Munich Personal RePEc Archive

Decentralized Market Power in Credit Markets

Silva, Thiago and Souza, Sérgio and Guerra, Solange and Tabak, Benjamin

Banco Central do Brasil, Fundação Getulio Vargas, Universidade Católica de Brasília

27 September 2022

Online at https://mpra.ub.uni-muenchen.de/114766/
MPRA Paper No. 114766, posted 11 Oct 2022 01:17 UTC

Decentralized Market Power in Credit Markets

Thiago Christiano Silva
Research Department, Banco Central do Brasil, thiago.silva@bcb.gov.br

Sergio Rubens Stancato de Souza
Research Department, Banco Central do Brasil, sergio.souza@bcb.gov.br

Solange Maria Guerra
Research Department, Banco Central do Brasil, solange.guerra@bcb.gov.br

Benjamin Miranda Tabak
School of Public Policy and Government, Getulio Vargas Foundation (EPPG/FGV), benjaminm.tabak@gmail.com

The literature measures a bank's market power using aggregated data at the bank level. However, market power may be exercised in a decentralized way by each bank branch and for specific banking products. This article proposes a novel methodology for estimating a bank's market power at the branch level in each locality and for each banking product. We find significant heterogeneity in banks' market power by locality and product, even within the same bank. Our results suggest that aggregate measures of bank market power may be misleading and distorted. Accurate quantification of market power requires fine-grained measures, which are essential for enhancing financial regulation and competition.

Key words: market power, Lerner index, competition, credit market, COVID-19.

1. Introduction

Bank market power is an important subject for policymakers and academia because it affects the distribution of income between the financial and real sectors of the economy. The case of banks is interesting because of their financial intermediation role in the economy. Unlike in traditional economic sectors where competition brings gains to consumers, with rising quality and falling prices, in the banking market, fierce competition can lead to insolvencies in the financial system, which can harm consumers of financial services (Berger et al. 2009, Beck et al. 2013, Stomper 2006, Zhang 2021). On the other hand, when banking competition is low and banks' market power is high, financial service consumers suffer from expensive products.[1]

[1] Girotti and Salvadè (2022) show an important positive feature of bank competition: a reduction on managerial self-dealing due higher competition.

Market power is usually measured using the Lerner index (Lerner 1934). This index evaluates the ability of banks to adjust prices above marginal costs in imperfectly competitive markets.[2] Most studies compute the Lerner index typically at bank level, i.e., assuming that banks have a single unit in the entire country. This simplification is in part due to the lack of microdata required to estimate the local cost function of bank branches. By aggregating all branches of the same bank into a representative one, this approach effectively evaluates a centralized market power of that bank. This aggregate approach may overlook important aspects of local competition, as credit markets may have particularities across localities and credit modalities even for the same bank.[3] This problem becomes even more prominent for countries with continental dimensions, which have a large diversity of features across municipalities that could affect market power locally.

To overcome these limitations, we examine banks' market power in a decentralized way. We propose an innovative methodology that uses granular data for each bank branch to calculate each bank's market power in each locality and credit modality. Our decentralized market power measure is a data-intensive version of the Lerner index. Credit modalities differ considerably regarding prices, terms, and resource utilization, due to the different financial intermediation purposes. Besides, demand for credit can vary spatially, together with the availability of banks' inputs, physical structures, and, specifically, information technology (IT) resources. Our results suggest that the usual way of measuring the degree of competition or market power in the financial system using aggregated data leads to distorted results and makes it difficult to implement public policies and more efficient financial regulation.

The concept of decentralized market power is built on the definition of a local market, which derives from the existence of bank branches of the same bank in multiple localities. Because bank branches may engage in transactions with both local and remote customers, it becomes challenging to decompose the country-level credit market into a set of disjoint local credit markets in which bank branches and customers from a location do not transact with agents from other locations. We

[2] There is a widespread use of the Lerner index among central banks and academia to assess market power and competition in banking systems. The World Bank uses Demirgüç-Kunt and Martínez Pería (2010)'s methodology as a benchmark to calculate the Lerner index of the banking systems of many countries at the national level. Lerner indices are also widely used by international organizations and central banks. Examples include the IMF (Tan et al. 2020), Bank of England (De-Ramon et al. 2018) and *Banco de España* (Cruz-García et al. 2018). Research on the Lerner index and its variants is also active in academia: Shaffer and Spierdijk (2020) provide a summary of recent banking studies that use the Lerner index. Another property of a Lerner index is that it is proportional to the inverse of the demand's price-elasticity. This means that banks with greater market power can extract higher profits, as an increase in credit prices results in a comparatively lower decrease in the demand for loans.

[3] Loecker et al. (2020) highlight the importance of the level of granularity in the analysis. They document a rise of firms' market power for the U.S. economy since 1955 and discuss the macroeconomic implications of this increase. They show that the markup distribution suffers significant changes while the median is unchanged over time. Their results reinforce the importance of analyzing market power more granularly rather than relying on aggregate approaches or statistics.

choose to associate credit markets with the location of the bank branch that originated the credit rather than the customer's location. This strategy has two advantages. First, it does not restrict the customers' localities to the bank branch's locality. Therefore, this approach accommodates bank branches' lending both to local and remote borrowers, which is important given the increasing bank digitalization and online banking adoption. Second, it is consistent with the notion that a bank branch is a local producer that is part of a country-level producer (the bank itself). In this context, the lending bank branch (local producer) bears the associated costs corresponding to its credit operations, regardless of the borrower's locality[4]. In this setting, the term "locality" refers to the physical location of the bank branch extending credit. A "local bank" refers to the representative bank branch in that locality (sum of the branches of the same bank in that locality). We also segregate markets according to the credit modality because of their specific uses and costs. Our methodology ultimately segments credit markets by the bank, bank branch's locality, and credit modality, enabling us to compute a bank's decentralized market power from many perspectives, depending on how we aggregate across these dimensions.

Decentralized market power assessment also poses another challenge regarding data availability, particularly bank branches' local inputs and outputs. We overcome this limitation by developing heuristics that reallocate national-level bank resources across local inputs, products, and costs for each of its branches using several proprietary and public data sources. Besides proposing a decentralized Lerner index for computing the decentralized market power, we also improve it in many aspects by leveraging available microdata. Similar to the centralized Lerner index, we need information on prices and marginal costs. However, the decentralized version requires these two components at the bank branch rather than at the national level.

Traditionally, the evaluation of the Lerner index for a banking system requires estimating the parameters of a translog cost function for each producer in the industry under analysis. This estimation assumes that the observable variables taken as inputs—total costs, input prices, and output volumes—result from a previous optimization process. Therefore, we assume that branches of a bank in a particular locality form a relatively autonomous entity capable of making production decisions.

This assumption appears strong; however, competition among bank branches supports that autonomy. Branches adhere to a set of directives from their headquarters, but they have used their autonomy to compete and ensure that they are not closed in the face of the rising digitalization and online banking. Banks compete in the market by either expanding their customer base or offering

[4] The association of credit markets with the borrowers' location is impractical because customers can borrow from any bank branch. In this instance, defining a local producer for the market is impossible because we cannot estimate production costs from a local combination of products, which is essential for calculating the Lerner index.

more competitive products and services to increase their added value. In this way, bank branches compete to maintain their current status quo and competitive advantage. In order to attract more customers, bank branch managers can set their prices and promote their products as they see fit. As a result, a comprehensive examination of bank market power at the branch and product levels is necessary.

We highlight that if a large bank in our sample has multiple branches in the same locality, we compose a representative branch of that bank in that locality. Given total local costs, input prices, and output volumes, we estimate a decentralized Lerner index for each locality. If the bank's organizational structure changes, potentially resulting in changes in output volumes in each locality, we will observe changes in the estimated decentralized Lerner indices.

Regarding prices, due to data unavailability, instead of the *contractual price* in the Lerner index[5] the literature typically uses the *effective price*, which corresponds to the ratio of credit income and outstanding credit.[6] We improve this definition in this paper. First, we do not use the bank's outstanding credit, which potentially contains previously granted credit operations that do not necessarily capture the current competitive market conditions. Instead, we explicitly separate new credit grants from older ones and focus on the former when evaluating market power. This approach enables us to measure the current competitive conditions more accurately. Second, we reduce the distortion between credit income and outstanding credit when we use data from end-of-month income statements. For very short-term operations, we would observe the credit income at the end-of-month financial statement but not the outstanding credit volume.[7] This limitation biases credit prices upwards materially if there is a substantial volume of very short-term credit. We mitigate this problem by resorting to (billions of records of) loan-level income data with balance position and cash flows before and after repayments and computing the monthly accrued income and the monthly average outstanding credit *for each loan*. Third, we estimate marginal costs for each bank branch and credit modality using a translog total cost functional form with bank branch and locality-time fixed effects, enabling us to control for many non-observable bank branch- and locality-specific factors that would not be possible in the usual estimation at the bank level.

We can draw parallels between our decentralized version of market power and the conventional centralized version. When one aggregates the same bank's decentralized market power across all

[5] Lerner indices are computed from prices and marginal costs in a given market.

[6] *Effective prices* are net of losses due to default and other risk factors since they effectively measure the credit income that the bank receives in its credit operations. *Contractual prices* are not.

[7] As an example, consider a \$100 credit operation that matures in one week and begins on November 3, 2020. The weekly interest rate is 10%. If no default occurs, the bank will cash in ten dollars by the end of the current week. By the end of November 2020, the bank's income statements will include the credit income of \$10 generated from this credit operation. However, the outstanding balance for this operation at the end of the month will be zero.

(branches') localities and credit modalities, the latter becomes comparable to the former. Nevertheless, there is a conceptual difference between the centralized and decentralized versions. While the centralized market power calculation assumes that the bank's entire production process occurs in a single location, as if it only had one branch, the decentralized version assumes that the production process is geographically distributed across its branches. One of the primary benefits of utilizing decentralized market power is comprehending its dynamics using local variables. We take advantage of this characteristic and provide econometric analyses correlating local and bank characteristics with banks' decentralized market power, which may offer valuable insights into formulating policies that promote competition in credit markets[8].

We apply our methodology to Brazil. The application to the Brazilian case brings important insights due to its substantial territorial extension (it occupies almost half a continent) and significant regional heterogeneity reflected in the banking services offered in the different municipalities of the country. A wide variety of domestic, public, and foreign banks operating in the country still brings diversity to bank management, adding more relevant elements to the analysis of banking competition. We leverage the use of many proprietary and public datasets, enabling us to evaluate decentralized Lerner indices for each bank operating in each locality and for each credit modality across time. Due to data limitations, we examine the period from 2015 to 2020. Brazil is an emerging country with a strongly bank-oriented economy, a characteristic that is typically shared among emerging countries. This feature makes investigating bank market power particularly important because the average Brazilian firm primarily relies on bank credit for external funding. Our study also includes credit to individuals who borrow mainly from the banking system. We supply empirical evidence that examining market power at the aggregate level may overlook important features of credit markets.

The main advantage of the Lerner index is that it tells us about the channels through which market power changes: either through the *effective price channel* or the *marginal cost channel*. All else equal, increases in the first (second) lead to higher (lower) market power. This interpretation is important to rationalize differences in market power across time and banks, which would be a compound effect of both channels. We make use of this interpretation and build econometric analyses to understand local and bank features correlate with decentralized market power. In the first, we analyze the influence of locality-specific observables by resorting to a within-bank and across-locality empirical strategy. This setup enables us to eliminate confounding factors arising from changes in bank-specific credit supply while letting locality-specific conditions vary. To mitigate concerns with omitted-variable biases, we compare across localities geographically close. Our

[8] See Alyakoob et al. (2021) for a discussion on the importance of measuring local bank competition.

variation comes from the *same* bank operating in *different* but close localities for the *same* credit modality. In the second analysis, we focus on how bank features associate with decentralized market power using a within-locality and across-bank analysis. This empirical strategy enables us to control for any locality-specific factor that could drive our results. Our variation comes from *different* banks operating in the *same* locality for the *same* credit modality. In both cases, we show that local features help explain banks' decentralized market power in Brazil.

2. Related Literature

In addition to the Lerner index, concentration indices, such as the Hirschman-Herfindahl Index (HHI), are widely used to assess the level of competition—hence the degree of market power—in the banking sector. While all of these measures may fail to identify market power accurately, concentration indices are more disputed (Shaffer and Spierdijk 2020). The contestability theory suggests firms in concentrated markets can behave competitively if entry and exit barriers are low (Baumol et al. 1982). Concentration indices assume that only the internal market characteristics affect competition. However, Bernheim and Whinston (1990) argue that external characteristics, such as multimarket contact,[9] facilitate collusion, even with the presence of many firms in the local market. Another controversial point is the potential endogeneity between concentration and competition. More efficient firms can increase their market shares, increasing concentration (Peltzman 1977). It is also challenging to define a relevant local market or product empirically (Shaffer 2004). The scarcity of microdata also encourages the use of concentration indicators, which are less data-intensive. Furthermore, Blair and Sokol (2014) claim the Lerner index is the standard measure of market power among economists.

There is a large body of research on market power and competitiveness in the banking sector due to its relevance for assessing deregulation, mergers and acquisitions, technological innovations, entry of foreign banks, and, consequently, the consequences on the real economy and financial stability (Degryse et al. 2018). Regarding macroeconomic research on market power, Loecker et al. (2020) document a rise of firms' market power over the last six decades for the U.S. economy. They show that, while the markup distribution changes significantly over time, the median remains unchanged. While firms with a high markup gain market power over time, the remaining firms maintain the same markup. As a result, the median markup remains stable over the period. At the same time, economic activity is reallocated toward high-markup and large firms. They also analyze firm profitability and conclude that its distribution has changed similarly with the changes in the

[9] Multimarket contact occurs when companies compete with the same rivals in multiple markets. When companies compete in more than one market, their competitive behavior may differ from that of competitors in a single market.

markup distribution. They claim that the reduction in labor market dynamism is a macroeconomic implication of these changes.

Empirical studies use different ways to measure the market power and competitiveness of the banking sector. They mainly fall into two approaches. In the first—the ”Structure-Conduct-Performance” (SCP) paradigm—the literature employs concentration measures, such as the HHI and the Concentration Ratio (CR), to proxy for market power. The underlying hypothesis is that collusion is easier in more concentrated markets, leading to anti-competitive behavior by banks. Empirical research shows mixed results, and there is no consensus about the validity of the SCP hypothesis. In the second—the ”New Empirical Industrial Organization” (NEIO) paradigm—the literature directly estimates the banks' conduct using methodologies grounded on theory. These methodologies are more data-intensive, requiring detailed information on bank inputs and outputs. Measurements that use the NEIO paradigm include the mark-up test (Bresnaham 1982, Lau 1982), the H-statistic (Panzar and Rosse 1987), the Boone indicator (Boone 2008), and the Lerner index (Lerner 1934).[10]

The literature on banks' market power is extensive and predominantly composed of studies comparing countries (Claessens and Laeven 2004, Fungácová et al. 2017, Wang et al. 2020, Coccorese et al. 2021). There are also studies analyzing the market power of a country's financial system. For instance, Das and Kumbhakar (2016) examine the market power in the Indian banking system, Whited et al. (2021) investigate the relationship between market power, low interest rates, and risk-taking for US commercial banks, and Cruz-García et al. (2021) analyze the impact of multimarket contacts in the competition of Spanish banks. However, studies on market power at the local level investigate a broader range of research questions. Degryse and Ongena (2005) use a loan-level sample of corporate credit from a large Belgian bank and analyze the effect of the distance between firms and the creditor bank and the presence of other nearby banks. They find loan rates decrease for longer distances between the borrowing firm and the creditor bank and increase if the firm and competitor banks are further apart. Kick and Prieto (2014) investigate the competition-stability nexus for the United States using concentration measures and market power at the bank, county, and state level. They find evidence that reducing competition by regulation does not necessarily improve bank stability. Degl'Innocenti et al. (2018) study how changes in the structure of the bank branch network at the provincial level affect banks in Italy. Their results show that geographical diversification can reduce lending activities but improve funding strategies, both measured by Lerner indices. Also for Italy, Coccorese (2008) uses the mark-up test to assess the level of local competition and identify factors that explain the differences in competition across

[10] Shaffer and Spierdijk (2017) provide a comprehensive comparison of measures of competition in banking markets.

localities. He concludes that the market power level of Italian banks is low and heterogeneous across localities, and the local banking market structure is more relevant than macroeconomic factors to explain local competition. Hakenes et al. (2014) study the role of small regional banks in the credit market. They show that small German regional banks spur local economic growth, especially in localities with credit rationing. For Brazil, Joaquim et al. (2019) use bank-municipality data for the corporate sector and show that decreases in banking competition, measured by changes in local HHI arising from mergers and acquisition events, increase the cost and reduce the volume of credit.

3. Data and Design Choices

We first define the term *locality* used in this paper. Brazil had 5,570 municipalities in 2021, many of which sharing strong economic and financial relationships with neighboring municipalities. For instance, it is common to have a job and a bank account in a neighboring municipality. Therefore, we believe the effective circumscription of credit markets is broader than a municipality's boundaries in Brazil. In this way, we define locality as the Immediate Geographic Region, as defined and published by the Brazilian Institute of Geography and Statistics (IBGE).[11] These regions are strongly connected urban networks comprising a local and central urban center and nearby peripheral urban centers connected through relations of economic dependency and frequent displacement of the population in search of goods, work, health and education services, and the provision of public services, such as the judiciary and assistance and social security. For simplicity, we use *locality* to refer to an Immediate Geographic Region in this paper.[12] We use the location of bank branches instead of borrowers when estimating banks' total cost functions, which is more coherent from a production function viewpoint. In this setup, borrowers can be anywhere.[13]

We also need to define a time frame in which we evaluate the decentralized market power. Ideally, it should not be too narrow because one would not have sufficient credit operations to observe competitive behavior nor too broad because older credit operations could contaminate our analysis as they do not necessarily reflect the current market conditions. Therefore, we enclose credit operations within a semiannual period to evaluate granular market power over time.

We compile and merge the following datasets in this paper:[14]

[11] IBGE groups the 5,570 municipalities into 510 Immediate Geographic Regions. However, there are no banks in the sample in two of them, restricting the analysis to 508 localities.

[12] We note that our methodology is flexible and can take any geographical area as the locality. For instance, localities can be entire states, municipalities, districts, or even streets. Limitation often comes from data availability and the economic sense of the best cut for a local credit market.

[13] Lending to remote borrowers has increased due to the bank digitalization provided by more developed IT systems. In December 2020, banks channeled 31.3% of the outstanding local credit to borrowers from other Immediate Geographic Regions (40.5% of the borrowers). In the wealthiest region in Brazil (Southeast Region), these amounts were maximal: 36.2% of the outstanding credit and 49.8% of the borrowers.

[14] Appendix A supplies detailed data treatment procedures and an overview of Brazilian local bank credit markets.

- Banks' consolidated financial statements from the Accounting Plan of the Institutions of the National Financial System (Cosif) maintained by the Central Bank of Brazil (BCB). The BCB frequently uses this dataset for monitoring purposes, thereby increasing the data quality. Cosif is only available at the national bank level (proprietary data);
- Individual and firm registration data from the Brazilian Federal Revenue Service (RFB), to identify the borrower's and bank's locations (proprietary data);
- Identified bank credit operations of individuals and companies in Brazil from the Credit Information System (SCR) maintained by the BCB. Together with the RFB data, these datasets allow obtaining the credit volume for each modality granted by each bank within a period in a specific location. We can also evaluate the average effective price of these operations locally for each bank and credit modality (proprietary data);
- Identified historical registry of financial institutions from the Information on Entities of Interest to the Central Bank (Unicad) by the BCB. This dataset contains bank-level meta-information, such as bank type of control, size, prudential segment, among others (proprietary data);
- Monthly Banking Statistics by Municipality (ESTBAN) maintained by the BCB. This dataset is a declaratory database that contains *limited* balance-sheet information for each bank branch in Brazilian municipalities over time (public data);
- IBGE geographic data to associate municipalities with corresponding localities (public data);
- Identified formal employment relationships from the Annual List of Social Information (RAIS) and the General Register of Employed and Unemployed (Caged), both maintained by the Ministry of Economy. The data contains information on the payroll and the number of employees in each bank branch in Brazil (proprietary data).

4. Estimation of Decentralized Market Power in Credit Markets in Brazil

This section presents the main methodological contribution of the paper, considering Brazilian datasets as a use case.

4.1. Model definition

Decentralized market power measures are computed using a data-intensive version of the Lerner index. We need two pieces of information to estimate the Lerner index of a specific bank in a given market: (i) the effective price (observable variable) and (ii) the marginal cost (non-observable variable) of the product. We evaluate the decentralized Lerner index of bank b at location l in period t for the banking product j using the following expression:

$$L_{blt}^{(j)} = \frac{p_{blt}^{(j)} - MC_{blt}^{(j)}}{p_{blt}^{(j)}}, \tag{1}$$

in which $p_{blt}^{(j)}$ and $MC_{blt}^{(j)}$ are the average effective price and marginal cost of bank b at location l at time t relative to banking product j, respectively.

After computation, prices, marginal costs and Lerner indices for each period and market (bank, credit modality, locality) can be aggregated to represent information on broader markets over time, for instance, the Lerner index aggregated for all banks and credit modalities in a locality, or the marginal cost aggregated for the credit modalities to non-financial firms, all banks, in a country region (for further details, see Section 5).

The banking literature uses a total cost function to estimate the marginal cost. We follow the literature and assume that the cost function takes a transcendental logarithmic functional form (translog) with a set of banks' inputs and products as arguments.[15] Then, the derivative of the cost function with respect to a specific product is used to estimate the product's marginal cost. We follow this procedure and estimate the marginal cost using a cost function. However, we differ from the literature in the dimension in which the estimation takes place. While the banking literature assesses marginal cost at the (national) bank-time level, we use bank-locality-time data. In this way, we can identify local idiosyncrasies in bank market power.

Considering that banks may operate across localities differently, we saturate the total cost function with fixed effects. In this way, we can control for non-observable bank-specific institutional settings in each location and location-specific shocks. This approach is vital because the cost function assumes that banks have the same production function and, therefore, the cost-related parameters are the same for all banks, locations, and time. We use the following empirical specification for the bank b's total cost in location l at time t (TC_{blt}):

$$\ln\left(\frac{TC_{blt}}{W_{blt}^{(1)}}\right) = \alpha_{bl} + \alpha_{lt} + \sum_{j=1}^{N}\beta_j \ln Q_{blt}^{(j)} + \frac{1}{2}\sum_{j=1}^{N}\sum_{k=1}^{N}\beta_{jk}\ln Q_{blt}^{(j)}\ln Q_{blt}^{(k)} + \sum_{i=2}^{M}\delta_i \ln\left(\frac{W_{blt}^{(i)}}{W_{blt}^{(1)}}\right) + \\ + \frac{1}{2}\sum_{i=2}^{M}\sum_{k=2}^{M}\delta_{ik}\ln\left(\frac{W_{blt}^{(i)}}{W_{blt}^{(1)}}\right)\ln\left(\frac{W_{blt}^{(k)}}{W_{blt}^{(1)}}\right) + \sum_{j=1}^{N}\sum_{i=2}^{M}\gamma_{ji}\ln Q_{blt}^{(j)}\ln\left(\frac{W_{blt}^{(i)}}{W_{blt}^{(1)}}\right) + \epsilon_{blt}, \qquad (2)$$

in which $W_{blt}^{(i)}$ and $Q_{blt}^{(j)}$ represent the price of the i-th input and the quantity produced of the j-th product by bank b at location l during period t. The bank uses M inputs and produces N products. In (2), the total cost TC_{blt} and input prices $W_{blt}^{(i)}$, $i \neq 1$, are divided by the price $W_{blt}^{(1)}$ to ensure the linear homogeneity of the estimated cost function.[16] In addition, $\beta_{jk} = \beta_{kj}$, $\forall j, k$, and $\delta_{ik} = \delta_{ki}$,

[15] In this approach, one assumes that banks are optimizing costs taking input prices and quantities to be produced as given. It is well-suited for estimating bank costs, that are non-observable, from observed data.

[16] The linear homogeneity assures the same cost function when prices and costs are multiplied by a constant and the other parameters remain unchanged. We choose the funding price ($W_{blt}^{(1)}$) as the divisor for numerical stability. First, it has a reasonable magnitude (not too small like the tax price and not too large as the labor price) and standard deviation. Second, the literature also uses funding as the divisor due to banks' traditional financial intermediation role.

$\forall i, k$. We introduce bank-locality effects α_{bl} to capture non-observable characteristics of bank b in location l that are time-invariant, and time-locality effects α_{lt} to absorb locality-specific factors that affect banks over time.[17] The term ϵ_{blt} is the stochastic error.

We differentiate the total cost function in (2) with respect to the quantity produced of product j to obtain the decentralized marginal costs associated with the same product j by bank b in location l during period t ($MC_{blt}^{(j)}$), i.e.:

$$MC_{blt}^{(j)} = \frac{\partial TC_{blt}}{\partial Q_{blt}^{(j)}} = \left(\frac{TC_{blt}}{Q_{blt}^{(j)}}\right)\left(\beta_j + \beta_{jj}\ln Q_{blt}^{(j)} + \sum_{k=2}^{N}\beta_{jk}\ln Q_{blt}^{(k)} + \sum_{i=2}^{M}\gamma_{ji}\ln\left(\frac{W_{blt}^{(i)}}{W_{blt}^{(1)}}\right)\right). \quad (3)$$

The marginal cost in (3) is the monetary amount spent by bank b to increase the banking product j in locality l during period t by *one* monetary unit.

The empirical challenge in evaluating market power at more fine-grained levels is to estimate bank-specific input prices and the quantity of each product in (2) locally. This information usually is present at the national bank level. We overcome this limitation by constructing heuristics to reallocate national-level bank resources across local inputs, products, and costs for each of its branches using several proprietary and public data sources from Brazil. We address this issue in the next section.

4.2. Productive process: the bank's local total cost function

This section details the components of the total cost function that we evaluate for each location according to (2).

Input prices ($W_{blt}^{(i)}$): Table 1 shows the definition of input prices of the local total cost function.

Local total cost (TC_{blt}): While it is common for central banks to have consolidated financial statements of banks to pursue their institutional goals, it is unusual to have information at the bank branch level. Brazil is not an exception to this as well.[19] While the BCB has detailed data on the total costs of each financial institution in Brazil through the Cosif dataset, there is no information on specific cost factors for each bank branch. The latter would require complete financial

[17] The bank-locality fixed effects (α_{bl}) capture the average effects of the strategic positioning of each bank regarding local market niches and organizational choices both at the bank and at the bank branch level. The time-locality fixed effects (α_{lt}) absorb locality-specific non-observable shocks, such as the effect of local public policies on regional economic activity, the local court efficiency, environmental risks and the local diversification of economic activities.

[18] The federal tax burden of Brazilian financial institutions was approximately 79% of all the collected taxes between 2015 and 2020. Therefore, most of the tax costs were under the same legal framework, in a way that our hypothesis about the tax price is reasonable.

[19] The BCB receives financial statements and many other datasets to pursue its institutional goals of ensuring the stability of the currency purchasing power, fostering a sound, efficient and competitive financial system, and promoting the economic well-being of society. Specifically, financial institutions report their financial statements monthly to the BCB. This information is subject to many quality and accounting controls allowing the BCB to use such information to monitor the minimum prudential requirements (such as liquidity and capital requirements) for every bank.

Table 1 Bank input prices ($W^{(i)}_{blt}$) used to estimate the total cost function in (2).

i	Price of input $\mathbf{W^{(i)}_{blt}}$	Name and Rationale
1	$W^{(1)}_{blt} = \dfrac{\text{Funding Costs}_{bt}}{\text{Total Funding}_{bt}}$	**Funding prices**. We assume the local funding price is uniform for the same bank in different locations, as the bank's funding strategy normally follows centralized internal governance. The expenses variable Funding Costs$_{bt}$ (Cosif) and the Total Funding$_{bt}$ variable (Cosif) are the bank b's funding expense in period t and the average outstanding funding in period t, respectively.
2	$W^{(2)}_{blt} = \dfrac{\text{Tax Costs}_{bt}}{\text{Total Assets}_{bt}}$	**Tax prices**. We assume the local taxation price is approximately uniform across localities since taxation costs refer mainly to federal taxes in Brazil.[18] The expenses variable Tax Costs$_{bt}$ (Cosif) and stock variable Total Assets$_{bt}$ (Cosif) are the bank b's tax costs in period t and its total assets.
3	$W^{(3)}_{blt} = \dfrac{\text{Labor Costs}_{blt}}{\text{Number of Employees}_{blt}}$	**Labor prices**. We take the price of labor resources as the local average salary. The expenses variable Labor Costs$_{blt}$ (RAIS/Caged) and the Number of Employees$_{blt}$ variable (RAIS/Caged) are the bank b's total labor costs in t and the *average* number of employees at location l during period t.
4	$W^{(4)}_{blt} = \dfrac{\text{Other Admin. Costs}_{bt}}{\text{Total Assets}_{bt}}$	**Other administrative prices**. We consider the price of other administrative resources, such as rental expenses, depreciation, amortization and cost of supplies required for running the bank's operational infrastructure, uniform across locations due to data unavailability. The expenses variable Other Admin. Costs$_{bt}$ is the sum of administrative (Cosif), depreciation (Cosif) and amortization (Cosif) costs minus labor (RAIS/Caged) costs, all of which relative to bank b in period t.

statements at the bank branch level. One potential option would be to use ESTBAN. However, ESTBAN contains information on balance sheet accounts with an intermediate level of detail and only summarized information on income statement accounts. It only contains the aggregate income statement accounts total costs and total revenues. This information is insufficient to evaluate the required information on banks' inputs in (2), as we would need to break down total costs in specific factors such as funding, tax costs, labor, and other administrative costs.

We overcome this limitation by constructing heuristics to allocate national-level bank-specific costs across their branches. Our strategy is to allocate the high-quality and detailed national-level costs of each bank from the Cosif dataset to every branch across localities using other datasets with useful local bank branch information, such as the ESTBAN or SCR. The combination of local information data with Cosif guarantees that the sum of all bank branches' costs coincides with the aggregate financial statement of that bank.

Table 2 shows the four cost components that we employ to estimate each bank's local total costs. In each line, we report the aggregate base value from Cosif and the heuristics for allocation of that value across bank branches.[20]

[20] For instance, suppose that bank b has branches in two localities and that, for the computation of total costs TC_{blt} we need to allocate personnel expenses to each locality. We have the bank's aggregate labor cost (Cosif) = 130, the

Table 2 Components of the bank's local total costs (TC_{blt} in (2)). For each cost component, we divide national-level cost components of a bank (second column) across its bank branches using an heuristics for allocation (third column).

Comp.	Aggregate base value (Cosif)	Heuristics for allocation (location-specific)
1	Funding costs, except those related to bonds and securities.	Proportion of the outstanding credit originated by the bank branch regardless of the borrower's locality (SCR) in relation to the bank's national aggregate.
2	Funding costs related to bonds, securities, and repo operations at the interbank market.	Proportion of the sum of [interbank and liquidity applications with securities (ESTBAN)] and [derivative financial instruments (ESTBAN)] in the locality relative to the bank's national aggregate.
3	Sum of tax costs, administrative costs excluding labor, and amortization and depreciation costs.	Proportion of the sum of [outstanding credit operations originated by the bank branch regardless of the borrower's locality (SCR)] + [interbank and liquidity applications (ESTBAN)] + [securities and derivative financial instruments (ESTBAN)] + [leasing and other securities and assets (ESTBAN)] in the locality relative to the bank's national aggregate.
4	Labor costs.	Proportion of the bank branch's payroll (RAIS / Caged) relative to the bank's national payroll.

Quantity of products ($Q^{(j)}_{blt}$): In this study, we define banks' products by choosing the two largest earning assets categories and a residual category, which results in these outputs:[21] credit operations (SCR), bonds and securities (ESTBAN), and operations with other assets[22] (ESTBAN). Within credit operations, our granular data enables us to subdivide it into credit modalities. The composition of banks' credit portfolios may substantially vary across municipalities and can be a source of potential differences in market power. In this way, we opt to model credit products in terms of their modalities. Table 3 lists the considered credit modalities in terms of the product segment: households or non-financial firms.[23]

Some credit modalities typically have long maturities. In this way, a bank's stock of credit operations may include active operations originated a long time before, under market conditions potentially different from those observed in the current period. Research in this area usually considers the whole stock of credit operations and has this potential problem in their marginal cost

bank's aggregate payroll (RAIS / Caged) = 100 and the branches' total payroll. For locality $l = 1$, it is 30, while for $l = 2$, it is 70. Thus, we will allocate labor costs LC_{blt} as follows. For $l = 1$, $LC_{b1t} = 130 * 30/100 = 39$, and for $l = 2$, $LC_{b2t} = 130 * 70/100 = 91$.

[21] This product list is line with the literature. Shaffer and Spierdijk (2020) provide a list with an overview of recent banking studies that use the Lerner index computed from a translog cost function. The list has about 50 studies from which 10 consider loans and securities as products.

[22] We evaluate operations with other assets in a residual form: cash and cash equivalents, interbank investments, bonds and securities, interbank relationships, interdependence relationships and credit, and leasing operations are subtracted from the value of the sum of current assets and long-term assets.

[23] The division roughly follows the credit modalities published in the Financial Stability Report of the BCB.

estimates. This limitation may result from these works be relying solely on (national-level) banks' financial statements, which do not permit the identification of new grants and previous outstanding credit. In order to better capture the competitive market conditions in each period (a half-year), we subdivide the credit volume into that granted *within* the half-year and that granted *before* the half-year. To the best of our knowledge, this is the first work that considers this feature to better estimate market power.

Table 3 Credit modalities considered as credit-related banking products when evaluating (2). Each credit modality is represented by two banking products: operations that occurred within and before the half-year under analysis.

Credit modality for individuals	Credit modality for non-financial firms
1. Payroll-deducted personal credit	1. Working capital credit
2. Non-payroll-deducted personal credit	2. Revolving working capital credit
3. Real estate financing	3. Infrastructure financing
4. Rural credit	4. Real estate financing
5. Vehicle financing	5. Investment credit
6. Other credit	6. Account receivables credit
	7. Agribusiness credit
	8. Other credit

Note: The "other credit" modality in each segment refers to an aggregation of credit modalities with a small share in the segment's outstanding credit. In the credit segment for non-financial firms, the modalities below may have non-standard characteristics compared to credit modalities available in other countries. Infrastructure financing refers to earmarked credit for financing infrastructure projects. Investment credit is non-earmarked and is used for financing firm investment projects. Finally, account receivables credit refers to the anticipation of receivables, given as collateral, such as promissory notes, bills, checks, and credit card bills.

Therefore, in our model, each bank can produce thirty products: (i) fourteen products referring to credit operations granted within the half-year of the modalities listed in Table 3; (ii) fourteen for operations before the half-year of those modalities; (iii) one for operations with bonds and securities; and (iv) one for operations with other assets.

4.3. Effective price of credit products

We focus on credit products granted within a half-year. We explicitly index these products with an m superscript. Formally, it is a subset of all j bank products as in (2). The banking literature normally uses the ratio between the revenue from credit operations and the volume of credit as a proxy for the *average credit price*.[24] This effective price is net of losses due to credit default, since this measure is based on the income that is received by the bank in its credit operations. It differs from the contractual interest rate, which incorporates expected default and other risk factors. Ideally, the average effective price of a portfolio of a credit product m granted by bank

[24] Shaffer and Spierdijk (2020) evaluate market power in multi-product banks using the Lerner index. They state that in these computations banks' output price is typically calculated as the average revenue, given by the total revenue divided by total assets. Studying regional competition in US banking, Erler et al. (2017) also adopt this method to compute credit prices.

b during period t at location l should be computed as the internal interest rate of its cash flow. However, due to the unavailability of complete cash flow data (cash flow dates and amounts), we resort to a proxy in line with the literature: we compute the portfolio's average effective price as the ratio of the sum of monthly income flows from credit grants within the half-year (SCR) and the 6-month average of monthly outstanding credit averages within the half-year (SCR).[25] The portfolio's average effective price, expressed in terms of semiannual interest rate, is:

$$p_{blt}^{(m)} = \frac{\text{Credit Income}_{blt}^{(m)}}{\text{Credit Concessions}_{blt}^{(m)}} = \frac{\sum_{k \in \mathcal{H}_t} I_{blk}^{(m)}}{\frac{1}{6}\sum_{k \in \mathcal{H}_t} V_{blk}^{(m)}}, \tag{4}$$

in which $\mathcal{H}_t$ is the set of all months within half-year t, $I_{blk}^{(m)}$ indicates the portfolio sum of income inflows of each operation of credit modality m granted in t, computed by the accrual method, that bank b at locality l received during month k, and $V_{blk}^{(m)}$ is the sum of monthly outstanding credit average for these operations at the same month.[26]

There are two important distinctions of our methodology to the literature. First, we focus on credit operations within a half-year when evaluating their effective price, instead of the entire credit portfolio of a bank. This approach enables us to better measure the current market conditions. Second, we explicitly take into account very short-term credit, i.e., operations that mature in less than one month. The traditional approach taken in the literature is to consider end-of-month accounting data to retrieve the effective credit income and outstanding credit volume. In this approach, for a single operation we would find the credit income computed at the end-of-month financial statement but the outstanding credit volume would be zero. Hence, after aggregating these operations with others in the portfolio, effective prices would be biased upwards. If there is a significant volume of very short-term credit, then the distortion could be substantial.[27] In turn, our approach of computing the portfolio's average effective price as the ratio of the sum of monthly income flows from credit grants within the half-year (SCR) and the average of monthly outstanding credit averages within the half-year (SCR) mitigates this problem.[28]

[25] Monthly income flows are obtained from the SCR database for single operations. They are computed by the accrual method and reflect daily effects of the contractual interest rate and outstanding credit. Additionally, loans in default receive zero income. Regarding monthly outstanding credit averages, due to lack of data, we proxy them as the sum of the outstanding amount in the beginning of the month to new credit grants during the month, if any.

[26] We are simplifying the computation by assuming a simple compounding over months. This simplification does not distort the results because we are looking at a short horizon.

[27] In fact, along the semiannual periods in the data sample, operations that mature in less than 30 days correspond to 7% to 12% of the average overall outstanding credit in these periods. However, these operations are concentrated in shorter-term (and higher price) modalities, which impose a much larger distortion on prices computed for these modalities.

[28] However, substituting the monthly outstanding credit averages in the denominator by the sum of the outstanding amount in the beginning of the month and the new credit grants during the month as we do will bias effective prices down. This bias may become of low relevance after aggregating all the operations of credit product m granted by bank b in locality l during period t.

5. Evolution of Decentralized Market Power in Brazil

This section provides a comprehensive view of the decentralized market power across Brazilian localities. Since the literature normally looks at national aggregates, this information is entirely novel. We report average effective prices (not contractual prices) and the estimation of marginal costs and decentralized Lerner indices across Brazilian localities. Our model's outputs yield these three variables for each bank for a specific credit product in a locality during a semiannual period. Our focus is on within-half-year credit products listed in Table 3. We display these variables at different levels of aggregation: localities, regions, and the whole country.[29] Table 4 shows summary statistics of variables used in the estimation of decentralized Lerner indices.

Figure 1 shows the distribution of the effective price, marginal cost, and decentralized Lerner over time aggregated by locality[30] for the overall credit market in each locality. The black line denotes the median of the variables and the distribution is plotted for the range of percentiles 25 to 75%. There is a large dispersion of these variables across localities. This fact suggests national-level analysis may overlook many important aspects of market power across localities, reinforcing the need of developing methods to estimate market power locally. Effective prices decrease over time, with a substantial reduction of its dispersion after the COVID-19 outbreak. Marginal costs have an inverted U-shaped behavior, with similar dispersion across the sample period. Lerner decreases over time, with increasing dispersion. The similar trends of the effective price and Lerner indicate the effective price channel (and not the marginal cost channel) dictates the Lerner index in the aggregate level.

To get a sense of the level of variation of our local estimates, Figure 2 shows the spatial distribution of the average effective prices, marginal costs, and decentralized Lerner indices across each of the Brazilian localities in the pre-pandemic (2019) and the first year of the pandemic (2020). These three measures exhibit considerable heterogeneity, even within adjacent localities. Additionally, the three measures substantially changed during the COVID-19 outbreak compared to their pre-pandemic values. For instance, prices mostly decreased in all regions. However, the changes in marginal costs were specific to each locality. Consequently, the Lerner index changed in nontrivial ways. Overall, these results suggest that competition at a national level shadows many important local aspects of credit markets. Our method enables us to capture regional differences in competition.

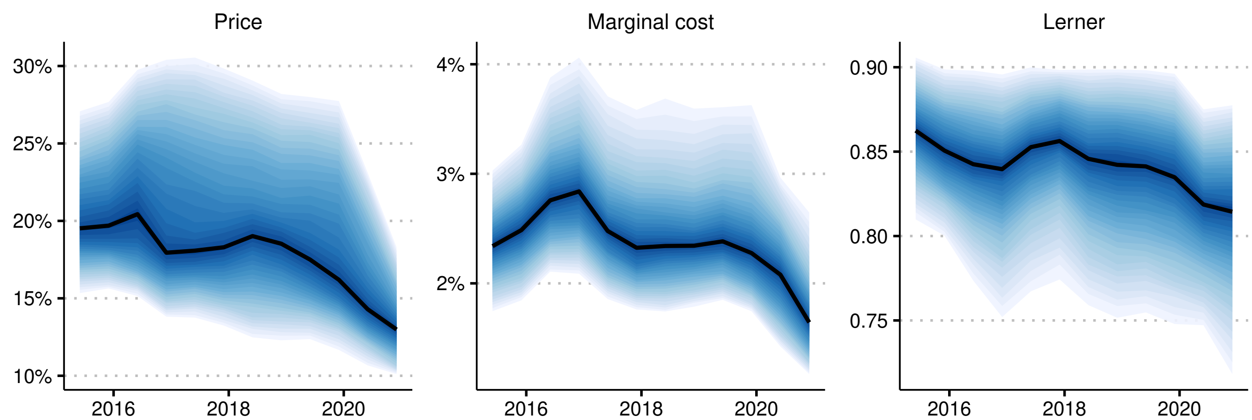
[29] Shaffer and Spierdijk (2020) demonstrate we can aggregate multi-product banks Lerner indices consistently by using the credit income as a weighing strategy. We follow this guideline and use the bank's credit modality income. This paper uses this procedure to aggregate Lerner indices, marginal costs, and effective prices of different banks for different credit modalities and localities.

[30] We compute these distributions by firstly obtaining a local aggregate for each variable weighing bank-modality observations within the same locality and time (semiannual period) by local credit income. Then we display the distributions of these local aggregates for each date, for each variable.

Table 4 Summary statistics of variables used in the estimation of decentralized Lerner indices. Semiannual data, from 2015 to 2020. Local total costs are sums of monthly accrued amounts. The other variables are averages over a half-year.

Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Median	Pctl(75)	Max
A. Local total cost in a half-year (in log R$)								
Local cost	32,975	16.439	1.448	13.784	15.406	16.269	17.278	20.515
B. Input prices (in log R$)								
Funding	32,975	−3.477	0.653	−6.737	−3.683	−3.408	−3.057	−2.535
Tax	32,975	−6.153	0.346	−6.861	−6.436	−6.151	−5.953	−5.202
Labor	32,975	10.618	0.385	9.718	10.399	10.611	10.88	11.485
Administrative (other)	32,975	−4.288	0.448	−5.342	−4.499	−4.279	−4.104	−3.065
C. Non-credit products (in log R$)								
Bonds and securities	32,975	2.506	5.945	0	0	0	0	27
Operations (other)	32,975	5.740	6.393	0	0	0	11.7	22
D. Credit granted to individuals within the half-year (modality outstanding average in log R$)								
Payroll-deducted	32,975	13.835	4.666	0.000	13.907	15.189	16.177	22.225
Non-payroll-deducted	32,975	13.487	3.640	0.000	12.944	14.277	15.339	21.825
Real estate	32,975	9.604	6.732	0	0	12.7	14.6	22
Rural	32,975	7.202	7.532	0.000	0.000	0.000	14.775	20.999
Vehicle	32,975	10.319	5.640	0.000	9.718	12.425	13.842	23.253
Other	32,975	13.754	3.268	0.000	12.895	14.198	15.543	22.721
E. Credit granted to non-financial firms within the half-year (modality outstanding average in log R$)								
Working capital	32,975	13.597	4.376	0.000	13.116	14.573	15.833	23.570
Revolving working capital	32,975	11.628	4.525	0.000	9.865	12.759	14.647	21.921
Infrastructure	32,975	8.404	6.340	0.000	0.000	11.545	13.495	21.456
Real estate	32,975	0.457	2.451	0	0	0	0	19
Investment	32,975	8.335	6.127	0.000	0.000	11.107	13.083	21.917
Account receivables	32,975	11.668	5.372	0.000	10.906	13.392	14.970	23.109
Agribusiness	32,975	2.913	5.875	0	0	0	0	22
Other	32,975	11.153	4.716	0.000	10.279	12.524	14.000	21.849
F. Credit granted to individuals before the half-year (modality outstanding average in log R$)								
Payroll-deducted	32,975	15.364	4.853	0.000	15.413	16.812	17.706	23.463
Non-payroll-deducted	32,975	14.690	3.495	0.000	14.188	15.380	16.373	22.081
Real estate	32,975	13.127	7.025	0.000	13.068	15.657	17.636	24.725
Rural	32,975	10.691	7.750	0.000	0.000	14.256	16.848	22.942
Vehicle	32,975	12.467	5.680	0.000	12.548	14.374	15.620	24.182
Other	32,975	14.866	3.313	0.000	14.291	15.423	16.424	23.277
G. Credit granted to non-financial firms before the half-year (modality outstanding average in log R$)								
Working capital	32,975	15.067	4.013	0.000	14.499	15.803	16.980	24.225
Revolving working capital	32,975	12.636	3.966	0.000	11.888	13.480	14.758	21.555
Infrastructure	32,975	12.536	6.364	0.000	12.060	14.899	16.525	23.909
Real estate	32,975	3.135	6.103	0	0	0	0	23
Investment	32,975	11.740	5.274	0.000	11.376	13.331	14.806	23.751
Account receivables	32,975	10.766	5.117	0.000	9.666	12.281	14.108	22.241
Agribusiness	32,975	5.424	7.179	0	0	0	13.5	23
Other	32,975	12.912	4.826	0.000	12.582	14.287	15.561	23.854
H. Credit effective prices of modalities for individuals (in % per half-year)								
Payroll-deducted	30,115	12.636	4.599	0.214	9.292	11.333	16.181	144.894
Non-payroll-deducted	31,258	27.087	9.870	0.245	20.197	26.842	34.344	199.026
Real estate	22,553	4.537	3.387	0.107	3.143	3.848	4.602	64.736
Rural	16,056	4.622	3.269	0.104	2.958	3.853	5.650	95.905
Vehicle	26,036	12.766	6.277	0.290	7.926	10.351	17.200	97.634
Other	31,857	26.442	15.820	0.113	12.109	22.643	40.033	155.509
I. Credit effective prices of modalities for non-financial firms (in % per half-year)								
Working capital	30,442	14.510	7.131	0.141	9.383	13.803	18.781	169.255
Revolving working capital	30,172	34.342	15.546	0.156	22.768	33.807	46.216	176.428
Infrastructure	21,411	5.400	5.343	0.128	2.924	4.144	6.064	80.212
Real estate	1,140	4.808	4.406	0.118	2.749	3.997	5.636	59.406
Investment	21,959	10.383	5.681	0.153	6.924	9.507	12.853	191.624
Account receivables	28,012	8.928	3.395	0.134	6.515	8.757	11.153	43.592
Agribusiness	6,593	3.448	2.916	0.104	2.556	3.192	3.881	93.275
Other	28,809	13.256	9.654	0.101	7.961	11.306	16.621	194.948

We now look at average effective price, marginal cost, and decentralized Lerner for individuals and non-financial firms across Brazilian regions. Figure 3a shows the average effective price of operations of credit to individuals was higher than to non-financial firms across Brazilian regions. In 2020, there was a significant drop in the average effective price in both segments, mainly for credit to individuals. This fall may be correlated with the effects on the economic activity of the COVID-19 pandemic and the debt renegotiation measures that took place in the period, which directly reduced the credit income flow of credit operations.



(a) (b) (c)

Figure 1 **Distributions of effective prices, marginal costs and Lerner indices over time at the locality level.**

Figure 3b shows the marginal cost of credit to non-financial firms was lower than that to individuals across Brazilian regions. Marginal costs of individuals credit consistently decreased over time. They remain steady for firms until 2018 when marginal costs start rising until the end of 2019. After the COVID-19 outbreak, marginal costs of individuals and non-financial firms credit decreased, notably for non-financial firms and less developed regions (North, Northeast, and Central-West).

Figure 3c exhibits the decentralized Lerner indices for credit to individuals and to non-financial firms across Brazilian localities. Until 2019, the Lerner indices increased for individuals while they decreased for non-financial firms. The increase in decentralized market power of banks in credit to individuals suggests that, despite the decrease in effective prices, the reduction in marginal costs was dominant. Conversely, the Lerner index decrease for credit to non-financial firms indicates the increase in marginal costs prevailed over the effective price channel. Despite the Southeast and South being the most developed regions in Brazil, they have different patterns for the Lerner index: the Southeast has the highest Lerner index (because of the lowest marginal costs), and the South has one of the lowest (one of the highest marginal costs).

Part of the heterogeneity we observe in the results may arise from different shares of credit modalities in each region. To mitigate this issue, we now further drill down our results and look at the credit modality level across Brazilian regions. Figures 4 and 5 display the average effective price of each credit modality for individuals and non-financial firms, respectively, across Brazilian regions. While the effective price trend seems similar across regions, the relative effective price ordering within a credit modality changes across regions, suggesting there is no dominance of a particular region in terms of pricing. Overall, there is a decrease of effective prices in Brazil for individuals and non-financial firms, consistent with our finding at the aggregate level in Figure 1a.[31]

Effective prices of payroll-deducted credit are very similar across regions and are, on average, 10–15 p.p. lower than non-payroll-deducted credit. Both modalities have stable effective prices until December 2017, when they consistently fall. There is a higher dispersion of non-payroll-deducted across regions, with lower effective prices in the Central-West and South. Even though collateralized, vehicle financing shows increasing dispersion over time, with the lowest effective prices in the Southeast. The "other credit" modality includes overdraft operations.[32] The significant decrease in effective prices of this modality may be a combined effect of the COVID-19 outbreak and a new regulation[33] introduced in January 2020 that established a maximum cap for the interest rate in overdraft operations.

Short-term credit for non-financial firms, such as working capital and account receivables, has lower effective prices in more developed regions. These modalities have roughly the same (higher) effective price in less developed regions. Effective prices of working capital decreased substantially in 2020, reflecting the government's credit programs to mitigate the effects of the pandemic. Effective prices of agribusiness credit are the lowest in the South, a region with developed rural activities.

Figures 6 and 7 display the marginal cost of each credit modality for individuals and non-financial firms, respectively, across Brazilian regions.[34,35] Overall, marginal costs are falling in the pre-pandemic period and increasing during the pandemic for individuals. One exception is vehicle financing, whose evolution pattern is the opposite. Marginal costs for individuals are typically the lowest in the Southeast region, which is consistent with the concentration of bank headquarters in the region and potential gains of scale. Although being an economically developed region, marginal costs in the South are usually high, especially for payroll-deducted and non-payroll-deducted credit.

Marginal costs for non-financial firms are typically constant in the pre-pandemic period. During the pandemic, in most cases they increase in the first half-year of 2020 and then drop in the second

[31] The fan charts in Figure 1 are less affected by large banks than the averages we report in Figure 3. Even though they show the same finding, they offer complementary views: the results are pervasive to all banks and are not only driven by large banks.

[32] In 2019, overdraft operations accounted for 17.9% of "other credit" modality, whereas in 2020, this share was 11.7%.

[33] Resolution n. 4,765 of October 27$^{\text{th}}$, 2019, of the Central Bank of Brazil, that came into effect in January, 6$^{\text{th}}$, 2020.

[34] Shaffer and Spierdijk (2017) discuss the existence of negative marginal costs and Lerner index in estimations of the translog specification. One reason is that the translog functional form may be too restrictive, causing economically implausible marginal costs and associated Lerner indices. We face the same problem in the estimation, as we deal with many outputs at a very granular level (bank-locality). For instance, marginal costs for vehicle financing are negative in Figure 6 during 2015 and 2020 in the Central-West. Nonetheless, the shares of negative marginal costs and Lerner are not relevant.

[35] A comparison among the marginal cost levels of credit modalities in each segment suggests that they are negatively related to their average tickets.

half-year. However, marginal costs end up 2020 with higher levels compared to pre-pandemic values. Exceptions are working capital in less developed regions and investment financing in the South and Central-West. Again, marginal costs are usually the lowest in the Southeast region. The gap in marginal costs of the Southeast to the remainder regions is substantial for working capital and account receivables, modalities with the highest within-half-year credit volumes.

Figures 8 and 9 exhibit the Lerner index of each modality of credit to individuals and non-financial firms, respectively, across Brazilian regions. Generally, Lerner indices increase for most modalities of credit to individuals in the pre-pandemic period and then fall after the COVID-19 outbreak. Since both effective prices and marginal costs fall, the increase in the Lerner index indicates the marginal cost channel prevails over the effective price channel. Vehicle financing has an opposite temporal pattern. The Lerner index for rural credit changes less following the COVID-19 pandemic. Both COVID-19 and changes in the overdraft regulation may drive the decrease of the Lerner index for the "other credit" modality.

There is a mixed pattern in the evolution of the Lerner index of credit modalities to non-financial firms. For working capital and account receivables, in general, the Lerner index decreases in both pre-pandemic and during the pandemic. An exception is working capital in less developed regions. The decrease in effective prices is the primary driver of decreases in the Lerner index of these modalities. While roughly constant during the pre-pandemic period, the Lerner index of infrastructure projects falls substantially during the pandemic. The sharp increase in marginal costs drives this increase. The Lerner index of investment financing increases over time, and there is no dominance of effective prices nor marginal costs in explaining the Lerner index for this modality.

Figure 10 shows a comparison of average effective prices, marginal costs, and Lerner indices when we aggregate these measures at the state level. These results suggest competition at a national level may overlook many important local aspects of credit markets. The proposition of our methodology attempts to contribute to the literature in this direction.

6. Local Correlates of Decentralized Market Power

The previous sections provided quantitative information on the spatial distribution of average effective prices, marginal costs, and decentralized Lerner indices across localities. This section leverages this granular information to examine how local financial, geographic, and socioeconomic factors correlate with these variables. We should emphasize that our analysis here reports interesting correlations that are novel to the literature, and they should not be interpreted as causal estimates.

6.1. Association of local features and competitive measures across different locations

This section examines the correlations between local factors and average effective prices, marginal costs, and Lerner indices. Because these measures depend on unobservable characteristics of borrowers and banks, our empirical strategy examines the perspective of the same bank (within-bank) operating in different but comparable localities for the same credit modality. This approach enables us to control for unobservable broad supply factors concerning the same bank. In this case, our variation comes from heterogeneities observed across localities where the same bank operates in the same credit modality. We compare localities that are members of the same macrolocality or *intermediate geographic region*. This broader geographical unit encompasses two or more contiguous immediate geographic regions (our definition of "locality"), as defined by the Brazilian Institute of Geography and Statistics (IBGE). Localities within the same macrolocality are expected to have strong economic ties and be comparable. Consequently, this strategy alleviates concerns regarding the impact of potentially omitted variables on our estimates. As an example, the model compares how average effective prices, marginal costs, and Lerner indices differ between two localities within the same macrolocality (e.g., Campinas and Ribeirão Preto, both in the state of São Paulo) for the same bank (Banco do Brasil) in a specific credit modality (e.g., payroll-deducted credit for individuals).

We use the following econometric specification in a panel-data format:

$$y_{b,m,l,t} = \alpha_{b,m,g(l),t} + \beta^T Factor_{b,m,l,t} + \epsilon_{b,m,l,t}, \tag{5}$$

in which b, m, l, and t index bank, credit modality (listed in Table 3), localities (immediate geographic region), and time (2015 to 2020, semiannually). We employ three different dependent variables: effective prices, marginal costs, and decentralized Lerner indices, all of which pertaining to bank b in the locality l for the credit modality m during the period t. The term $\alpha_{b,m,g(l),t}$ represents crossed fixed effects of bank (b) $\times$ credit modality (m) $\times$ macrolocality ($g(l)$) $\times$ time (t), which permits us to interpret the results in terms of the *same* bank operating in *different* localities within the same *macrolocality* in a *same* credit modality. The expression $g(l)$ is a function g that takes the locality (immediate geographic region) and maps to its corresponding macrolocality (intermediate geographic region). Table 5 reports the set of local financial, geographic, and socioeconomic factors that compose the vector $Factor_{b,m,l,t}$ (marked as employed in Equation (5)). The table also presents the data source, the level of variation for each covariate and the description of each variable. The term $\epsilon_{b,m,l,t}$ is the stochastic error. Since credit operations are likely to be correlated across localities

Table 5 Financial, geographic and socioeconomic covariates used to explain the average effective prices, marginal costs and decentralized Lerner indices.

Variable	Data Source	Employed in Specs.	Description
		Variation Level: Bank-Modality-Locality-Time	
Bank Market Share	SCR	(5), (6)	Bank branch's volume of credit in a credit modality as a percentage of the sum of the volume of credit across bank branches in that locality.
Provisions/Credit	SCR	(5), (6)	Bank branch's credit provisions in the credit modality as a percentage of its total credit in that modality.
Average Maturity	SCR	(5), (6)	Bank branch's credit maturity in a specific credit modality averaged across its operations and weighted by each operation's corresponding income.
# Clients/Local Population	SCR + IBGE	(5), (6)	Bank branch's number of clients in a credit modality as a percentage of the bank locality's population.
Average Ticket	SCR	(5), (6)	Bank branch's volume of credit divided by its number of clients, all of which with respect to a credit modality.
Share of Earmarked Credit	SCR	(6)	Bank branch's volume of earmarked credit as a percentage of the total volume (earmarked + nonearmarked credit) in a specific credit modality.
Share of Other Earmarked Credit	SCR	(6)	Bank branch's volume of earmarked credit in all other credit modalities expect the one in analysis as a percentage of the total volume (earmarked + nonearmarked) of these other credit modalities.
		Variation Level: Locality-Time	
Share of Credit Union Credit	SCR	(5)	Total volume of credit originated by credit unions in a locality as a percentage of the total volume of credit originated in that locality.
Share of Earmarked Credit	SCR	(5)	Total volume of earmarked credit originated in a locality as a percentage of the total volume of credit originated in that locality.
Per Capita GDP	IBGE	(5)	Ratio of the locality's GDP and population.
Share of Public Banks	SCR + Unicad	(5)	Number of public banks that originated credit in the locality as a percentage of the total number of banks that originated credit in that locality.
Financial Development	SCR + Unicad	(5)	Volume of credit originated in a locality as a percentage of the locality's GDP.
Agriculture is Preponderant Activity	IBGE	(5)	Dummy that equals one if the locality's GDP is mostly composed of agricultural activities.
Industry is Preponderant Activity	IBGE	(5)	Dummy that equals one if the locality's GDP is mostly composed of industrial activities.
		Variation Level: Locality	
Court Congestion	CNJ	(5)	Ratio of the number of pending judicial cases (backlog) and the number of local judges.
Locality has State Capital	IBGE	(5)	Dummy that equals one if the locality contains the state capital.
		Variation Level: Bank-Time	
Public Bank	Unicad	(6)	Dummy that equals one if the bank's ownership is public.
Capitalization Level	Cosif	(6)	Ratio between the bank's net worth and total assets.
Liquidity Index	Cosif	(6)	Bank's Liquidity Coverage Ratio (LCR), as defined by Basel III.
Total Assets	Cosif	(6)	Bank's total assets.

for the same bank, we take the conservative approach and cluster errors at the (national) bank level.

Table 6 reports the coefficient estimates for Equation (5) for effective prices (Specs. I and II), marginal costs (Spec. III and IV), and Lerner indices (Spec. V and VI). Odd-numbered (even-numbered) specifications are unweighted (weighted by the average population). We provide weighted regressions to examine whether our results are driven by the majority of the small localities in Brazil or whether they are common across small and large localities (a few), such as those in which there are state capitals.

Effective prices: Increases in a bank's local market share in the volume of credit of a given modality are associated with lower effective prices than the same bank's effective prices charged in other localities within the same macrolocality. In contrast, banks with a large share of the local population as clients have higher effective prices when compared to the same bank's effective prices in localities whose *clientele* is smaller. The average maturity does not have a statistically significant relationship with the local effective price, perhaps because we are looking *within* the same credit modality across different localities for the same bank in the analysis.

Brazilian localities' demographic, socioeconomic, and financial characteristics are incredibly diverse. Even though credit unions hold a small share of the overall credit market, they play a significant role in certain regions, such as the South and certain parts of the Central-West (predominantly agricultural localities). Our results are consistent with this view: banks charge lower effective prices in localities with a more substantial presence of credit unions. Earmarked credit also plays a vital role in the Brazilian credit market.[36] Banks charge a lower effective price in localities with a higher overall share of earmarked credit compared to neighboring locations with lower percentages of earmarked credit.

Effective prices are lower in localities that are wealthier (higher GDP *per capita*), have more financial institutions, have more remarkable local financial development (volume of credit / GDP), and are state capitals (compared to nearby inland localities). On the other hand, they are lower in localities that are more populous, have agriculture as the predominant local activity (compared to service activities), and have higher court congestion, which is consistent with the view that there are hold-up costs in localities where the judiciary is less efficient, prolonging the resolution time of judicial conflicts and, therefore, increasing the losses given default. Overall, our results for effective prices do not differ between weighted and unweighted regressions, indicating that the results hold for sparsely and densely populated regions.

Marginal costs: Banks with a higher share of the local population as clients have lower marginal costs than those experienced in nearby localities where their *clientele* is smaller. These findings are in line with potential local gains of scale. Consistent with this view, banks also have a lower marginal cost in more populous localities, especially in smaller ones where the population distribution across localities is heterogeneous. Banks with higher provisions as a percentage of the volume

[36] A significant portion of the Brazilian credit market is comprised of earmarked loans, which are allocated to specific sectors or activities through legally regulated resources. For example, we cite the mandatory lending to particular sectors, such as small rural producers and low-income families financing their first homes.

Table 6 How are financial, geographic and socioeconomic factors associated with decentralized market power across localities?

Dependent variable:	Effective Price		Marginal Cost		Decentralized Lerner	
Sample:	Unweighted	Weighted	Unweighted	Weighted	Unweighted	Weighted
Model Number:	(I)	(II)	(III)	(IV)	(V)	(VI)
Bank Market Share$_{bmlt}$	-0.057^{***}	-0.048^{***}	0.002	0.006	0.016	0.014
	(0.013)	(0.011)	(0.011)	(0.012)	(0.013)	(0.016)
Provisions/Credit$_{bmlt}$	0.005	0.020	0.018^{***}	0.019^{**}	-0.004	-0.005
	(0.013)	(0.013)	(0.006)	(0.008)	(0.005)	(0.006)
Average Maturity$_{bmlt}$	0.029	0.045^{**}	-0.017	-0.015	0.012	0.097^{*}
	(0.018)	(0.021)	(0.020)	(0.032)	(0.018)	(0.052)
# Clients/Local Population$_{bmlt}$	0.026^{**}	0.034^{***}	-0.015^{***}	-0.017^{***}	0.006^{*}	0.005
	(0.010)	(0.012)	(0.004)	(0.005)	(0.003)	(0.007)
Average Ticket$_{bmlt}$	-0.007^{*}	-0.011^{*}	0.009^{**}	0.015^{***}	0.014	0.019
	(0.004)	(0.006)	(0.003)	(0.005)	(0.010)	(0.013)
Share of Credit Union Credit$_{lt}$	-0.012^{***}	-0.018^{***}	-0.008^{*}	-0.006	0.007^{**}	0.005
	(0.004)	(0.006)	(0.004)	(0.007)	(0.003)	(0.006)
Share of Earmarked Credit$_{lt}$	-0.064^{***}	-0.117^{***}	-0.010	0.007	-0.061^{**}	-0.117^{***}
	(0.009)	(0.016)	(0.012)	(0.033)	(0.026)	(0.039)
Per Capita GDP$_{lt}$	-0.012^{***}	-0.019^{***}	0.003	-0.001	-0.004	-0.006
	(0.004)	(0.006)	(0.004)	(0.005)	(0.004)	(0.006)
Population$_{lt}$	0.041^{***}	0.026^{*}	-0.028^{*}	-0.028	0.033^{***}	0.044^{**}
	(0.015)	(0.014)	(0.016)	(0.022)	(0.011)	(0.019)
Number of Financial Institutions$_{lt}$	-0.111^{***}	-0.080^{***}	0.037	0.044	-0.018	-0.033
	(0.017)	(0.014)	(0.029)	(0.033)	(0.024)	(0.031)
Share of Public Banks$_{lt}$	-0.002	-0.008^{***}	-0.001	0.003	-0.001	-0.004
	(0.002)	(0.002)	(0.002)	(0.004)	(0.003)	(0.005)
Financial Development$_{lt}$	-0.011^{**}	-0.013^{**}	0.006	0.009	0.0004	-0.0004
	(0.005)	(0.006)	(0.006)	(0.006)	(0.004)	(0.004)
Agriculture is Preponderant Activity$_{lt}$	0.023^{**}	0.031^{**}	-0.015	-0.011	-0.008	-0.003
	(0.010)	(0.013)	(0.016)	(0.018)	(0.006)	(0.010)
Industry is Preponderant Activity$_{lt}$	0.008	0.020^{***}	-0.013	-0.011	0.005	0.008
	(0.006)	(0.007)	(0.009)	(0.011)	(0.007)	(0.010)
Court Congestion$_{l}$	0.004^{**}	0.001	0.006^{*}	0.004	-0.002	-0.001
	(0.001)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)
Locality has State Capital$_{l}$	-0.053^{***}	-0.085^{***}	0.008	-0.018	-0.001	0.018
	(0.019)	(0.018)	(0.027)	(0.025)	(0.017)	(0.015)
Fixed effects						
Time · Bank · Modality · Macrolocality	Yes	Yes	Yes	Yes	Yes	Yes
Statistics						
Observations	323,212	323,212	364,020	364,020	323,212	323,212
R^2	0.923	0.962	0.658	0.923	0.703	0.929
Number of banks	94	94	94	94	94	94
Number of localities	508	508	508	508	508	508
Number of credit modalities	16	16	16	16	16	16

Note: The table shows the coefficient estimates for Equation (5) for a sample of semiannual data from 2015 to 2020 (semiannually) at the bank-modality-locality-time level. We employ three dependent variables: effective prices (Specifications I and II), marginal costs (Specifications III and IV), and Lerner indices (Specifications V and VI). Odd-numbered (even-numbered) specifications are unweighted (weighted by the locality's average population). We use the same set of covariates in all specifications, as listed in Table 5. We apply a standardization transformation to all numeric variables. All regressions have bank-credit modality-macrolocality-time fixed effects. One-way (bank) standard errors in parentheses. *, **, *** denote statistical significance of 10%, 5%, and 1%, respectively.

of credit in a specific modality also experience higher marginal costs, suggesting risk increases bank marginal costs. Average ticket price also correlates positively with marginal costs. We should expect this result because large credit operations typically require close monitoring, and the contractual process may be more complex than smaller credit operations. Banks in localities with higher court congestion also endure higher marginal costs compared to the same bank operating in other localities with lower court congestion, corroborating the negative externality of an inefficient judicial system in the financial system.

Lerner indices: An interesting property of the Lerner index is that it facilitates interpretability as changes in market power can be interpreted in terms of changes in effective prices and marginal costs. For example, banks with a large local *clientele* charge relatively higher prices and enjoy lower marginal costs. Overall, these banks exert greater market power, with both factors contributing to the increase. In contrast, banks in localities with a strong presence of credit unions charge lower effective prices and have lower marginal costs. Since we observe an increase in these banks' Lerner indices, our findings indicate that the marginal cost component (which in this case pushes upward) predominates the effective price component (downwards). Likewise, banks in regions with a less efficient judicial system charge higher effective prices and incur higher marginal costs. In net terms, banks' market power remains unchanged, indicating that the two components cancel each other out.

6.2. Association of bank features and competitive measures in the same location

The previous section analyzed how local financial, geographic, and socioeconomic factors associated with average effective prices, marginal costs, and Lerner indices for the same bank operating in different locations concerning the same credit modality. This section complements these results and investigates how these three quantities are associated with bank-specific observable features in the *same* location. In this empirical strategy, we can introduce locality fixed effects, thereby controlling for non-observable locality-specific factors, such as demand for local credit, that could drive our estimates. Thus, our variation in the model comes from *different* banks operating in the *same* location in the *same* credit modality market.

We use the following econometric specification in a panel-data format:

$$y_{b,m,l,t} = \alpha_{m,l,t} + \beta^T Factor_{b,m,l,t} + \epsilon_{b,m,l,t}, \tag{6}$$

in which b, m, l, and t index the bank, credit modality (as defined in Table 3), localities (immediate geographic region), and time (2015 to 2020, semiannually). We use the same three dependent variables from the previous section. The introduction of the credit modality $\times$ location $\times$ time fixed effect $\alpha_{m,l,t}$ allows us to interpret the results for the same local credit modality market m in the same location l for different banks. The term $\epsilon_{b,m,l,t}$ is the stochastic error. We cluster errors at the (national) bank level. We standardize all numeric variables. The vector $Factors_{b,m,l,t}$ contains the covariates listed in Table 5 for Equation (6).

Among the bank-specific variables, we include the bank's size, which is particularly important in the Brazilian context. The BCB introduced the concept of prudential segmentation at the start of our sample (2015), which establishes an increasing set of rules proportional to the size of the bank, integration with international markets, and significance to the domestic economy. These regulatory differences may affect effective prices, marginal costs, and Lerner indices. In addition, the Brazilian government introduced several credit incentive programs to combat the effects of the COVID-19 pandemic in 2020, which large banks primarily implemented. In light of these considerations, we include bank size as a covariate to control for regulatory asymmetries among banks and credit government programs.

Table 7 reports the coefficient estimates for Equation (6) using as dependent variables the effective prices (Specs. I and II), marginal costs (Specs. III and IV), and Lerner indices (Specs. V and VI) as dependent variables. Similar to the previous section, we report unweighted (odd-numbered) and population-weighted (even-numbered) regressions.

Effective prices: public banks charge lower effective prices than private banks for credit operations originating in the same locality and credit modality. This finding is statistically significant in the unweighted regressions, suggesting this pricing wedge holds mainly in the average locality in Brazil, which tends to be sparsely populated. Banks with higher capitalization levels and liquidity indices have lower effective prices, suggesting solvency and liquidity are important in credit pricing. Banks with a higher provision as a percentage of the volume of credit charge higher prices, perhaps because they lend to riskier borrowers. Banks that are larger (total assets) and have a more representative *clientele* charge higher prices in populous localities but not in the average locality. Our findings are sensitive to whether or not we employ weighted or unweighted regressions, which suggests that locality is important.

Marginal costs: banks with higher local market shares have lower marginal costs than other banks that operate in the same locality and the same credit modality market, suggesting local scale gains. This statistical correlation becomes even more pronounced in more populated areas. We find a similar result for the size of the bank branch's *clientele*. Banks with a high share of earmarked credit in a specific modality have lower marginal costs than similar banks operating in the same locality and credit modality. This result does not hold for highly-populated localities. These results are important from the policy viewpoint, as we show that subsidized credit not only reflects in lower effective prices but also in lower marginal costs. Capitalization and liquidity are expensive for banks: higher values are accompanied by higher marginal costs, particularly in inland regions.

Lerner indices: similar to the previous section, we can better understand the Lerner index dynamics by looking at the individual variations in the price and marginal costs. For instance, banks with a large share of earmarked credit have higher market power, suggesting that the decrease in marginal expenses dominates the reduction in effective prices.

Table 7 How does bank features associate with decentralized market power in the same locality?

Dependent variable:	Effective Price		Marginal Cost		Decentralized Lerner	
Sample:	Unweighted	Weighted	Unweighted	Weighted	Unweighted	Weighted
Model Number:	(I)	(II)	(III)	(IV)	(V)	(VI)
Bank Market Share$_{bmlt}$	−0.001	−0.004	-0.033**	-0.041**	0.071***	0.140***
	(0.037)	(0.049)	(0.016)	(0.014)	(0.013)	(0.016)
Provisions/Credit$_{bmlt}$	0.085***	0.037*	0.016	0.011	0.008	0.024
	(0.019)	(0.020)	(0.012)	(0.021)	(0.006)	(0.017)
Average Maturity$_{bmlt}$	−0.017	−0.135*	−0.065***	−0.107**	0.033	0.064*
	(0.052)	(0.080)	(0.024)	(0.054)	(0.030)	(0.036)
# Clients/Local Population$_{bmlt}$	0.052	0.132**	−0.032**	−0.039*	−0.011*	−0.032**
	(0.039)	(0.052)	(0.015)	(0.021)	(0.006)	(0.015)
Average Ticket$_{bmlt}$	−0.015**	−0.006**	0.001	−0.00002	0.003**	0.003**
	(0.006)	(0.003)	(0.001)	(0.001)	(0.001)	(0.001)
Share of Earmarked Credit$_{bmlt}$	−0.515***	−0.288**	−0.086***	−0.106	0.083**	0.139
	(0.152)	(0.113)	(0.020)	(0.083)	(0.035)	(0.099)
Share of Other Earmarked Credit$_{bmlt}$	−0.010	−0.063	−0.033	−0.006	0.038	−0.036
	(0.040)	(0.046)	(0.022)	(0.035)	(0.026)	(0.034)
Public Bank$_{b}$	−0.481***	−0.203	−0.008	0.054	−0.002	−0.048
	(0.092)	(0.154)	(0.030)	(0.048)	(0.038)	(0.057)
Capitalization Level$_{bt}$	−0.135***	−0.047*	0.033*	0.006	0.002	0.0002
	(0.037)	(0.026)	(0.018)	(0.029)	(0.018)	(0.030)
Liquidity Index$_{bt}$	−0.093**	0.010	0.097***	0.057	−0.116***	−0.067
	(0.047)	(0.017)	(0.026)	(0.043)	(0.034)	(0.066)
Total Assets$_{bt}$	−0.005	0.090**	−0.003	−0.001	−0.020	0.016
	(0.040)	(0.037)	(0.018)	(0.030)	(0.018)	(0.027)
Fixed effects						
Time · Modality · Locality	Yes	Yes	Yes	Yes	Yes	Yes
Statistics						
Observations	323,184	323,184	363,986	363,986	323,184	323,184
R^2	0.739	0.607	0.254	0.137	0.293	0.171
Number of banks	94	94	94	94	94	94
Number of localities	508	508	508	508	508	508
Number of credit modalities	16	16	16	16	16	16

Note: The table shows the coefficient estimates for Equation (6) for a sample of semiannual data from 2015 to 2020 (semiannually) at the bank-modality-locality-time level. We employ three dependent variables: effective prices (Specifications I and II), marginal costs (Specifications III and IV), and Lerner indices (Specifications V and VI). Odd-numbered (even-numbered) specifications are unweighted (weighted by the locality's average population). We use the same set of covariates in all specifications, as listed in Table 5. We apply a standardization transformation to all numeric variables. All regressions have credit modality-locality-time fixed effects. One-way (bank) standard errors in parentheses. *, **, *** denote statistical significance of 10%, 5%, and 1%, respectively. One-way (bank) standard errors in parentheses. *, **, *** denote statistical significance of 10%, 5%, and 1%, respectively.

7. Conclusions

This paper provides a novel methodology to estimate a decentralized version of the Lerner index. The approach enables us to measure how market power behaves for each bank operating in each locality and for each credit modality. The usual bank-level Lerner index reported in the literature is a particular case of the decentralized version of our Lerner index when we consider that banks have a single branch. One of the main empirical challenges in estimating decentralized market power is the lack of data on local inputs and products of bank branches. We overcome this limitation by developing heuristics that reallocate national-level bank resources across local inputs and outputs for each of its branches using several proprietary and public data sources. We apply our methodology to the Brazilian case and provide empirical evidence that examining market power at the aggregate level may overlook important aspects of credit markets. Our results highlight that the decentralized market power in Brazil is significantly diverse across localities and credit modalities, even for the same bank. Conceptually, the aggregation problem becomes more significant for countries with continental dimensions, such as Brazil.

Despite being data-intensive, estimating market power and competition at more fine-grained levels has several advantages. First, it permits us to understand potential competitive relationships among credit modalities, localities, and banks. Second, it enables us to identify apparently similar localities but with substantially different levels of local competition. We contribute to this stream of research by providing econometric analyses to examine how local variables are associated with the decentralized Lerner index and its components: the effective price and the marginal cost. We find that local socioeconomic, demographic, and financial conditions help explain the diversity of decentralized market power profiles in Brazil. Understanding these relationships can support policies that promote competition in regional credit markets.

Acknowledgments

The views expressed in this paper are those of the authors and do not necessarily reflect those of the Central Bank of Brazil. We thank Julián Caballero, Dimas Fazio, Raquel de Freitas Oliveira, Vasso Ioannidou, Fábio Kanczuk, Césaire Meh, André Minella, João Manoel Pinho de Mello, Alexandre Tombini, and the participants at the XI BIS Consultative Council for the Americas Research Conference ”The Economics of the COVID-19 Pandemic”, at the Central Bank of Brazil's Research Network Workshop (2021) and an anonymous referee that participated in the Central Bank of Brazil's Working Papers Series submission process for their many valuable comments and suggestions. Thiago C. Silva (Grant no. 308171/2019-5) and Benjamin M. Tabak (Grant no. 310541/2018-2, 425123/2018-9) gratefully acknowledge financial support from the CNPq foundation.

References

Alyakoob M, Rahman MS, Wei Z (2021) Where you live matters: Local bank competition, online marketplace lending, and disparity in borrower benefits. *Information Systems Research* 32(4):1390–1411.

Baumol WJ, Panzar JC, Willig P (1982) *Contestable Markets and the Theory of Industry Structure* (Harcourt Brace Jovanovich).

Beck T, De Jonghe O, Schepens G (2013) Bank competition and stability: cross-country heterogeneity. *Journal of Financial Intermediation* 22(2):218–244.

Berger A, Klapper L, Turk-Ariss R (2009) Bank competition and financial stability. *Journal of Financial Services Research* 35(2):99–118.

Bernheim BD, Whinston MD (1990) Multimarket contact and collusive behavior. *RAND Journal of Economics* 1–26.

Blair R, Sokol D (2014) *Oxford Handbook of International Antitrust Economics*, volume 1 (USA: Oxford University Press).

Boone J (2008) A new way to measure competition. *Economic Journal* 118(531):1245–1261.

Bresnaham TF (1982) The oligopoly solution concept is identified. *Economic Letters* 10:87–92.

Claessens S, Laeven L (2004) What drives bank competition? Some international evidence. *Journal of Money, Credit and Banking* 36(3):563–583.

Coccorese P (2008) Bank competition and regional differences. *Economics Letters* 101(1):13–16.

Coccorese P, Girardone C, Shaffer S (2021) What affects bank market power in the Euro area? A structural model approach. *Journal of International Money and Finance* 117:102443.

Cruz-García P, Fernández de Guevara J, Maudos J (2021) Bank competition and multimarket contact intensity. *Journal of International Money and Finance* 113:102338.

Cruz-García P, Fernández de Guevara JF, Maudos J (2018) Banking concentration and competition in Spain: the impact of the crisis and restructuring. *Financial Stability Review. Issue 34, p. 57-76* .

Das A, Kumbhakar SC (2016) Markup and efficiency of Indian banks: an input distance function approach. *Empirical Economics* 51:1689–1719.

De-Ramon S, Francis W, Straughan M (2018) Bank competition and stability in the United Kingdom. *Working Paper n. 748, Bank of England* .

Degl'Innocenti M, Mishra T, Wolfe S (2018) Branching, lending and competition in Italian banking. *European Journal of Finance* 24(3):208–230.

Degryse H, Morales Acevedo A, Ongena S (2018) *Competition in Banking* (Oxford, GB: Oxford University Press), 2 edition.

Degryse H, Ongena S (2005) Distance, lending relationships, and competition. *Journal of Finance* 60(1):231–266.

Demirgüç-Kunt A, Martínez Pería MS (2010) A framework for analyzing competition in the banking sector: an application to the case of Jordan. World Bank Policy Research Working Paper n. 5499, World Bank.

Erler A, Gischer H, Herz B (2017) Regional competition in US banking: trends and determinants. *Working Paper n. 8, Faculty of Economics and Management Magdeburg* .

Fungácová Z, Shamshur A, Weill L (2017) Does bank competition reduce cost of credit? Cross-country evidence from Europe. *Journal of Banking and Finance* 83:104–120.

Girotti M, Salvadè F (2022) Competition and agency problems within banks: Evidence from insider lending. *Management Science* 68(5):3791–3812.

Hakenes H, Hasan I, Molyneux P, Xie R (2014) Small banks and local economic development. *Review of Finance* 19(2):653–683.

Joaquim G, Doornik BV, Ornelas JR (2019) Bank competition, cost of credit and economic activity: evidence from Brazil. Technical report, Working Paper n. 2019/508, Banco Central do Brasil.

Kick T, Prieto E (2014) Bank risk and competition: evidence from regional banking markets. *Review of Finance* 19(3):1185–1222.

Lau LJ (1982) Identifying the degree of competitiveness from industry price and output data. *Economic Letters* 10:93–99.

Lerner A (1934) The concept of monopoly and the measurement of monopoly power. *Review of Economic Studies* 1:157–175.

Loecker JD, Eeckhout J, Unger G (2020) The rise of market power and the macroeconomic implications. *The Quarterly Journal of Economics* 135(2):329–357.

Panzar J, Rosse JN (1987) Testing for monopoly equilibrium. *Journal of Industrial Economics* 35(4):443–456.

Peltzman S (1977) The gains and losses from industrial concentration. *Journal of Law and Economics* 20(2):229–263.

Shaffer S (2004) Patterns of competition in banking. *Journal of Economics and Business* 56(4):287–313, research Perspectives Special Issue.

Shaffer S, Spierdijk L (2017) Market power: competition across measures. Bikker JA, Spierdijk L, eds., *Handbook of Competition in Banking and Finance*, 11–26 (Cheltenham - UK: Edward Elgar).

Shaffer S, Spierdijk L (2020) Measuring multi-product banks' market power using the Lerner index. *Journal of Banking and Finance* 117:105859.

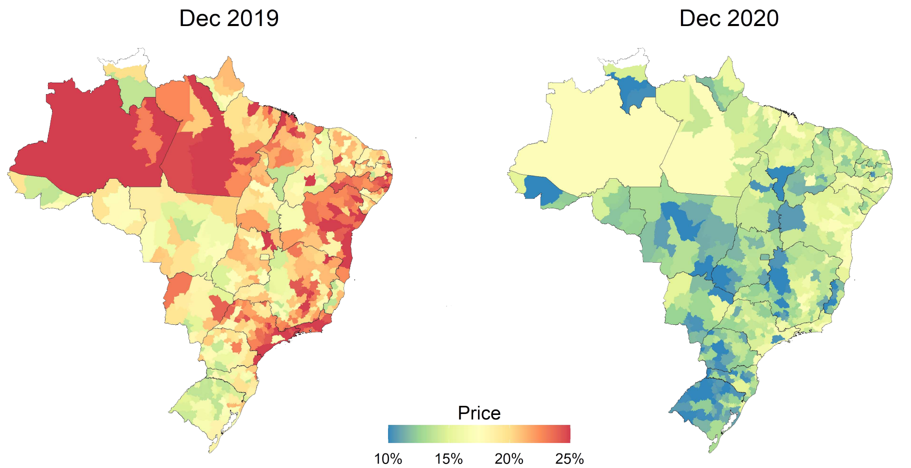
Stomper A (2006) A theory of banks' industry expertise, market power, and credit risk. *Management Science* 52(10):1618–1633.

Tan B, Martinez Peria MS, Pierri N, Presbitero AF (2020) Government intervention and bank market power: lessons from the Global Financial Crisis for the COVID-19 Crisis. Technical report, Working Paper n. 2020/275, International Monetary Fund.

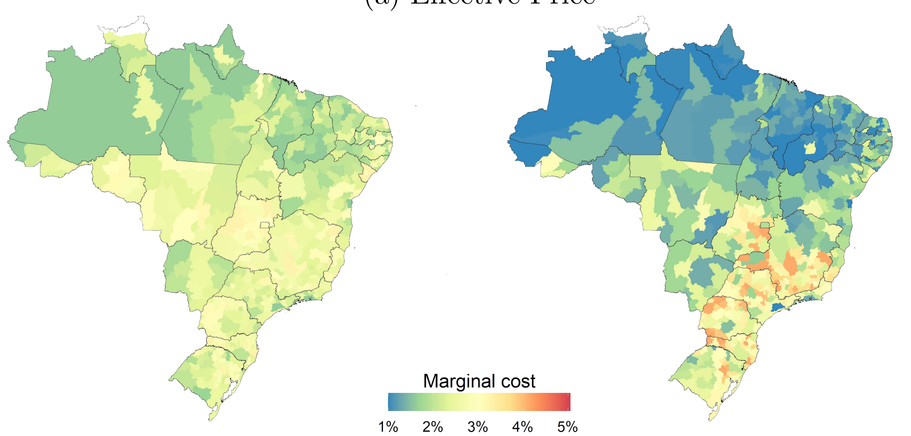
Wang X, Han L, Huang X (2020) Bank market power and SME finance: firm-bank evidence from European countries. *Journal of International Financial Markets, Institutions and Money* 64:101162.

Whited TM, Wu Y, Xiao K (2021) Low interest rates and risk incentives for banks with market power. *Journal of Monetary Economics* 121:155–174.

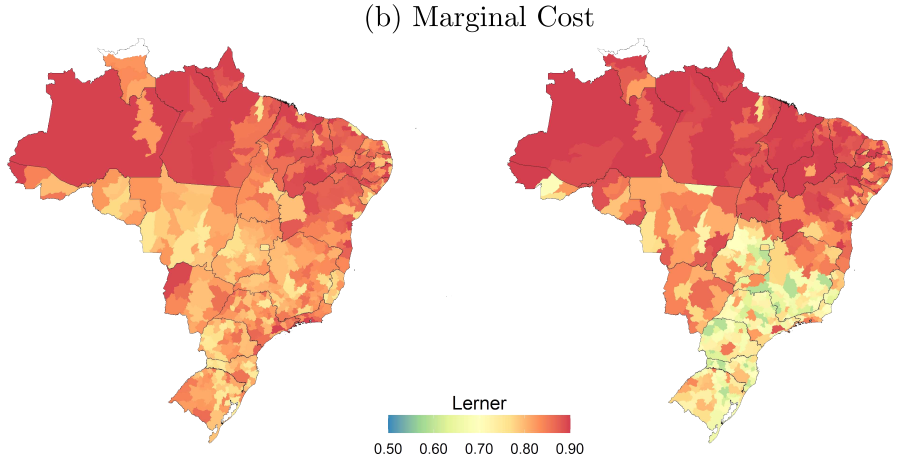
Zhang G (2021) Competition and opacity in the financial system. *Management Science* 67(3):1895–1913.



(a) Effective Price

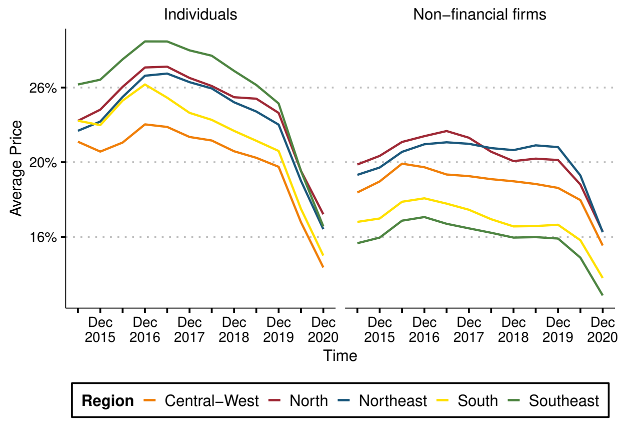


(b) Marginal Cost

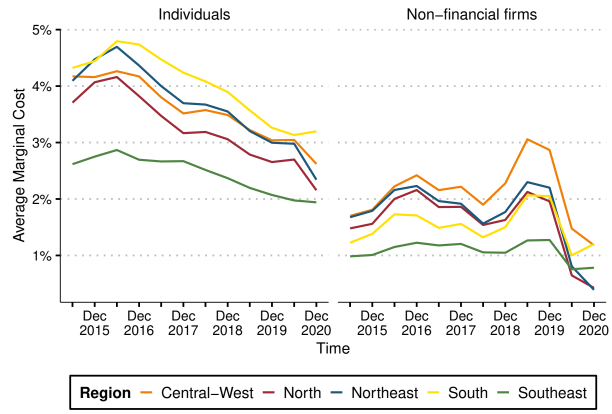


(c) Lerner

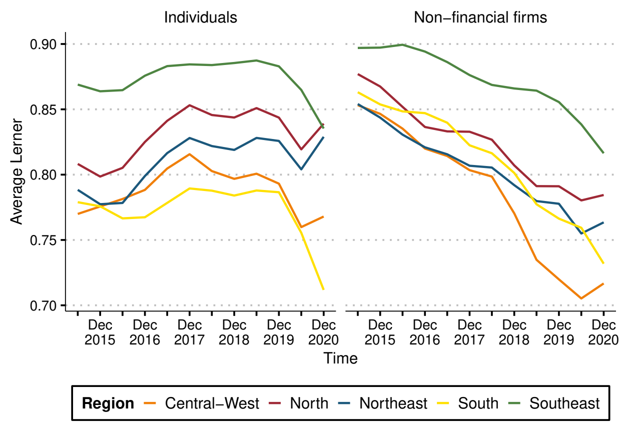
Figure 2 **Spatial distribution of the average effective prices, marginal costs, and Lerner indices across each of the Brazilian localities. We aggregate bank-modality observations within the same locality, including modalities for individuals and non-financial firms. We compare the pre-pandemic (left panel) and pandemic (right panel) periods.**



(a) Effective Price



(b) Marginal Cost



(c) Lerner

Figure 3 **Evolution of effective prices, marginal costs and Lerner indices aggregated by region and segment (individuals and non-financial firms).**

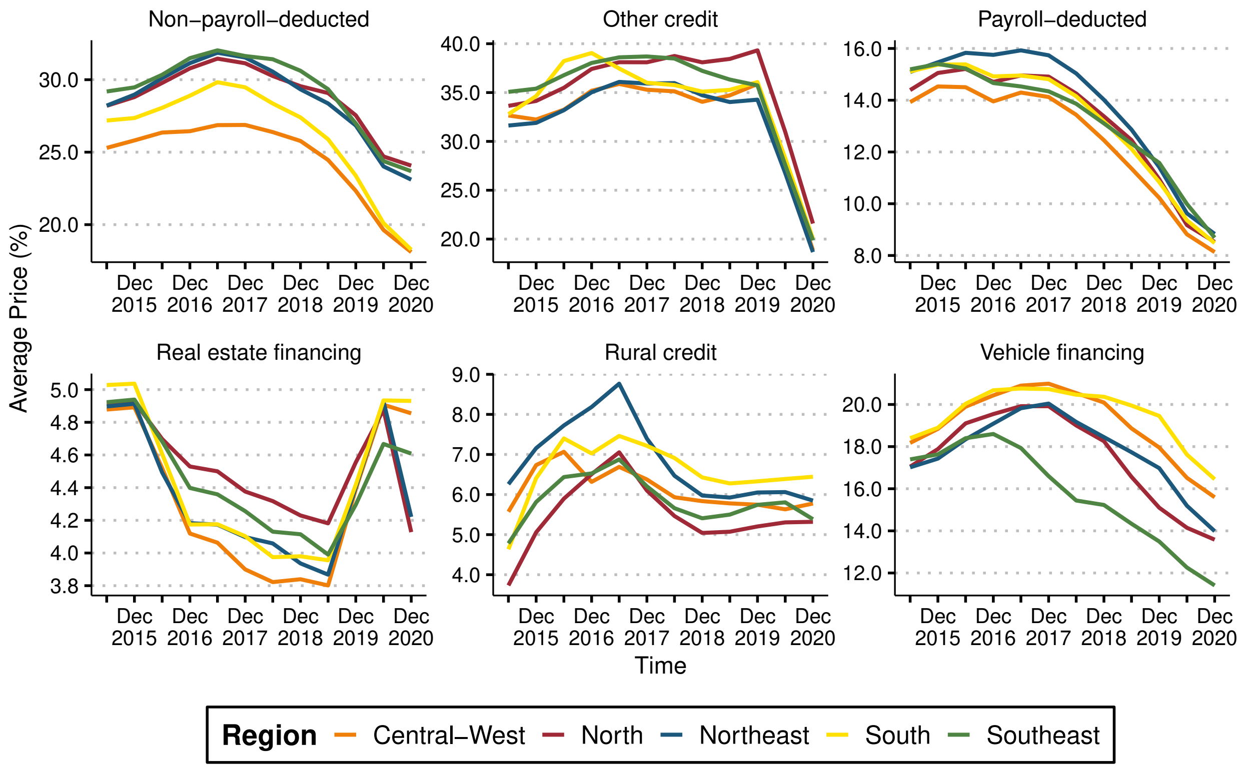


Figure 4 **Evolution of the average effective price of each credit modality for individuals aggregated to the regional level from 2015 to 2020.**

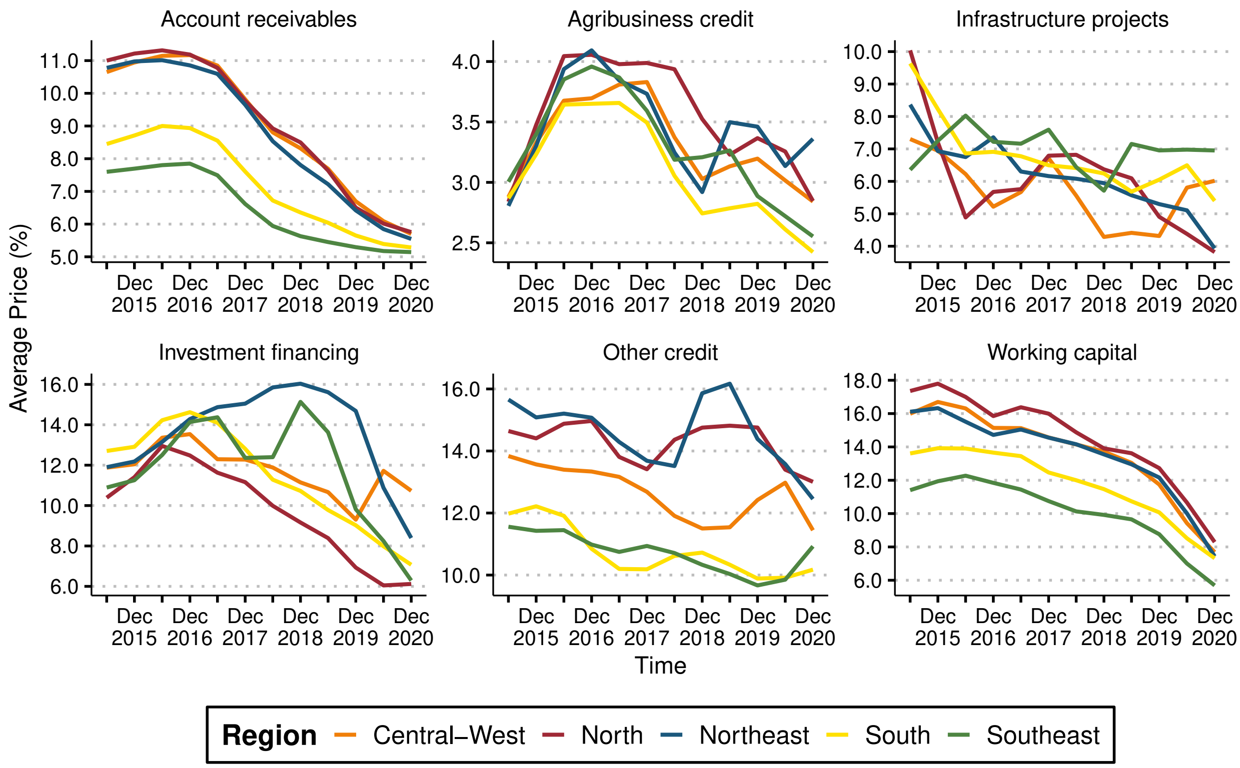


Figure 5 **Evolution of the average effective price of each credit modality for non-financial firms aggregated to the regional level from 2015 to 2020.**

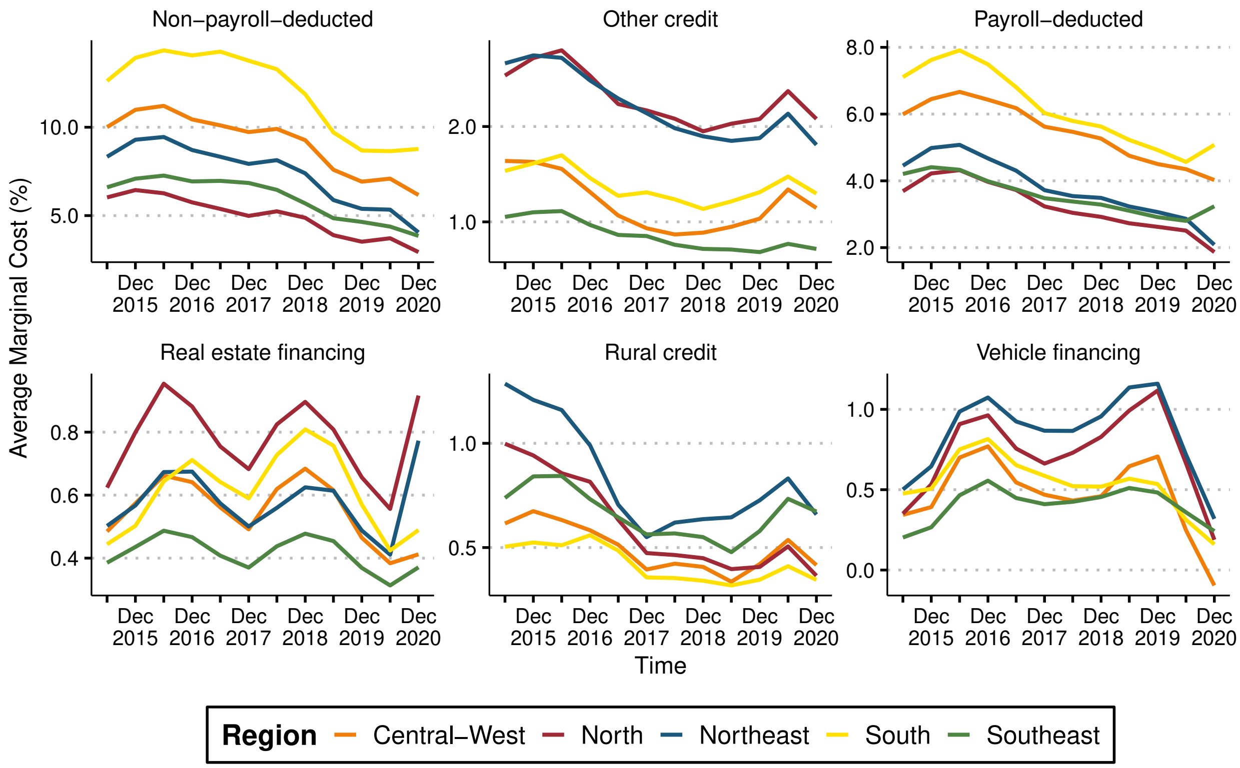


Figure 6 **Evolution of the marginal cost of each credit modality for individuals aggregated to the regional level from 2015 to 2020.**

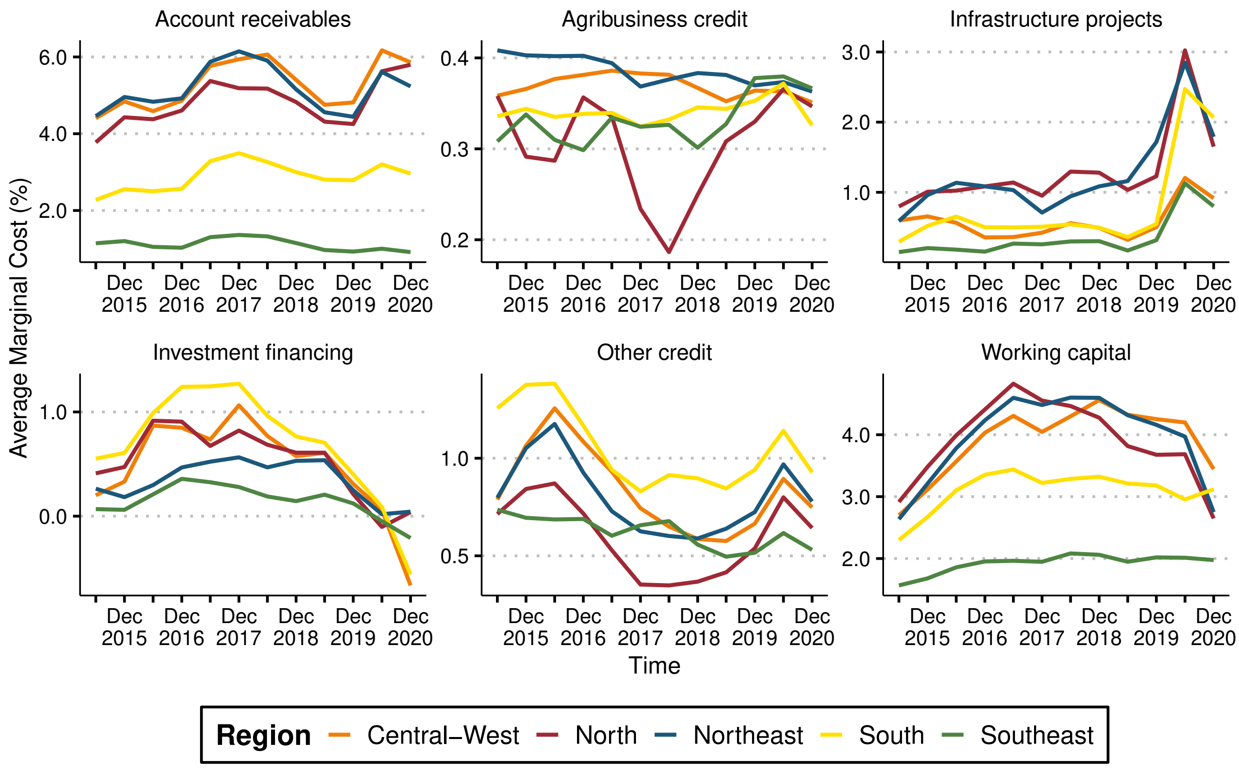


Figure 7 **Evolution of the marginal cost of each credit modality for non-financial firms aggregated to the regional level from 2015 to 2020.**

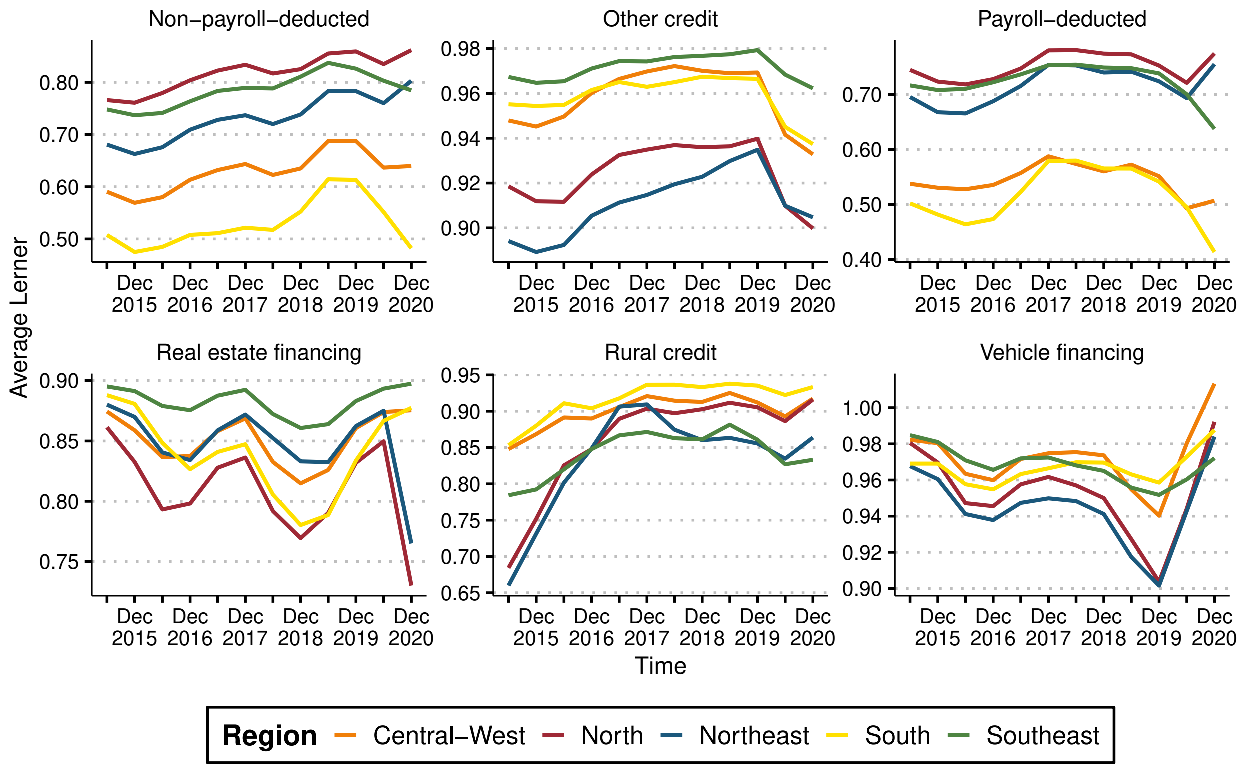


Figure 8 **Evolution of the Lerner index cost of each credit modality for individuals aggregated to the regional level from 2015 to 2020.**

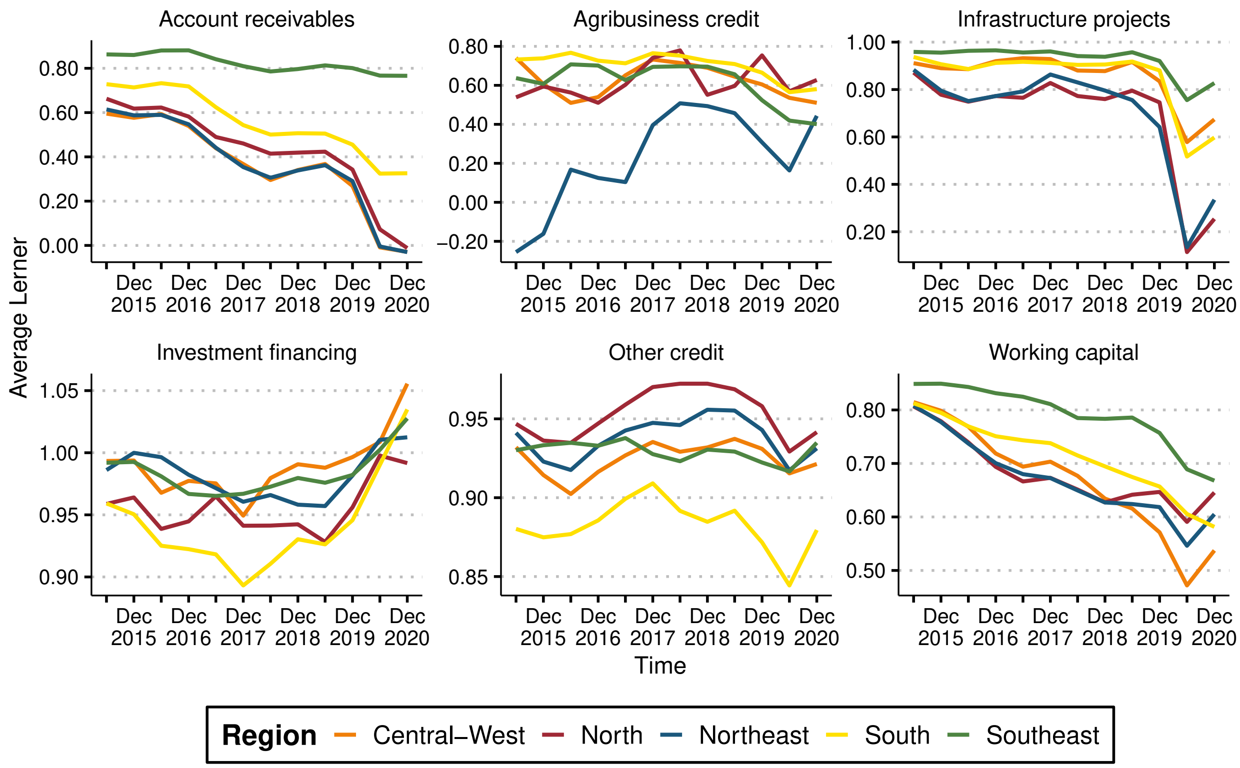
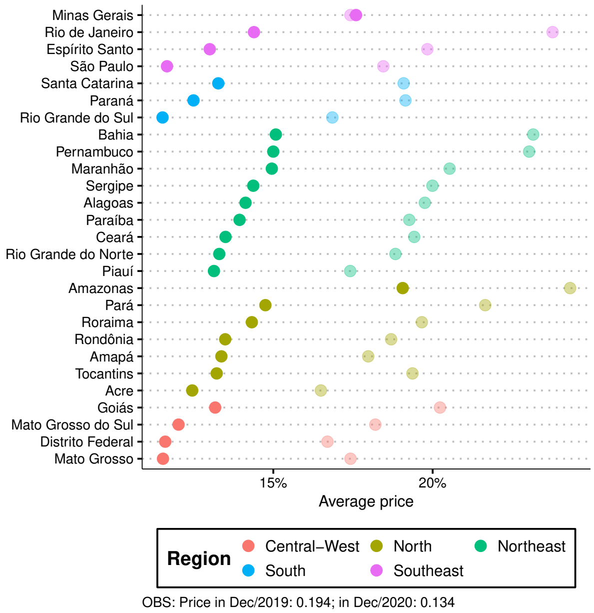
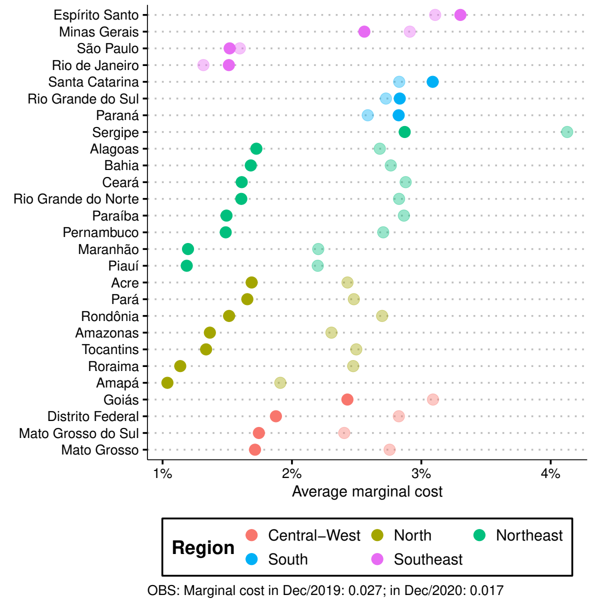


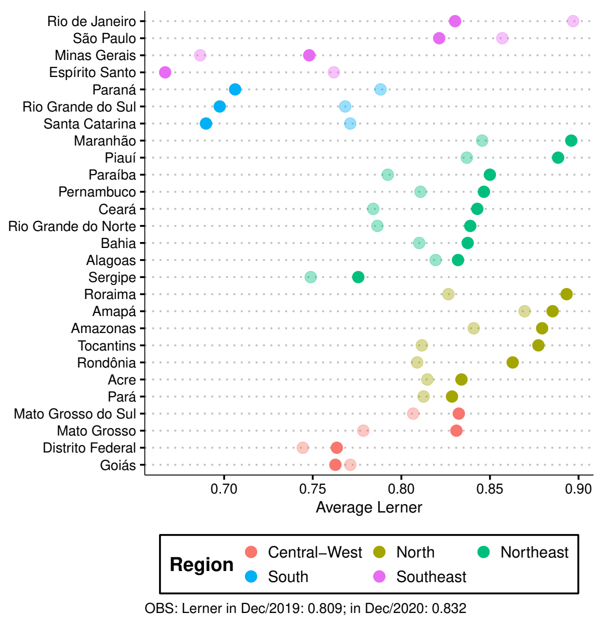
Figure 9 **Evolution of the Lerner index cost of each credit modality for non-financial firms aggregated to the regional level from 2015 to 2020.**



(a) Effective Price



(b) Marginal Cost



(c) Lerner

Figure 10 **Average effective prices, marginal costs, and Lerner indices for Brazilian states in the pre-pandemic (December 2019, more transparent disks) and during the pandemic (December 2020, more opaque disks). We aggregate bank-modality-locality observations within the same state.**

Appendix A Data and overview of bank credit markets

A large amount of data is required to estimate market power in a decentralized way. This appendix initially provides details on data processing: sources, extraction strategies, treatment procedures. Then, using these data, we bring an overview of bank credit markets that contextualize our results of market power across Brazilian localities.

A.1 Data treatment

We collect data from January 2015 to December 2020. We compile and transform them into semiannual variables, as of June and December of each year. We perform the following data treatments:

• SCR. We use SCR data to compute credit product quantities $Q_{blt}^{(m)}$ and effective prices $p_{blt}^{(m)}$ of bank b for the credit modality m in the locality l during the semiannual period t. Our methodology computes effective prices of credit modalities in each period from credit income and outstanding credit immediately before lenders receive repayments, requiring information for all open loan operations in these periods. In this paper, we have processed 10.8 billion records of outstanding positions of individual credit operations. We then group these credit operations by semiannual period, bank, locality of the *bank branch that granted the credit* (according to bank branch's ZIP code), credit modality, and an indicator of the credit grant having occurred within the half-year under analysis or before it. For each of these groups, we compute semiannual outstanding amounts (product quantities) and effective prices from the available monthly information. For product quantities, we consider the average of the monthly amounts. For effective prices, we use Equation (4).

• Cosif. We use information of monthly banks' consolidated financial statements and supervisory variables to compute input prices and total bank local costs, according to Table 1 in Section 4.2. We then take the semiannual average of balance sheet variables and the sum of the expenses variables within the half-year to compute the costs. All of this information is available at the bank level.

• ESTBAN. This database contains monthly records of summarized balance-sheet information at the bank-municipality level. Similar to what we do for the Cosif database, we rebase this information to a semiannual basis. After this, we aggregate geographically this municipality-level information to the corresponding bank-locality level using the IBGE Geographic database. Finally, we use bank-locality ratios of the local ESTBAN variable to the country-level aggregate ESTBAN amount to apportion the bank-level Cosif variables. We use this strategy because, most of times, accounting aggregates extracted from the ESTBAN database are not the same as those from Cosif.

• IBGE Geographic data. This database has information on geographic units of the Brazilian territory. It serves to map municipalities into their respective Immediate Geographical Region (our unit of locality in this work), a more appropriate unit of analysis for analyzing competition locally.

- RAIS and Caged. These datasets have monthly employment relationships for all bank branches in Brazil. Similar to the previous transformations, we re-base this information on a semiannual basis. We sum the bank's payroll and average the number of employees within the half-year.[37] We also aggregate this information to the bank-locality level.

A.2 Overview of bank credit markets

This section shows an overview of the bank credit market from 2015 to 2020, exploring the bank production function variables used in our translog model (Equation (2)). We intend to provide information on the relative relevance of each input and output, with a particular focus on credit modalities.

Our data encompasses commercial and universal banks operating in Brazil, including private (35 in December 2020), state-owned (9), and foreign banks (30). In December 2020, they corresponded to roughly 83% of the overall credit market (banking and non-banking credit). Table A1 reports the number of banks with positive outstanding credit in Brazil and in each region. Despite the slight decrease in the number of banks, large banks are equally present in all regions throughout the sample period. Smaller banks concentrate in the Southeast, the most developed region in Brazil.

Although we focus on credit products in this paper, the production function has to include all banking products: credit (within and before the half-year), bonds and securities, and operations with other assets. Figure A1 displays the evolution of semiannual outstanding averages for these products. Bonds and securities have roughly the same volume as the aggregation of all credit products. Stocks of operations with other assets are relatively negligible. Within-half-year granted credit corresponds to 15 to 20% of the overall credit stock. The large volume of operations before the current half-year highlights the importance of focusing on most recent operations—those within the half-year—to better capture the current conditions and more reliably estimate market power in a decentralized way.

We focus on within-half-year credit products, thus we now describe the relative importance of within-half-year credit modalities. Figures A2 and A3 exhibit the within-half-year credit volume by credit modality for individuals and non-financial firms, respectively. The within-half-year credit volume for individuals has increased for all modalities since 2017 at the country level. Payroll-deducted credit has the highest outstanding position in all regions, except in the Central-West, where prevails rural credit. The within-half-year credit volume for non-financial firms had a steep increase in 2020, probably due to the effects of the COVID-19 pandemic. Working capital and account receivables are the modalities with the highest within-half-year outstanding volumes.

[37] We take the average of the bank branch's number of employees considering the number of months for which there are data within the half-year. The Kendall correlation between the average number of employees and the outstanding bank credit of the entire sample is 0.68. This correlation is sensitive to the region: 0.55 (North), 0.70 (Northeast), Central-West (0.62), Southeast (0.70), and South (0.69). Therefore, there is not a trivial relationship between the amount of outstanding credit and the number of local employees in bank branches.

Table A1 **Number of banks with positive outstanding credit in the whole country and in each region from 2015 to 2020. The same bank may appear more than once when it operates in more than a single region.**

Size	2015	2016	2017	2018	2019	2020
Country	*79*	*78*	*78*	*76*	*75*	*74*
Large	6	5	5	5	5	5
Medium-sized	6	6	6	6	5	5
Small	28	27	29	30	30	29
Micro	39	40	38	35	35	35
Central-West	*20*	*20*	*19*	*19*	*18*	*16*
Large	6	5	5	5	5	5
Medium-sized	4	4	4	4	3	2
Small	7	8	7	7	7	7
Micro	3	3	3	3	3	2
North	*12*	*11*	*11*	*11*	*10*	*10*
Large	6	5	5	5	5	5
Medium-sized	1	1	1	1	0	0
Small	4	4	4	4	4	4
Micro	1	1	1	1	1	1
Northeast	*20*	*19*	*19*	*18*	*17*	*16*
Large	6	5	5	5	5	5
Medium-sized	5	5	5	4	3	2
Small	6	6	6	6	6	6
Micro	3	3	3	3	3	3
South	*26*	*25*	*24*	*23*	*20*	*21*
Large	6	5	5	5	5	5
Medium-sized	5	5	5	5	4	4
Small	7	8	7	6	5	7
Micro	8	7	7	7	6	5
Southeast	*69*	*69*	*70*	*69*	*68*	*67*
Large	6	5	5	5	5	5
Medium-sized	6	6	6	6	5	5
Small	25	24	27	28	28	27
Micro	32	34	32	30	30	30

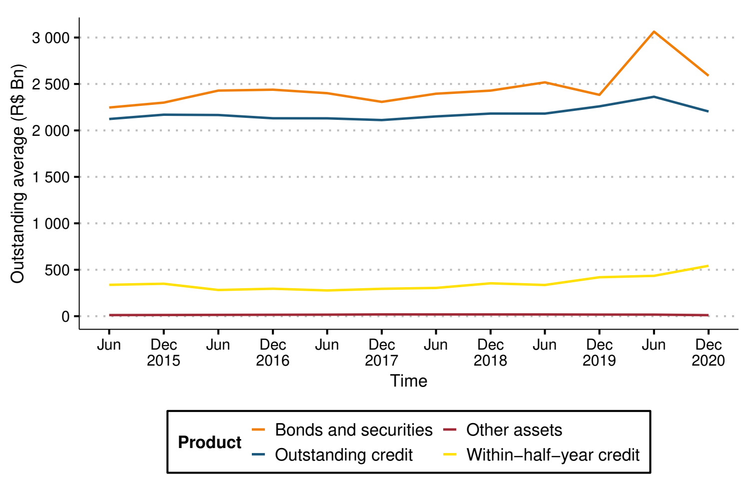


Figure A1 **Evolution of the volume of (country-level) bank products: outstanding credit (total and within-half-year), bonds and securities, and other assets.**

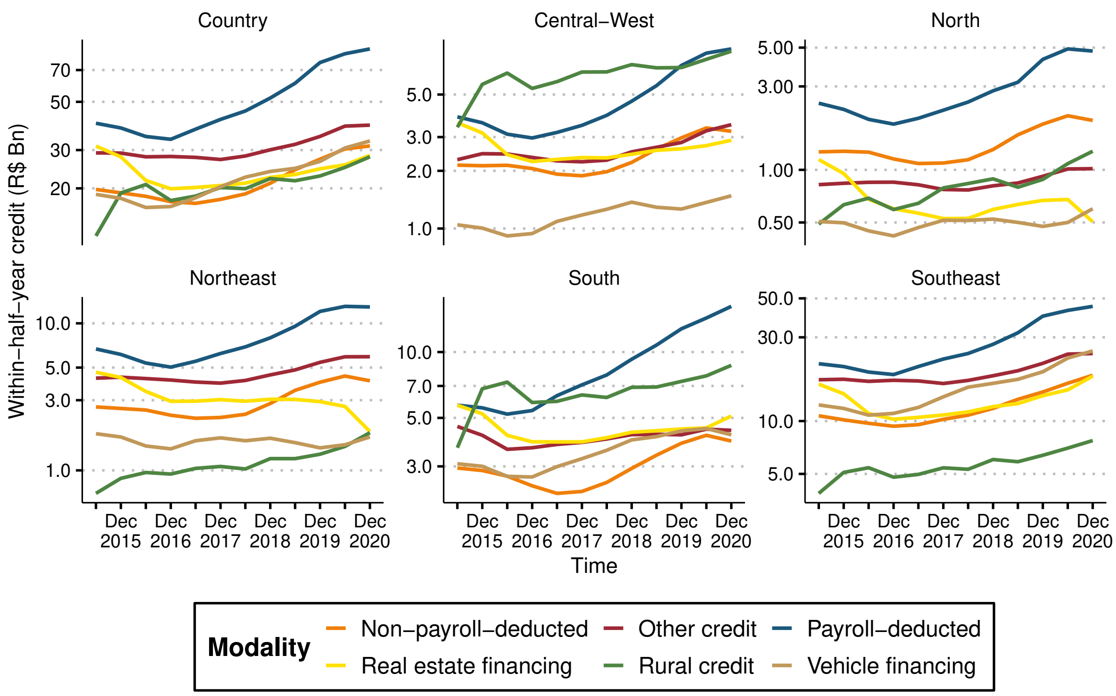


Figure A2 **Outstanding position of within-half-year credit granted in each region for credit modalities for individuals. Vertical axes are in log-scale.**

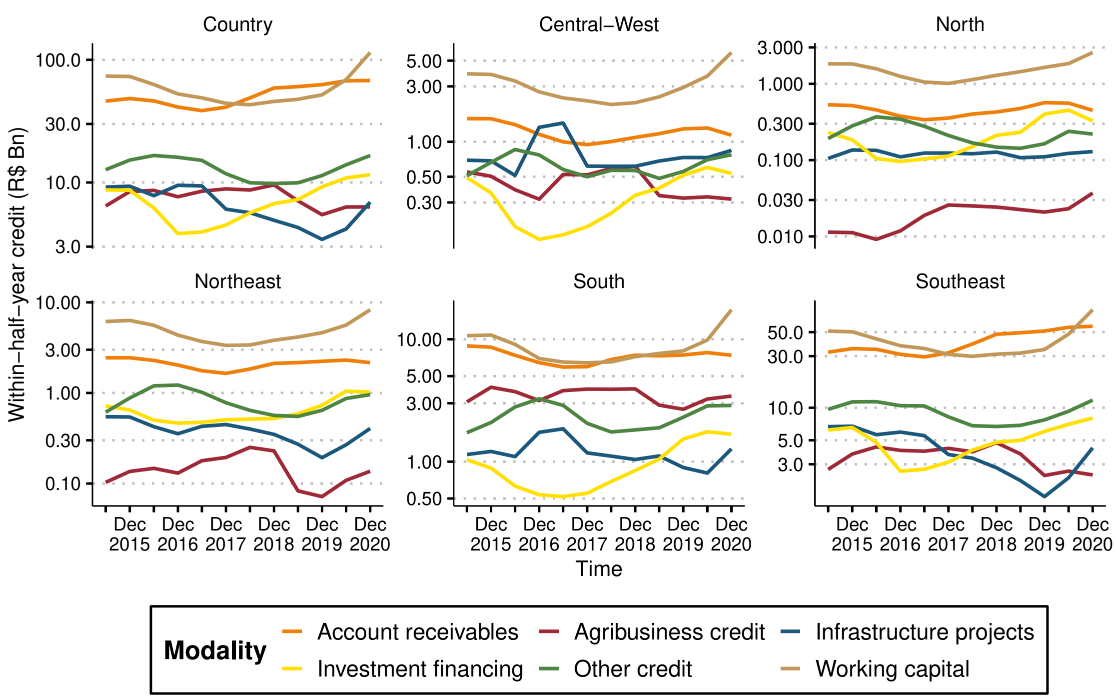


Figure A3 **Outstanding position of within-half-year credit granted in each region for credit modalities for non-financial firms. Vertical axes are in log-scale.**