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Local Market Structure and Bank Competition: evidence from the Brazilian auto loan market

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Local Market Structure and Bank Competition:

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Abstract:

Asymmetric information and transportation costs incurred by borrowers may raise spatial price discrimination in bank lending. This paper exploits the large geographic dispersion in the market structure of the Brazilian banking sector to investigate the relationship between market concentration and bank competition. Local markets are also distinguished by the degree of barrier to entry in order to assess its effect on bank competitive behavior. The findings indicate a negative correlation between market concentration and bank competition and an even stronger effect in locations where the barriers to entry are higher. The paper also highlights the importance of evaluating the geographic impact of mergers and acquisitions for the analysis of the effect of market concentration on bank competition.

1. Introduction

The collapse of the global financial system in 2008 and the resulting process of bank consolidation have drawn attention to the costs and benefits of a more concentrated financial market. The current debate focuses on the relation between bank competition and financial stability[1]. However, the discussion has been inattentive to the impact of a more concentrated banking system on the market power of banks and, consequently, on the costs of financial intermediation in the future.

Recent technological and regulatory advances, such as the emergence of alternative funding sources and financial deregulation, are reducing information asymmetries and switching costs between borrowers, depositors and financial institutions and also have decreased the barriers to entry in the financial market. Hence, the effect of financial consolidation on the market power of banks has not attracted great attention among policymakers. Regulatory aspects, entry barriers and the performance of government-controlled banks have been treated as the most important issues in this respect. However, the emergence of huge financial conglomerates may reduce the degree of competition as the economies of scale and scope and the perception of depository safety by creditors create competitive advantages that work as a strong barrier to entry in the financial market.

The increasing availability of micro-data has allowed empirical studies regarding price discrimination among similar markets. Financial institutions operating in different locations, for example, may charge different interest rates in each area because of the existence of asymmetric information between lenders and borrowers and the fact the transportation costs incurred by borrowers and the monitoring costs incurred by lenders are distance related (Degryse and Ongena 2005). Further, due to economies of scale and scope,

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[1] When confronted with increased competition, banks rationally choose more risky portfolios (Padoa-Schioppa, 2001). Besides this, when banks earn monopoly rents, they become relatively conservative because bankruptcy would cause the loss of a valuable charter (charter value literature). On the other hand, there is a large literature arguing that banks become more risky as markets become more concentrated. The argument is that banks earn more rents in their loan markets by charging higher loan rates as competition declines, attracting riskier borrowers (Boyd and De Nicoló, 2005). Additionally, higher bank concentration might generate moral hazard by the perception of an implicit public guarantee in case of bankruptcy (too big to fail argument).

smaller markets are usually more concentrated, opening up opportunities for empirical investigation of price discrimination in the credit market.

This paper investigates the relation between market concentration and bank competition, assuming that financial institutions compete for local markets[2]. So, the definition of market is not related only to the type of loan but also to the geographic location of borrowers. Since the Brazilian banking sector is characterized by a large dispersion in the market structure among different locations, the assumption of local competition allows the investigation of price discrimination in the Brazilian credit market and so the empirical identification of correlation between market concentration and bank competition. Additionally, local markets are differentiated by their degree of barrier to entry in order to recognize its importance during the analyses of the effect of market concentration on bank competition.

In line with the international evidence, the findings show a negative relation between local concentration and bank competition in Brazil, where banks use their market power to charge higher interest rates in more concentrated areas. Additionally, the relation is even stronger in markets where the entry barriers are higher, proving the importance of such barriers for the competitive climate in the credit market. The results suggests that, at least for the auto loan market, part of the cost of loans observed in Brazil comes from the market power of banks and their awareness of the possible increase in the cost of financial intermediation due to the current conjuncture of global financial consolidation. The paper also highlights the importance of the geographical dimension in the process of analysis of mergers and acquisitions in the banking industry.

The remainder of the paper is organized as follows. Section 2 reviews the empirical literature related to the link market structure and bank competition, section 3 presents the structure of the Brazilian banking sector, section 4 brings the database used, section 5 outlines the empirical strategy and the results and section 6 concludes.

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[2] There is empirical evidence suggesting that competition for the retail credit market is delimited by a relatively small geographic area. In this sense, interest rates charged on loans and paid to depositors would be set according to local conditions. Radecki (1998) shows that local markets have been absorbed into larger arenas of competition.

2. Literature Review

Following the Industrial Organization literature, several studies have tried to identify the degree of competition in the banking industry. Theory suggests that competition must be inferred directly from the markup of prices over marginal cost. However, the complexities of banks, among them the mismatch of maturities between assets and liabilities and the forward looking aspect of the return and risk exposure, make it hard to adopt this simple measure of competition. Therefore, different methods have been applied in order to assess the level of competition of the banking sector.

Some concentration measures, such as the Herfindahl-Hirschman Index (HHI) and the sum of market shares of the *n* largest banks (CR- n), are frequently proposed as indirect indicators of competition. Such indicators are relevant since high concentration is usually associated with non-competitive practices, or the formation of collusion among market participants. The traditional approach of Structure-Conduct-Performance (SCP) is based on this hypothesis. The idea is that higher concentration of the banking industry increases banks' profitability, as banks make use of their market power by charging (paying) higher (lower) interest rates in credit agreements (on deposits). An alternative explanation to the positive relation between bank concentration and profitability is that market concentration is driven by bank efficiency. So, as more efficient banks will gain market share, assessing competition by the simple link between concentration and bank performance can lead to incorrect conclusions[3].

Following the SCP's approach, many studies have measured the market power of banks (conduct) using the correlation between market concentration (structure) and the profitability (performance) of banks. The evidence points to a positive correlation between bank concentration and market power. Sapienza (2002), Corvoisier and Groop (2002) and Degryse and Ongena (2005) find a positive relation between concentration and lending rates, and Corvoisier and Groop (2002), Hannan and Prager (2004) and Heitfield and

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[3] The correlation between market structure and profitability has been replaced by the link between market structure and interest rate. Besides this, some measures of efficiency, such as the banks' market share, have been incorporated in the models' specification in order to control for bank efficiency.

Prager (2004) show a negative correlation between bank concentration and interest rate paid to depositors.

Moreover, since the distance between lenders and borrowers can determine the pricing of loans (Petersen and Rajan 2002) and the transportation costs incurred by borrowers may be fixed per loan, spatial pricing, at least in the retail credit market, makes location an additional driver. Berger and Hannan (1989), Calem and Carlino (1991) and Hannan (1997) find a negative correlation between bank concentration, measure by a local HHI, and the interest rate paid to depositors, indicating that market concentration may be a good indirect measure of market power and giving support to the assumption that banks compete for local markets.

In contrast, some studies have treated the market structure as endogenous. That is, the market structure not only affects the competition but may also be determined by it. Barriers to entry and regulatory aspects, such as the forbiddance of foreign banks and the existence of government-controlled banks, have been considered important factors in determining the level of bank competition. In this context, some studies have analyzed the level of bank competition without the use of indirect indicators to assess competition.

Panzar and Rosse (1987) developed a reduced form approach using bank-level data to determine bank competition. Their indicator of competition is based on the sum of the elasticities of the (scaled) total interest revenue with respect to input prices. The higher the competition level, the higher the pass-through of changes in input costs over the price of bank products[4]. Boone (2008) introduces the elasticity of profits towards marginal costs as a measurement of competition. Furthermore, Brenahan (1982) and Lau (1982) propose a new way to measure competition. It is based on the idea that a bank, when choosing its output, takes into account the reaction of its rivals. The idea is that the imperfect competition (collusion) equilibrium is unstable, where each competitor has the incentive to deviate from the equilibrium in order to make short-term profits. However, individual

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[4]Bikker, Shaffer and Spierdijk (2009) argue that scaling (i.e., interest rate revenues to total assets) changes the nature of the model, since it transforms the revenue equation into a pricing equation, leading to a systematic distortion in the measurement of competition. Moreover, they conclude that even an unscaled revenue function generally requires additional information about costs and market equilibrium.

actions are followed by rivals' reactions, reducing aggregate future profits. Therefore, the measurement of competition is based on the elasticity of the aggregate market towards changes in individual output.

Some papers have tried to measure the level of competition in the Brazilian banking market. Although market participants usually complain about an apparent lack of bank competition due to the observed equilibrium of high concentration and high cost of financial intermediation, the empirical findings have not been conclusive. Using the method of Bresnahan (1982) and Lau (1982), Nakane (2001) concludes that the Brazilian banking market is highly competitive, but rejects the hypothesis of perfect competition. Following Panzar and Rosse's (1987) approach, Yildirim and Philippatos (2007) and Nasser (2008) conclude that banks operate under monopolistic competition. Applying the SCP method and assuming each type of credit as an independent market, Tonooka and Koyama (2003) do not find any correlation between bank concentration and interest spread in Brazil[5].

3. Market structure of the Brazilian banking sector

Banking crisis are generally followed by financial consolidation. The Brazilian banking system has not been an exception. The adoption of the Real Plan (currency stabilization) in 1994, and the banking crisis that followed[6], caused a significant shakeout in the Brazilian banking market. Although the nation's banking system emerged relatively unscathed by the global financial crisis of 2008, it became even more concentrated. Not surprisingly, the structure of the Brazilian banking sector is characterized by its high concentration. At the end of 2011, the five largest financial conglomerates held approximately 77% of assets, 76% of credit outstanding and 80% of the balance of deposits.

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[5]Due to the absence of time variation in the aggregate measure of bank concentration in Brazil, the correlation between market structure and bank competition might be statistically difficult to identify. Therefore, the use of aggregated data, even for each type of credit, may not be the best way to identify such correlation.

[6] Several banks were not able to find alternative sources of revenue and became distressed. In order to deal with the banking system fragility, the Brazilian government launched the Program of Incentives for Restructuring and Strengthening the National Financial System (PROER) in 1995 and the Program of Incentives for Reduction of the State Role in Banking Activity (PROES) in 1996.

The regulations in Brazil allow banks to offer different services and products and to open branches anywhere. As a result, the industry is formed typically of full-service banks. However, only the largest commercial banks are physically installed in small local markets. Therefore, most of the financial institutions focus their operation in more developed and wealthy areas, making the structure of the banking sector highly geographically dispersed.

The high bank concentration in Brazil is regularly perceived by market participants as a strong indicator of low competition and as being responsible for the equilibrium of high cost of credit. Charts 1 and 2 show the evolution of bank concentration and profitability[7] (expected return) charged on free credit (as opposed to directed lending) operations since June 2000. The first graph presents the profitability of nonfinancial corporate loans and the second one shows the same for personal overdraft loans. The concentration measure refers to the sum of the five largest banks' market share in the credit market.
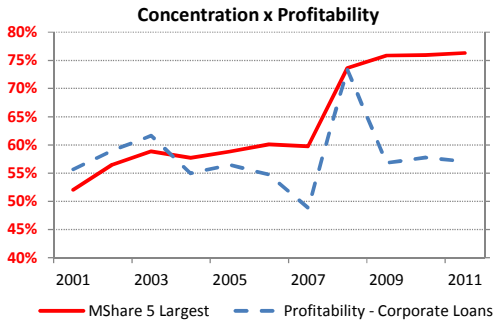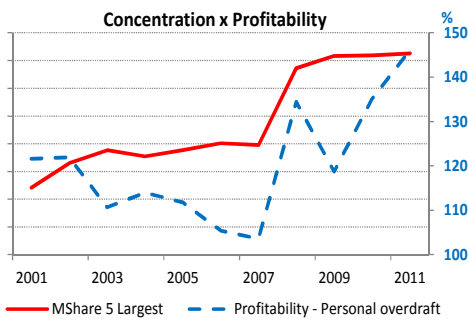
Chart 1:   Chart 2:

There is a notable difference between the average return charged by banks on nonfinancial corporate loans and personal overdraft loans. While the level of profitability on nonfinancial corporate loans quickly returns to the level observed before the crisis, even after strong market consolidation, the profitability charged on personal overdraft loans rises considerably. This may indicate a possible difference in the competitive climate between the retail and wholesale credit markets. Perhaps information asymmetries, switching and

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[7]All outstanding loans more than 90 days overdue are considered in default and counted as a 100% loss. It is important to note that the average return (profitability) was calculated with the actual rate of delinquency and not with the expected default rate.

searching costs are lower for companies. In this case, the impact of bank consolidation on the cost of credit would be stronger in the retail credit market.

Moreover, the reasonable stability of the concentration measure between 2000 and 2008 indicates that the correlation between market concentration and bank performance might be empirically difficult to identify (at least using aggregated data). Furthermore, the structural break observed in the level of bank concentration after the crisis may indicate an increase in banks' market power. The next charts show the evolution of bank concentration calculated by the Herfindahl-Hirschman Index[8] for the whole credit market (Chart 3) and for different credit lines (Charts 4, 5 and 6).
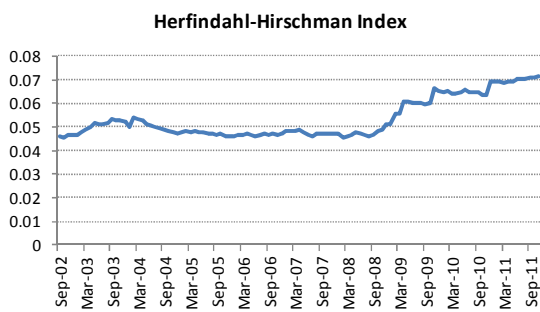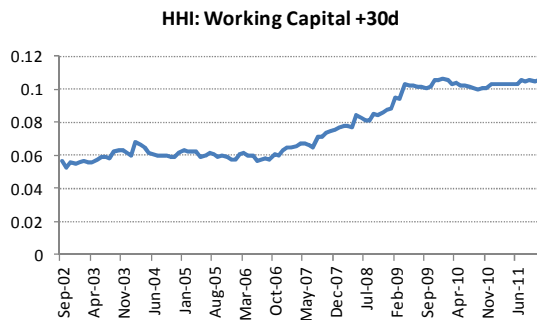
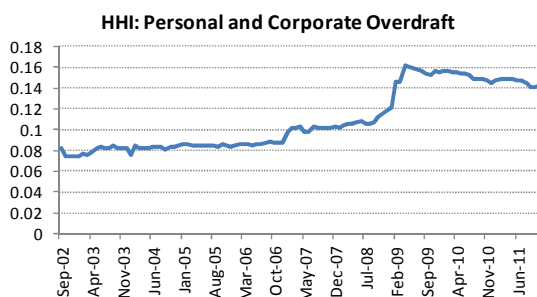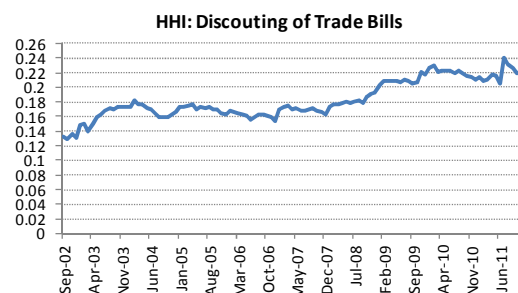Chart 3:   Chart 4:

Chart 5:   Chart 6:

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[8] Herfindahl-Hirschman Index $= \sum_{i=1}^{I} \alpha_i^2$, where α is the market share of bank i in the credit market. Only development banks were excluded.

Even disaggregating the dataset by credit line, the concentration indexes show a fairly stable pattern until 2008, confirming the suspicion that the correlation between market concentration and bank competition may be empirically difficult to identify.

Due to lack of information regarding risk profile of local borrowers, identifying price discrimination in local markets has to be done using credit lines whose credit risk is less dependent on local conditions. Although the probability of default on auto loans is highly correlated with local borrowers' profile, the loss given default is less dependent on local conditions since the value of the collateral used in this type of loan (vehicles) is less correlated with local conditions. Hence, this paper focuses on the bank competitive behavior in the vehicle loan market. The structure of the auto loan market and its geographical dispersion in the state of São Paulo is presented in the next subsection.

a. Auto Loans

Total outstanding auto loans represent 35% of total balance of credit to households in Brazil. As it is a credit line intensive in collateral (the vehicle itself is usually used to guarantee auto loans) and the recovery in case of default is reasonably fast, the interest rates charged on auto loans is low compared with other types of household credit lines[9]. In addition, corporate banks (financial institutions of the automakers) and credit unions are important lenders in this segment. Chart 7 shows the evolution of the concentration rate (HHI) for the auto loan market.

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[9] In November, 2010, the average interest rate charged on auto loans reached 22.76% annually.

Chart 7:

HHI: Auto Loans
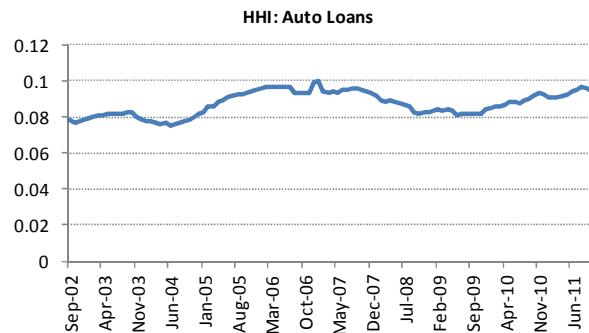
The structure of the auto loan market has not been affected so much by the global financial crisis. Despite the slight increase, the indicator of concentration is still at the levels observed during 2005 and 2006, and its variation ranges only from 0.08 to 0.10.

Local Markets

Despite recent technological advances, competition in the retail loan market seems to be driven by local demand and supply conditions. Asymmetric information and transportation costs may explain the behavioral of borrowers when looking for better credit terms among lenders located within a delimited geographical boundary. The spatial price discrimination is well documented by economic theory and recognized empirically[10].

Due to economies of scale and scope, larger markets are usually less concentrated. This can be seen in the auto loan market in the state of São Paulo, which has a highly dispersed structure among different locations[11]. The following charts show the evolution of the distribution (average and standard deviation) of two measures of concentration in each period, the HHI (Charts 8 and 9) and the sum of the five largest banks' market share (CR5, Charts 10 and 11). Charts 8 and 10 show the distribution among all 63 micro regions of Sao

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[10] See Petersen and Rajan (2002), Degryse and Ongena (2005), Berger and Hannan (1989), Calem and Carlino (1991) and Hannan (1997).

[11] Location is defined by the borrowers' address, information available at the Credit Information System of the Central Bank of Brazil (SCR).

Paulo state and Charts 9 and 11 present the distribution among all 645 municipalities[12] in the state.
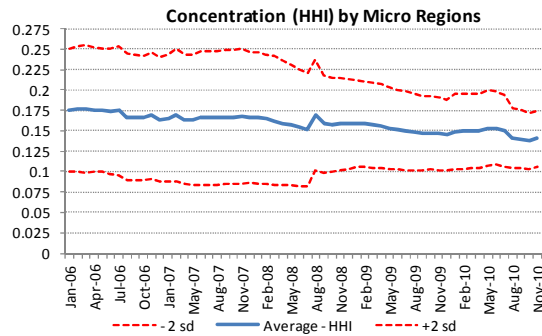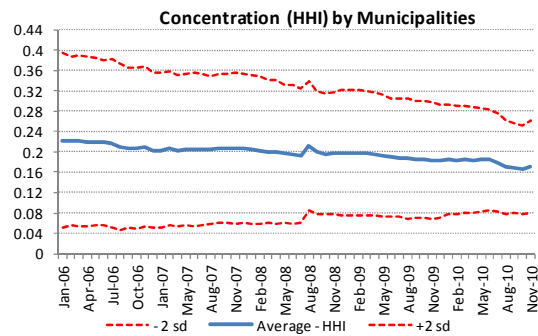
Chart 8:

Concentration (HHI) by Micro Regions

Chart 9:

Concentration (HHI) by Municipalities

Chart 10:

Concentration (Market Share) by Micro Regions
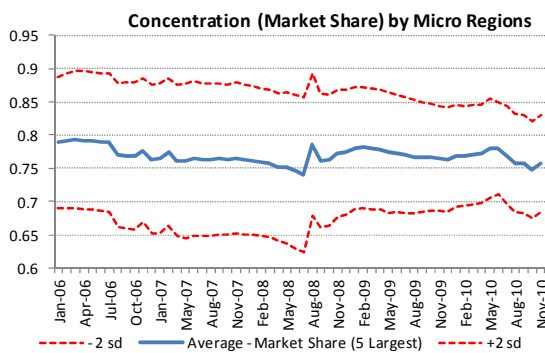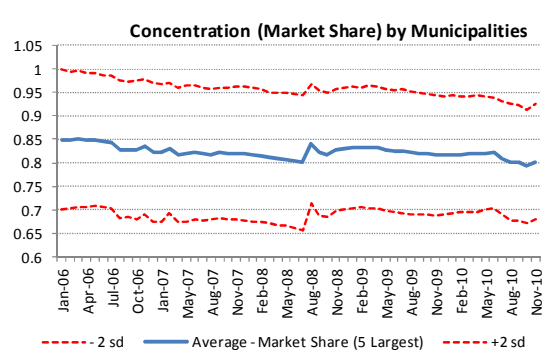
Chart 11:

Concentration (Market Share) by Municipalities

As the geographic border is restricted, the average of the degree of bank concentration increases, indicating that the concentration is higher in smaller markets. Despite the stable time pattern, it is possible to observe a high dispersion in the level of concentration among the locations. The next charts show the distribution along all 63 micro regions (Charts 12 and 13) and all 645 municipalities (Charts 14 and 15), of the time average of two indicators of concentration, the HHI (Charts 12 and 14) and the CR5 (Charts 13 and 15).

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[12] The local political unit in Brazil is the municipality, which is a akin to a county, except it has a single mayor and municipal council.
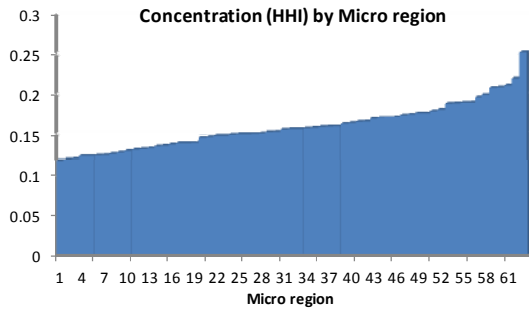
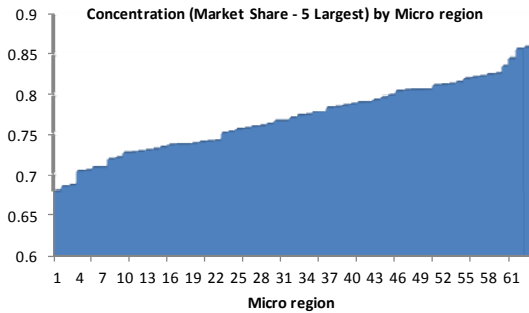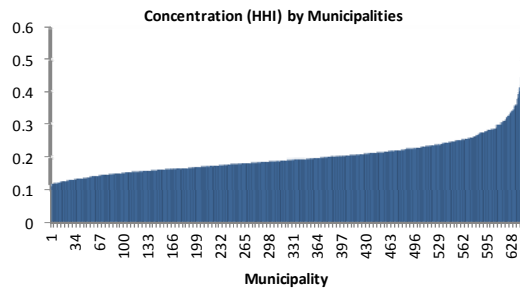Chart 12:   Chart 13:

Concentration (HHI) by Micro region   **Concentration (Market Share - 5 Largest) by Micro region**

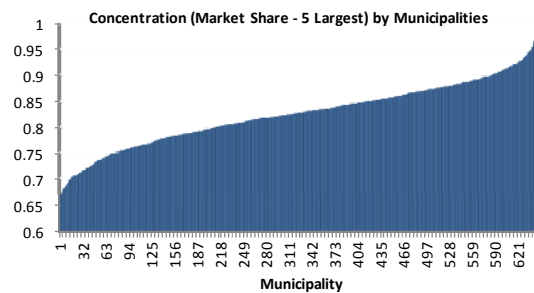**The great local dispersion** observed in the indicators of bank concentration for the auto loan market allows an empirical investigation about the occurrence of price discrimination in local markets and hence conjectures about the impact of market concentration on bank competition in the credit market.

4. Database

The main data source comes from the Credit Information System (SCR) of the Central Bank of Brazil, a huge repository of Brazilian banks' loans that registers all credit operations above R\$5,000[13], reporting information on lending rates and loan controls. Banks' balance-sheet data, used as bank controls, comes from the accounting database of Brazilian financial institutions (COSIF). The sample used in this paper comprises new and outstanding auto loans granted to borrowers from the state of São Paulo (SCR brings the borrowers' address) between January, 2006 and November, 2010. The entire database

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[13] Roughly US\$ 2,500 as of this writing.

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consists of 5,708,706 auto loan contracts, totaling 4,364,094 borrowers from all 63 micro regions and 645 municipalities of the São Paulo state and 280 financial conglomerates or independent financial institutions. The total balance of auto loans by lender at each location was also collected to calculate the measurements of local bank concentration[14].

Restricting the sample for borrowers from São Paulo state deserves some comments. First, the large number of small municipalities in Brazil, where the market concentration is very high, would bias the empirical exercise as the dispersion of bank concentration would become very low. Second, the great social, economic and institutional differences among Brazilian states would distort the estimations, since the SCR does not provide any information about the financial condition of borrowers[15]. Furthermore, apart from its representativeness (almost 40% of the overall bank credit in Brazil is granted in São Paulo state), there is a high variation in the indicators of concentration among the municipalities in that state.

In December, 2010, the Central Bank of Brazil established new levels of capital requirement for auto loans with maturity over 24 months. As there were significant changes in the auto credit market afterward, the sample was limited until November 2010.

Limiting the sample to auto loans also deserves some comments. It is based on the best empirical strategy to identify the relationship between local concentration and bank competition. First, auto loans are intensive in mobile collateral (the vehicle itself is used as guarantee). Therefore, their credit risk is less related to local conditions, being more associated with macroeconomic, institutional and structural factors, such as the local competitive climate. Additionally, as the SCR registers only loan contracts greater than R$5,000, using other kinds of retail loans could produce significant measurement errors.

Local borders were delimited by the borrowers' address, information available at in the SCR[16]. Possible measurement errors may arise. First, the borrower may take the loan in

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[14] The option for the balance of auto loan is given by the fact that the use of credit flow for each period makes the indicator of concentration very volatile in the smallest markets, which may distort the empirical analyses.
[15] Credit risk controls are based on banks' balance sheet, as the delinquency rates of banks' credit portfolio.
[16] The location where the loan is granted could have been used but this information is not reliable, as many banks report the address of its head office as the origination of the contract.

a location but live in another one. Second, the information reported in the SCR may not correspond to the actual residence of the borrower. Therefore, two criteria will be analyzed when delimiting the locations (micro region and municipality), and econometric techniques will be applied to deal with correlation among nearby municipalities in the empirical exercise.

Table 1 provides summary statistics of volume, maturity and interest rate for auto loans of borrowers from the state of São Paulo between January, 2006 and November, 2010:

Table 1:

variable	obs	mean	sd	min	max
volume	5,707,505	16,516	14,579	5,000	1,763,701
lending rate*	5,473,860	27.40	8.61	10	99.96
maturity	5,707,504	41.14	12.99	0.033	214.1

* Only preset loan rates higher than 10% and lower than 100% per year were included.

Tables 2 and 3 compare the auto loan market in locations (micro region and municipality) differenced by degree of bank concentration[17] (HHI). It offers a first look at the question of whether banks charge higher loan rates in more concentrated markets. The statistics refer to the average values of new auto loans extended monthly per bank in each location. The statistics of volume, maturity and interest rate are constrained by the nine largest lenders, representing more than 77% of the entire sample[18]. The standard deviations are in parentheses.

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[17]The threshold was defined in order to split the sample into two similar parts.
[18] The restriction was made to avoid the inclusion of small lenders that operates in just few locations and those with a completely different funding cost structure.

Table 2:

Average (63 micro regions)	HHI > 0.15	TOTAL	HHI <= 0.15
nº of operations	93	168	248
	(435)	(581)	(697)
nº of lenders (new)	20.05	22.65	25.47
	(5.37)	(6.25)	(5.91)
nº of lenders (outstanding)	37.40	41.65	46.26
	(9.31)	(12.23)	(13.30)
volume (average)	14,741	15,359	16,028
	(7,746)	(7,593)	(7,365)
maturity (in days)	1,214	1,232	1,252
	(183)	(182)	(180)
interest rate (average)	29.24	28.83	28.39
	(7.54)	(7.51)	(7.46)
interest rate (median)	28.83	28.35	27.83
	(7.71)	(7.72)	(7.70)

Table 3:

Average(645 municipalities)	HHI > 0.172	TOTAL	HHI <= 0.172
nº of operations	8.82	25	41.23
	(71)	(180)	(244)
nº of lenders (new)	8.47	11.66	14.85
	(4.67)	(6.67)	(6.84)
nº of lenders (outstanding)	20.64	25.49	30.34
	(7.56)	(10.22)	(10.23)
volume (average)	14,306	14,944	15,583
	(10,320)	(9,796)	(9,196)
maturity (in days)	1,236	1,250	1,263
	(263)	(250)	(234)
interest rate (average)	29.60	29.11	28.62
	(7.51)	(7.51)	(7.49)
interest rate (median)	29.43	28.84	28.28
	(7.61)	(7.67)	(7.69)

Both tables show that banks charge higher interest rate in more concentrated markets, indicating a possible negative relationship between market concentration and bank competition. The next section investigates this link empirically.

5. Empirical strategy and results

Since aggregate measures of bank concentration are reasonably stable across time, this paper exploits the large local disparity in credit market structure in order to empirically identify the correlation between market concentration and bank competition. The primary identification assumption is that asymmetric information and transportation costs make borrowers "prefer" local lenders. Therefore, the strategy is to identify if banks take advantage of these frictions by charging higher loan rates in more concentrated locations.

A panel analysis will be carried out to test if banks operating in most of the locations (only the 9 largest banks will be considered in the regressions) use their market power to charge higher auto loan rates. These banks represent around 77% of the total volume of auto loans in the state of São Paulo between January, 2006 and November, 2010. Only preset loan rates higher than 10% and lower than 100% per year were included.

The baseline specification is:

$$INTEREST_{l,t}^{b} = c + \beta * CONCENTRATION_{l,t} + \alpha * LN\_SIZE_{l,t} + \varphi * SHARE_{l,t}^{b} +$$
$$+ \mu * NUM\_BANKS_{l,t} + \theta * LN\_MATURITY_{l,t}^{b} + \upsilon * LN\_VOLUME_{l,t}^{b} + \sigma * NPL_{l,t}^{b} +$$
$$+ \gamma * WRITEOFF_{l,t}^{b} + \delta * DUMMY\_CRISIS_{t} + \sum_{k=1}^{K} \tau^{k} * MACRO_{t}^{k} + \sum_{b=1}^{B} \omega^{b} * BANK_{t}^{b} + \mu_{l} + \varepsilon_{l,t}$$

where b refers to bank, l to location and t to the time period.

The dependent variable, *INTEREST*, is the average interest rates charged by bank b on new auto loans in location l at time t. The local concentration measure, *CONCENTRATION*, refers to HHI or CR5 and is calculated from the total balance of auto loans granted by bank in each locality. The coefficient β captures the correlation between the local concentration and the average interest rate charged by each bank in each location. Therefore, a positive sign for β indicates lower bank competition in more concentrated credit markets.

Due to economies of scale and scope, larger markets are frequently less concentrated. Thus, higher loan rates in more concentrated markets may not reflect anti-competitive behavior of banks. Therefore, a measure of market size, *LN_SIZE*, is included in the model to control for the scale effect. *LN_SIZE* is defined as the logarithm of the total balance of auto loans granted in each location l at time t. Because of the dilution of fixed-costs, it is expected that banks charge lower interest rates in larger markets ($\alpha < 0$).

As mentioned before, market concentration may be correlated with bank efficiency. The idea is that more efficient banks gain market share over time, increasing market concentration. Hence, more concentrated local markets might be associated with more

efficient competitors that charge lower rates. So, a proxy for bank efficiency is incorporated in the model. *SHARE* refers to the bank's auto loan market share in each location. So, the coefficient φ captures the effect of bank efficiency on loan rates. A negative sign is expected for it. The variable *NUM_BANKS* controls for the impact of the number of competitors on the competitive behavior of banks. A negative sign for the coefficient μ is expected.

The set of loan controls include the log of the loan amount (*LN_VOLUME*) and the log of the loan maturity in days (*LN_MATURITY*), representing the average amount and the average maturity of new auto loans charged by bank *b* in location *l* at time *t*. Larger or longer loans represent higher credit risk, so the expected effect of these variables on loan rates is positive. On the other hand, these loan controls can be jointly determined with loan interest rates and also reflect credit demand characteristics. So, higher loan rates may reduce the loan amount and the maturity demanded by borrowers, so negative signs for these loan controls may also arise.

Local credit risk controls are also included. Non-performing loans (arrears over 90 days), *NPL*, and net loan write-offs as a fraction of total loan, *WRITEOFF*, for bank *b* in location *l* at time *t* captures the local credit risk. The coefficients γ and σ are expected to be positive in order to represent the effect of credit risk on the loan rates charged by banks.

A dummy variable representing the financial crisis of 2008 was also included. This variable takes the value of 1 between October and December, 2008 and 0 otherwise. Macroeconomic controls were also included, such as the basic interest rate *(SELIC)* and the monthly economic activity index (*IBC-Br)*, calculated by the Central Bank of Brazil.

Several bank controls were also included. Funding cost (FUNDING COST) is derived from interbank funding expenses divided by total interbank liabilities. Although more sensitive to bank risk than the risk-free rates commonly used in the empirical banking literature, this funding cost measure is still a backward-looking accounting concept. Therefore, indicators of bank risk and bank financial position were also included to help control for the true funding cost that a bank faces. So, higher capital to assets ratio (CAPITAL) and holdings of cash and marketable securities as a fraction of total assets

(LIQUIDITY) translate into improved financial position of the bank, leading to lower costs of funding and, therefore, lower loan interest rates. The total credit as a fraction of total assets (CREDIT_ASSET) was also included to control for a change in banks' credit portfolio.

5.1 Results

Table 4 presents the estimation results of models using fixed effect estimators when the location is delimited by the borrowers' town. Cluster analysis by micro region was undertaken to deal with possible correlations among nearby municipalities or those in the same micro region.

The second column brings the estimates using the HHI as concentration measure, while column 3 contains the estimation results using CR5. The coefficients of the macroeconomic and bank controls are consistent with prior expectations but are not reported.

Table 4

Panel ID: Bank (9) - Municipality (645)	Concentration measurement	
Dependent variable: Lending Rate	HHI	CR 5
Local Concentration	4.0411***	6.8421***
	[0.003]	[0.000]
Market Share	-7.3077***	-7.4643 ***
	[0.000]	[0.000]
n^o of lenders	-0.13449***	-0.13298***
	[0.000]	[0.000]
Market Size	-3.1984***	-3.1021***
	[0.001]	[0.001]
Loan Controls		
Maturity	-3.7406***	-3.7419***
	[0.000]	[0.000]
Volume	-3.1787***	-3.1993***
	[0.000]	[0.000]
Risk Controls		
NPL (90 days)	6.1721***	6.0773***
	[0.002]	[0.003]
Writeoff	-0.50375	-0.61303
	[0.431]	[0.339]
Macro Controls	Yes	Yes
Bank Controls	Yes	Yes
n^o of observations	174,430	174,430
R^2 within	0.4133	0.4142

Note: *, ** and *** indicate coefficients statistically significant at 10%, 5% and 1%, respectively.

P-values in brackets. Cluster-robust standard errors in micro region.

The coefficient β is positive and statistically different from zero, indicating a positive correlation between local concentration and loan rates. It represents a negative relationship between market concentration and bank competition. And the magnitude of the effect is relevant. A change in the HHI (CR5) from zero to one, or from perfect competition to monopoly environment, increases the auto loan rates by 404 points (684), or 4.04% (6.84%) per year.

The negative correlation between interest rate and banks' market share, captured by coefficient ϕ, may be associated with bank efficiency, as suggested by the banking efficiency literature (Berger, 1995). The estimates were also aligned with the expectations that economies of scale, captured by market size, allow banks to charge lower interest rates in larger markets and that the number of competitors also alters the interest charged by banks. The coefficients of local credit risk and loan controls were also in line with the prior assumptions.

Table 5 reports the estimates when the location is delimited by the borrowers' micro region.

Table 5

Panel ID: Bank (9) - Micro region (43)	Concentration measurement	
Dependent variable: Lending Rate	HHI	CR 5
Local Concentration	2.4398	8.8032***
	[0.495]	[0.000]
Market Share	-16.421***	-14.0360***
	[0.000]	[0.000]
nº of lenders	-0.04053***	-0.0749***
	[0.003]	[0.000]
Market Size	-8.9468***	-7.9013***
	[0.000]	[0.000]
Loan Controls		
Maturity	-3.1516***	-2.3574***
	[0.000]	[0.000]
Volume	-2.1705***	-1.8260***
	[0.000]	[0.000]
Risk Controls		
NPL (90 days)	13.924***	13.3115***
	[0.000]	[0.000]
Writeoff	5.2085***	5.6938***
	[0.000]	[0.000]
Macro Controls	Yes	Yes
Bank Controls	Yes	Yes
nº of observations	26,945	26,945
R^2 within	0.5520	0.5540

Note: *, ** and *** indicate coefficients statistically significant at 10%, 5% and 1%, respectively.

P-values in brackets.

Using the HHI as concentration measure, the coefficient β in Table 5 is not statistically significant. This may indicate that the relevant competitive climate in the retail credit market is local and delimited by shorter distance areas, such as the borrowers' town. Moreover, the magnitude of the coefficients of credit risk, market size and banks' market share is greater when local border is amplified.

The definition of credit market used in this study, not only related to the type of loan but also to geographic location of borrowers, allowed the realization of empirical investigation regarding price discrimination in the Brazilian credit market and hence identification of possible correlation between market concentration and bank competition.

Contrasting with previous studies using the SCP method for the Brazilian credit market, the findings of this paper indicate a positive relationship between local concentration and loan rates, in line with international evidence. The paper suggests that the cost of financial intermediation in Brazil is partly related to low competition in the credit market (high market power of banks). Besides this, the results point to a possible increase in the cost of credit due to the recent process of bank consolidation worldwide. Additionally, the paper highlights the importance of the geographic dimension when evaluating the effect of mergers and acquisitions in the banking industry.

5.2 Entry barriers

The use of indirect measures of bank competition, such as market concentration, has been criticized by many as it ignores other factors that alter the competitive behavior of firms. For example, firms may charge competitive prices to discourage new entrants. So, the degree of competition might be high in a very concentrated market if barriers to entry are low. In this context, measures of concentration, such as the HHI and the CR5, may not be good indicators of competition. To deal with barriers to entry in local markets, this section introduces an indicator variable that divides the sample according to the dispersion of the number of competitors in each location. The idea is that the dispersion in the number of competitors in each location is a proxy for local barrier to entry. So, two terms were introduced in the model in order to quantify the impact of the entry barriers on bank competition. The indicator variable (*Entry_Barrier)* assumes the value of 1 if the local

dispersion of the number of competitors is lower than 0.105[19] and is zero otherwise. The second term is the interaction between the indicator variable and the measurement of bank concentration, (*Entry_Barrier*Concentration*). Table 6 reports the estimates.

Table 6

Painel ID: Bank (9) - Municipality (645)	Concentration measurement	
Dependent variable: Lending Rate	HHI	CR 5
Local Concentration	3.1027*	5.5833***
	[0.057]	[0.000]
Local Concentration x Entry Barrier [1]	3.68006*	3.4147
	[0.081]	[0.105]
Market Share	-7.2977***	-7.4437***
	[0.000]	[0.000]
nº of lenders	-0.13583***	-0.13423***
	[0.000]	[0.000]
Market Size	-3.1994***	-3.1035***
	[0.001]	[0.001]
Loan Controls		
Maturity	-3.7383***	-3.7413***
	[0.000]	[0.000]
Volume	-3.1767***	-3.1997***
	[0.000]	[0.000]
Risk Controls		
NPL (90 days)	6.2024***	6.0779***
	[0.002]	[0.003]
Writeoff	-0.50139***	-0.63057
	[0.432]	[0.326]
Macro Controls	Yes	Yes
Bank Controls	Yes	Yes
nº of observations	174,430	174,430
R^2 within	0.4134	0.4143

Note: *, ** and *** indicate coefficients statistically significant at 10%, 5% and 1%, respectively.

P-values in brackets. Cluster-robust standard errors in micro region.

[1] Assumes the value of 1 if the local dispersion of the number of competitors is lower than 0.105.

Table 6 shows that the impact of bank concentration on lending rates is even greater in locations where the entry barriers are higher. If the HHI (CR5) goes from zero to one, or from perfect competition to monopoly, the increase in lending rate is 368 (341) basis

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[19] The threshold was defined in order to split the sample in two subsamples with similar size.

points, or 3.68% (3.41%), higher in locations where the barriers to entry are higher. This finding highlights the significance of entry barriers on the analysis of the competitive behavior of banks. In other words, the impact of market consolidation on bank competition depends on the level of local entry barriers.

5.3 Robustness

In order to address potential endogeneity problems, the model is also estimated by instrumental variable technique, via 2SLS, using the first lag of the endogenous variables LN_VOLUME, LN_MATURITY, SHARE and CONCENTRATION and all exogenous variables as instruments. Table 7 reports the estimates, where the main findings were maintained.

Table 7

Painel ID: Bank (9) - Municipality (645)	IV - FE	
Dependent variable: Lending Rate	Municipality	Micro region
Local Concentration - HHI	1.1078**	-0.3925
	[0.038]	[0.755]
Market Share	-5.2822***	-13.877***
	[0.000]	[0.000]
nº of lenders	-0.04649***	-0.0122*
	[0.000]	[0.062]
Market Size	-1.9908***	-8.1611***
	[0.000]	[0.000]
Loan Controls		
Maturity	-16.836***	-7.17201***
	[0.000]	[0.000]
Volume	-3.5134***	-2.1558***
	[0.000]	[0.000]
Risk Controls		
	6.3616***	20.177***
NPL (90 days)	[0.000]	[0.000]
	0.18179	4.2182***
Writeoff	[0.495]	[0.000]
Macro Controls	Yes	Yes
Bank Controls	Yes	Yes
nº of observations	144,601	25,755

Note: *, ** and *** indicate coefficients statistically significant at 10%, 5% and 1%, respectively.

P-values in brackets.

6 Conclusion

This paper investigates the relationship between market concentration and bank competition in the Brazilian auto loan market under the assumption that the competitive behavior of banks in the retail credit market is mainly driven by local conditions, since spatial price discrimination may be caused by asymmetric information and transportation costs incurred by borrowers. So, the definition of market is not related only to the type of loan but also to the geographic location of borrowers. The assumption of local competition allows an empirical investigation of price discrimination in the Brazilian credit market and

so the identification of correlation between market concentration and bank competition. Additionally, local markets are distinguished by their degree of barrier to entry in order to recognize the importance of this aspect during the analyses of the effect of market concentration on bank competition.

In line with international evidence and contrary to most studies of the Brazilian credit market, the findings indicate a negative correlation between market concentration and bank competition, indicating less competitive behavior in more concentrated local markets. Additionally, this effect is even stronger in locations where the entry barriers are higher, proving the importance of such barriers for the competitive climate in the credit market.

The results suggest that the cost of financial intermediation is also determined by local competitive climate. The paper also highlights the importance of geographical dimension in the process of analysis and evaluation of mergers and acquisitions in the banking industry.

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