}^{\equiv \tilde{Q}_t}. \tag{63}$$

Then, plugging this into the budget constraint equation (51) and using equation (62), we get

$$\frac{Q_t D_{t+1}}{\alpha} + D_{t+1}Q_t^{\eta}\tilde{Q}_t = M_t \to D_{t+1} = \frac{\alpha M_t}{Q_t + \alpha Q_t^{\eta}\tilde{Q}_t} \tag{64}$$

$$\text{and } P_t C_t^c = \frac{Q_t M_t}{Q_t + \alpha Q_t^{\eta}\tilde{Q}_t}. \tag{65}$$

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

$$\begin{aligned} A_{t+1} &\equiv \sum_b D_{t+1}^b(1+r_t^b) \\ &= \sum_b D_{t+1}(\tfrac{Q_t}{q_t^b})^{\eta}(1+r_t^b) \\ &= D_{t+1}\overbrace{Q_t^{\eta}[\sum_b \frac{(1+r_t^b)}{(q_t^b)^{\eta}}]}^{\equiv Q^A} \end{aligned} \tag{66}$$

From equation (66), equation (65) evaluated at $t+1$ and equation (64)

$$P_{t+1}C_{t+1} = \frac{1}{1+\alpha Q_{t+1}^{\eta-1}\tilde{Q}_{t+1}}\left[k_{t+1}(\hat{r}_{t+1} - R_t P_t) + \alpha M_t \tfrac{Q_t^A}{Q_t + \alpha Q_t^{\eta}\tilde{Q}_t} + k_t(1-\delta)R_t P_t\right] \tag{67}$$

Plugging this and equation (65) into equation (57) we end up with an equation that implicitly defines a policy function of k_{t+1},

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

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

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

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

$$\frac{\partial k_{t+1}}{\partial R_t} = -\frac{k_{t+1}P_t}{R_tP_t-\hat{r}_{t+1}} + \frac{1}{R_tP_t-\hat{r}_{t+1}}\left[(1-\delta)P_tk_t - \beta(1-\delta)\frac{P_tM_t}{R_{t-1}P_{t-1}-\hat{r}_t}\frac{1+\alpha Q_{t+1}^{\eta-1}\tilde{Q}_{t+1}}{1+\alpha Q_t^{\eta-1}\tilde{Q}_t}\right] \tag{68}$$

$$= -\frac{P_t}{R_tP_t-\hat{r}_{t+1}}\left[i_t + \beta(1-\delta)\frac{M_t}{R_{t-1}P_{t-1}-\hat{r}_t}\frac{1+\alpha Q_{t+1}^{\eta-1}\tilde{Q}_{t+1}}{1+\alpha Q_t^{\eta-1}\tilde{Q}_t}\right] \tag{69}$$

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

$$\frac{\partial Q_t}{\partial q^b_t} = \left(\frac{Q_t}{q^b_t}\right)^\eta \text{ and } \frac{\partial \tilde{Q}_t}{\partial q^b_t} = -\eta(q^b_t)^{-(1+\eta)}. \tag{70}$$

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

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

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

And then, we know that:

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

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

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

which follows from $\frac{\partial R_n}{\partial r_n} = \frac{L_n^b}{i_n P_n}$ and $\frac{\partial i_n}{\partial R_n}$ is given byequation (69).

B.2 Bank's problem

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

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

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,

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

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

$$\frac{1}{\epsilon^L} + (1+r_n) - \frac{1}{\beta} = \mu \tag{71}$$
$$\frac{1}{\epsilon^D} + (1+\tilde{r}_n) - \frac{1}{\beta} = \mu \tag{72}$$
$$\mu \leq (1+r^w) - \frac{1}{\beta} \tag{73}$$
$$\mu \geq (1+r^w)(1+\tau) - \frac{1}{\beta} \tag{74}$$
$$\bar{W}(\mu - [(1+r^w) - \frac{1}{\beta}]) = 0 \tag{75}$$
$$\underline{W}[\mu - ((1+r^w)(1+\tau) - \frac{1}{\beta})] = 0 \tag{76}$$
$$\bar{W} \geq 0 \tag{77}$$
$$\underline{W} \geq 0 \tag{78}$$

Where ϵ^L, ϵ^D are the elasticities of loan and deposits with respect to interest rates. It follows from equation (74) and equation (75) 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,

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

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

$$
\frac{\partial L_{nt+1}}{\partial r_{nt}}\left[\frac{1}{\beta} - (1+r_{nt}) + \mu_t\right] = L_{nt+1}, \tag{79}
$$

$$
\frac{\partial D_{nt+1}}{\partial \tilde{r}_{nt}}\left[\frac{1}{\beta} - (1+\tilde{r}_{nt}) + \tau'\left(\frac{W_{t+1}}{D_{t+1}}\right)(1+r^W_t)\frac{W^2_{t+1}}{D^2_{t+1}} + \mu_t\right] = D_{nt+1}, \tag{80}
$$

$$
\tau\left(\frac{W_{t+1}}{D_{t+1}}\right)(1+r^W_t) + \tau'\left(\frac{W_{t+1}}{D_{t+1}}\right)(1+r^W_t)\frac{W_{t+1}}{D_{t+1}} = \mu_t \tag{81}
$$

Let us write this in terms of elasticities. First, let us define:

$$
\varepsilon_L \equiv -\frac{\partial L_{nt+1}}{\partial r_{nt}}\frac{1+r_{nt}}{L_{nt+1}} \tag{82}
$$

$$
\varepsilon_D \equiv \frac{\partial D_{nt+1}}{\partial \tilde{r}_{nt}}\frac{1+\tilde{r}_{nt}}{D_{nt}} \tag{83}
$$

$$
(1+r_{nt})^* = \frac{\varepsilon_L}{\varepsilon_L - 1}\left[\frac{1}{\beta} + \tau\left(\frac{W_{t+1}}{D_{t+1}}\right)(1+r^W_t) + \tau'\left(\frac{W_{t+1}}{D_{t+1}}\right)(1+r^W_t)\frac{W_{t+1}}{D_{t+1}}\right], \tag{84}
$$

$$
(1+\tilde{r}_{nt})^* = \frac{\varepsilon_D}{\varepsilon_D + 1}\left[\frac{1}{\beta} + \tau\left(\frac{W_{t+1}}{D_{t+1}}\right)(1+r^W_t) + \tau'\left(\frac{W_{t+1}}{D_{t+1}}\right)(1+r^W_t)\frac{W_{t+1}}{D_{t+1}}\frac{D_{t+1}+W_{t+1}}{D_{t+1}}\right] \tag{85}
$$

B.3.1 Wholesale market clearing

The interest rate r_t^W 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:

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

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

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

$$(1+\pi)(1-\tau_{\text{AFP}}) = \underbrace{\left[1 + r^W \tau_{\text{AFP}}\right]}_{\text{Multiplier}} w_n \ell_n \tag{86}$$

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

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

Knowing the value of loans in each city-bank pair we can calculate M_n from its definition, and D_n^b from equation (64). Individual deposits in each city-bank pair follow from equation (22).