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ABSTRACT

This paper analyzes the effects of the regional distribution of the banking system on investment rates in Brazil. The investigation relies on a perspective whereby the role of external funds in inducing firms' investment is determined by the disparate regional distribution of the banking system. Empirical results from a panel-data multilevel model indicate that the regional concentration and centralization of the banking system are relevant for firms' investment choices. More importantly, the fitness of the multilevel model indicates the need to consider that investment rates vary according to a regional hierarchical banking structure (centre versus periphery).

KEYWORDS
investment rate; banks; regions; concentration; centralization

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INTRODUCTION

In 1994, the government of Brazil succeeded in curbing high rates of inflation, ending a long period of uncertainty for the economy. From 1995 on, the country recovered its consumption and investment levels, propelled by an increase in overall confidence in the macroeconomic conditions. Between 1995 and 2014, the average gross domestic product (GDP) annual growth was 3%, while consumption and investment averaged 3.40% and 4.77% respectively (Brazilian Institute of Geography and Statistics (IBGE), 2015). However, Brazilian growth was heavily marked by an unstable global macroeconomic scenario, characterized by a sequence of crises in external markets (Mexico, Asia, Russia and Argentina), which affected the availability of global funds for investment.

The national financial sector was especially affected by these macroeconomic conditions. Lacking the usual revenues from overnight operations in an inflationary context, it had to readapt by acquiring new forms of revenues under increased systemic competition and concentration, which accrued from large public banks' privatization plans. Nonetheless, the financial system adapted quickly to the new economic environment, mostly because of increased demand for consumption credit and higher returns on government bonds. Banks could then fund their credit operations smoothly, favouring the expansion of their loans to firms and households. Total outstanding loans, which averaged 24.4% of GDP between 1995 and 2013, reached 58.9% of GDP in 2014.[1]

The changes in the Brazilian economy, however, were not homogeneously spread over the territory. As Amado (1997) showed, central regions in the country would be characterized by a more stable and self-generated growth path than the periphery, with more developed financial markets and a lower propensity to import. In contrast, the peripheral regions were usually marked by low levels of income and unstable growth paths that were highly dependent on the production of primary goods to fulfil the centre's demands. Such characteristics reinforce centre–periphery dynamics, which concentrate regional growth and development through virtuous and vicious cycles of growth. This paper extends such studies by analysing the regional patterns of investment rates and the effects of the regional distribution of the banking system on the latter. This study is relevant for three reasons. Firstly, from a theoretical point of view, it is important to scrutinize regional evidence of the relationship between financial development and investment rates, particularly if one is interested in informing public policy. For this purpose, a novel financial development concept is assumed, which is fully regionally oriented. In brief, it is suggested that regional financial development is the smooth operation of finance and funding facilities, which are primarily rooted in transactions occurring at the regional level (Cavalcante, 2012). In such a case, financial

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development refers to the increased functionality of local financial institutions in intermediating services related to investment and growth. If this view is substantiated, then the distribution of financial activity has significant effects on banks' portfolio decisions, which ultimately affect the availability of credit and investment decisions by firms. As far as we know, only a few studies have addressed the financial determinants of local investment rates, and none has attempted to estimate them empirically. On the one hand, the usual literature on financial development (Levine, 2005) has placed little emphasis on the importance of studying the regional context in which financial processes are embedded. On the other hand, the regional finance literature has very often replicated general macro-models' relationships to regional analysis, offering very little insight into the development of regional institutions. The regional financial literature has invariably included studies focusing on the regional evolution of financial processes (Crocco, Figueiredo, & Santos, 2010a, 2010b; Dow, 1993). However, these studies have usually favoured a strict view whereby regions are necessarily restrained by an immutable centre–periphery structure. Despite being important for the general analysis, these studies might have overlooked some significant regional growth perspectives, most specifically those in which growth can be stimulated by indigenous financial capabilities. This paper supports the view that encompassing a more regional framework is necessary to analyze the effects of financial processes on growth.

Secondly, references to the Kaleckian approach for the investment function also add a new character to this paper. A few studies estimating investment rate functions assume the parameters envisaged by Kalecki (1971) and even less or none that apply such assumptions at the regional level. The empirical appreciation is the third novelty of this paper: the use of a hierarchical model to estimate regional investment functions is also not contemplated by the literature. A multilevel model adequately fits the purpose of the study by considering that regions might present different sensitivities to changes in both interest rates and local financial attributes. This assumption is radically different from models that assume regional diversity to be a significant factor, rendering economic, social and political features homogeneous through space. This study could shed some light on the importance of considering regions' own characteristics as crucial factors for growth and development

In line with this view, this paper is structured as follows. The next section reviews studies of investment, internal and external funds, which have served as guides for the regional appreciation of the subject. The third section presents the function to be estimated, as well as the data set, variables and estimation methodology. The fourth section reports specifically the estimation results, which are separated by different empirical model specifications. The last section concludes.

FIRMS, INVESTMENT AND THE BANKING SYSTEM

In general, studies of investment have usually been based on macro-theories. The dynamic developments introduced by Harrod (1937) over Keynes' (1936) approach were inspired by the (un)stable characteristics of the investment and growth relationship. Owing to the parsimonious nature of this approach, Jorgenson and Hall (1971) partly covered the points missing from the discussion by including in their model real rates of interest, depreciation costs and prices of capital goods. Following these steps, Tobin's (1969) model assumes that investment is determined by firms according to the Q ratio, which is affected by the marginal cost of new investment and the prompt availability of capital goods. In the investment model of Sneessens (1987), the firm has two crucial decisions to make: whether or not it will produce, given the utilized capacity in the economy; and how much capital it will use. Such decisions must consider the levels of capital profitability (capital costs and interest rates) and also the subsequent differences in mark-ups caused by the different profitability possibilities.

Another perspective comes from Kalecki (1971), whereby investment is closely related to the dynamics of the distribution of income. The latter is shared between capitalists and workers, and firms consider growth expectations to devise capital accumulation plans (Arestis, 1996). This decision is reflected in an investment rate function, which is affected by the level of profits in two manners: as a source of internal funds that enables investment to be realized; and as a sign of whether future growth expectations will materialize.

Investment decisions by firms have also been studied from the viewpoint of imperfect markets. Fazzari, Hubbard, and Petersen (1988) pointed out that the complexity of investment precludes the use of rules of thumb by firms. Stiglitz and Weiss (1981) emphasized the effects of information asymmetry on credit markets. For these authors, the use of external funds for investment increases firms' efficiency in managing the available funds, but this efficiency also comes at the expense of increasing the costs of bankruptcy.

External funds have also been important in explaining firms' investment in studies concerned with institutional parameters of financial development (Beck & Demirgüc-Kunt, 2006; Levine & Zervos, 1998), more specifically, the effects of the efficient provision of financial services on firms' investment constraints. For Berger and Udell (2006), available lending technologies and the degree of financial development are fundamental to guarantee the availability of credit to firms. Guiso, Japelli, Padula, and Pagano (2004) reiterated this view, stressing the importance of integrated financial markets. Agarwal and Mohtadi (2004) analyzed the differences between equity and debt financing in markets with underdeveloped financial institutions. Overall, studies have reported that banking sector development propels debt financing by affecting capital costs, the availability of long-term loans and collateral requirements (Russo & Rossi, 2001; Shen & Wang, 2005).

Investment and the banking system: the regional case

According to Rocha (2010), the regional context of investment is studied by reductionist forms in the

aforementioned models, using regions instead of countries as the main subjects of study. The focus on regions has the advantage of presenting fewer cultural, institutional and legal differences compared with countries. By assuming that capital is not perfectly mobile between regions, Amos and Wingender (1993) showed that financial activity is spatially segmented, giving rise to regional interest rate differentials that affect firms' investment decisions. In the regional case, financial system spatial segmentation has nurtured the development of three fields of study (Dow & Rodriguez-Fuentes, 1997) in regional finance: (1) regional monetary multipliers, whereby the regional quantity of money has short-term impacts on growth; (2) inter-regional flows of funds, a field that assumes that regional funds move around regions to adjust regional interest rate differentials; and (3) regional financial markets, whereby the financial structure is assumed to differ between regions, especially in relation to the available information, generating diverse effects on the availability of credit and interest rates (Samolyk, 1994).

The aforementioned studies are crucial for understanding the dynamics of regions, investment and financial markets. Carbó, Rodriguez, and Udell (2006) found evidence that banking sector development positively affects regional output growth and investment. Once it is substantiated that the development of the financial system is related to its regional performance and structure, further issues regarding the distribution, size and functionality of regional financial markets arise (Cavalcante, 2012; Crocco et al., 2010a; Dow, 1993; Dow & Rodriguez-Fuentes, 1997). Banks have a direct influence on regional investment decisions because information is unequally available throughout the space, leading financial institutions to set diverse regional fees and prices for the required financial services for investment (Alessandrini, Presbitero, & Zazzaro, 2009a; Hirakawa & Bueno, 2009; Maudos & Guevara, 2004). Not only does the financial system provide the required finance for the realization of firms' investment plans, but also it supports such plans with financial intermediation services (Guiso, Sapienza, & Zingales, 2002). It is then straightforward to include the regional distribution of the banking activities and its effects on banks' regional interest rates as determinants of the regional investment process.

This paper takes this latter path, with which the behaviour of the banking system is conditioned by regional financial agglomeration features. Specifically, in this paper, the theoretical approach suggests that the regional pattern of investment by firms is related to the regional distribution of the banking system's activity and its hierarchy. Moreover, this work reinforces the role of the banking system by considering that regional interest rates are set by banks according to the regional demand for finance and the regional capacity to provide adequate funding to equilibrate the banks' desired liquidity.

These arguments are drawn from Cavalcante (2012), who offered a post-Keynesian model in which regional firms use internal (profits) and external funds to realize investment plans, generating income growth that is distributed towards profits and wages. In a dynamic fashion, subsequent changes in the rate of profits accruing from production induce adjustments to the regional financial market structure (concentration, centralization and polarization) via intensification of the use of financial services, in turn propelling banks to adjust their regional portfolios, thus altering mark-ups and interest rates. The model establishes an investment function, drawing from Kalecki (1971), that plays a central role in determining short-term changes in regional growth.

Thus, investment by firms are the main drivers of growth. Firms adjust their investment plans in the region according to the local levels of the profit rate, the real interest rates and, more importantly, regional financial attributes (financial concentration and centralization). The novelty of this approach is that it not only assumes that firms will consider retained profits important parameters for future accumulation plans but also that the prompt availability of *local* external funds from the banking system will be fundamental to the investment process. This availability is measured by the level of regional financial development, meaning the degree of bank functionality in offering credit and funding facilities in the local economy, determined by the concentration of banks and the complex services they offer.

Therefore, banks are important players in the regional growth process since they interpret changes in regional income and uncertainty as signs to alter their liquidity preference and, consequently, the distribution of financial resources and the mark-ups (interest rates) set on the financial services they offer, directly affecting the availability and prices of investment facilities (e.g., loans and financial services) for firms. The concentration of banks in a specific region improves the availability of financial services to firms.[2] In banking-concentrated areas, the volume of services is larger, propelling economies of scale to banks and agglomeration economies to firms. Conversely, banking centralization indicates that a wider array of complex financial services is available to firms in agglomerated areas, increasingly supporting investment decisions by firms. Concentration and centralization together determine the degree of accumulation (polarization) of financial funds in a given region (Crocco, Ruiz, & Cavalcante, 2008). Moreover, the polarization of resources in specific regions strengthens the links among finance, investment and funding (Cavalcante, 2012), pooling resources together that contribute to falling interest rates and higher marginal efficiency of investment. The logic underlying this effect is that the flow of funds to specific regions allows banks to adjust the assets and liabilities in their balance sheets according to the liquidity accrued in different regions. It follows from such a theoretical framework that regional interest rates will be affected by the spatial distribution of resources, subsequently changing regional investment and growth. Hence, this paper investigates this approach by estimating the effects of regional interest rates and financial agglomeration on regional investment in Brazil. The following sections present the empirical methods to verify these claims.

THE LOCAL INVESTMENT FUNCTION: DATA, ESTIMATION TECHNIQUE AND RESULTS

This section addresses the above discussion by investigating empirically the following investment rate function:

$$g^d = \alpha_0 + \alpha_1 r_p - \alpha_2(i_l - \hat{P}) + \alpha_3 bcc + \alpha_4 bct \quad (1)$$

The function is derived from the usual specifications of post-Kaleckian models (Lima & Meirelles, 2003). The investment rate by firms ($g^d = (I/K)$) is given positively by increasing rates of firms' regional profits (r_p) and the regional banking attributes (BA), namely banking concentration (*bcc*) and centralization (*bct*). Equation (1) also suggests a negative relationship between real interest rates ($i_l - \hat{P}$) and the investment rate.

This paper assumes that each region contains an institutional framework that enables and limits the prospects of local investment rate. This institutional framework includes a local banking structure available to firms. Banks in Brazil operate nationally; however, their decisions about the prices and availability of financial services among regions are also determined by local characteristics, such as economic structures, level of income (Guiso et al., 2002), liquidity preference and local uncertainty (Dow, 1993). Banks follow changes in income at the local level and are then responsible for determining the quantity, complexity and prices of services offered locally. The next section introduces the data set and explains the variables used to conduct the empirical investigation.

Data and variables

The data set comprises information about the level of firms by region in Brazil. The data come from the Annual Industrial Survey (Pesquisa Anual Industrial – PIA) managed by the IBGE, which is available for the period 1996–2005. Table A1 in Appendix A in the supplemental data online provides data descriptions and sources. The estimation analysis in this paper refers to investment functions in 128 mesoregions in Brazil.[3]

The banking system in Brazil is characterized by a centralized network, with headquarters in few regions and branches located all over the territory. According to data from the Central Bank of Brazil, in December 2015, the system was formed by 174 banks, of which 72% were retail banks, 25% were investment banks and the remaining 3% were cooperatives and development banks (national and regional). These retail banks accounted for 22,826 branches unevenly spread throughout the country. Moreover, banks also have subsidiary banking posts (*correspondentes*) that perform less complex financial transactions (mostly general payments). The number of *correspondentes* reached 293,767 in 2015. From the total number of publicly owned banks, eight of 13 were state banks confined to their specific territories. These banks were responsible for 744 branches in seven different states.

The four largest banks in Brazil are all nationally owned, and two of them are federal public retail banks. Together, these four banks account for 69% of total assets and 73% of total deposits in the banking system. The state of São Paulo has the highest number of banks' headquarters (113) and banks' branches (7116) in the country – figures that were much larger than in the second region on the list (the state of Rio de Janeiro, with 15 headquarters and 2093 branches). According to Crocco, Santos, and Amaral (2010b), in a system with such regional concentration and centralization characteristics, banking activity follows hierarchically given management directives (e.g., profitability targets) that are nonetheless conditioned by local economic conditions (e.g., number of clients, level of demand and time deposits, demand for loans etc.). Analysing such a set would, therefore, require a more complex methodological approach to consider such features.

Data from the banking system were gathered from the LEMTe-CEDEPLAR (2007) data set. The information refers to the banks' aggregated accounting balance sheets for each regional unit in the set. Therefore, data on the number of banks' branches, volume of loans, deposits, fixed assets and other banks' accounts are available for banks altogether in a specific region, limiting a more bank-specific approach. However, because the main idea is to discuss regional features of investment and banking activity, this information set would be sufficient to compute indicators of local attributes, which are attuned to the discussions of the last section.

The purpose on this study is to analyze banking concentration and centralization from a perspective that emphasizes banks' contributions to regional development. Thus, it is important to consider banking regional characteristics from this point of view. This supposition would require a more careful examination of banking concentration and centralization indices. Usual banking concentration indicators, such as the Hirschman–Herfindahl (HH) and concentration rate (CR) indices, are widely used in the literature. However, these indices, which usually refer to market structure evaluations, might not perfectly reflect the regional banking characteristics addressed by this paper. For instance, bank branches in regions might be governed by both hierarchical decisions coming from headquarters in central regions and local features that can affect their performance. This fact indicates that banks' decisions about the administration of local assets and liabilities, which affect the volume of services they provide, are subject to local dynamics, as well as hierarchical national directives. Therefore, one must be careful when analysing CR and HH indices since banking activity is not guided completely by local markets.

The computation of HH indices, which requires a prior definition of the treatment of spatial units, can be affected by how one decides to aggregate information spatially (the modifiable areal unit problem).[4] Moreover, the HH indices still might not fully consider regional banking activity and its hierarchical dependence. For instance, since mesoregions in Brazil are formed by its constituent sub-regions, a very remote mesoregion with only one local bank (branch) would be classified as highly concentrated by an HH index for branches. This concentration of activity is not

warranted since the remote region might have one bank with very low levels of deposits or outstanding loans. According to the discussion made in the previous section, because this study analyzes the concentration of activity from a more regionally oriented perspective, a more simplistic approach was adopted by assuming that concentration refers to relative shares of banking services provided in each region, which were proxied by the local presence of banks' branches. In this sense, local banking attributes (BA) are closely related to the weight of the banking system in each region. Thus, it will be important to perform the empirical analysis with caution, specifically in terms of concentration and centralization indicators.

Therefore, the idea here is to emphasize the concentration of banking activity in different regions, considering the regional agglomeration and hierarchical order of this activity. To combine these features, the financial concentration index (*brw*) suggested is computed as the sum of the regional share of banks' branches in the region and the share of banks' regional fixed assets (both in relation to the total in the country, subscript BR):

$$brw_i = \frac{\text{banks' branches}_i}{\text{total banks' branches}_{BR}} + \frac{\text{banks' branches fixed assets}_i}{\text{total banks' branches fixed assets}_{BR}} \quad (2)$$

The number of branches is a common indicator of banking activity in the literature (Maudos, 2016). The indicator being suggested here considers the share of regional banks' branches to the total number of banks in the country and complements it with the share of fixed assets (buildings and general equipment) owned by banks in each region relative to the whole country. It is assumed that investment plans by firms could benefit from the prompt support of the banks' local physical structures. In this sense, branches and fixed assets are both indicative of the physical presence of banks in regions.[5] As such, *brw* is an indicator of the regional weight of the banking system.

One could use *brw* as a proxy for banking regional concentration if it is assumed that the region (and its territorial limit) is the basic unit of analysis. In this sense, one could say that banks and the services they provide are concentrated in some regions more than others. This view is slightly different from the analysis of other regional concentration indicators, such as the HH index. The latter comes from the microeconomic literature, and is used here to analyze firms' shares in a given market, which might, or might not, coincide with a region's territorial limits. Because it is difficult to set spatial limits for some banking activities and their markets, *brw* is used here as the main indicator of local BA. Nonetheless, to reinforce the discussion about banking regional concentration, this study also considers other typical concentration indicators, such as the regional share of banks' branches to the total banks in the country, the total bank branches in each region and the volume of financial operation taxes collected per bank in each region. The latter is correlated with the volume of financial transactions in each region, and is determined by federal law. Finally, for the sake of comparison with the literature, the study also includes two more traditional measures: a regional index (HH) for banks' branches; and an efficiency indicator (*eff*) relating the volume of regional loans to the volume of regional deposits, as in Degryse, Elahi, and Penas (2013) and Crocco, Cavalcante, and Barra (2006).

To reinforce the analysis of the regional hierarchical banking set, a banking centralization (*bct*) index was also computed for the regions. In this case, to capture the regional availability of complex (central) financial services, the following variable was computed:

$$bct_i = \frac{\text{Special liabilities}_i}{\text{Total liabilities}_i} + \frac{(\text{Bonds} + \text{Equities})_i}{\text{Total assets}_i} \quad (3)$$

The *bct* index indicates the regional volume of complex financial services and products intermediated by banks, thus indicating hierarchical dependence on regional banking activity. More specifically, the term *Special liabilities* refers to banks' intermediation services with foreign currencies (imports and exports), acquisitions, underwriting and capitalization of bonds and equities, the payment of bonuses and profit shares, and capital subscriptions. All these intermediation services can be assumed to be highly complex compared with the other liabilities held by banks, such as demand and time deposits, and they are usually transacted in more specialized local markets. The *bct* index also includes the share of bonds and equities to total assets of banks' regional branches – a group of complex financial products only negotiated in central regional markets.[6] It is expected that regions with a high *bct* have banks that handle higher volumes of complex services, indicating that their degree of centrality is relatively elevated.

To reinforce the discussion of hierarchical dependence, we have also estimated models with an alternative indicator of banking functional distance (*bfd*) because it is the usual measure used in the literature (Alessandrini, Presbitero, & Zazzaro, 2009b; Degryse, Matthews, & Zhao, 2015; Presbitero, Udell, & Zazzaro, 2014). *bfd* is computed as the travel distance from the bank's branch in the region to its headquarters as:

$$bfd_i = \sum_{b=1}^{B_i} \frac{[\text{Branches}_{bi} \; x \ln(\sum D_{biz\_b})]}{\sum_{b=1}^{B_i} \text{Branches}_{bi}} \quad (4)$$

where B_i is the number of banks operating in mesoregion i; Branches_{bi} is the number of branches belonging to bank b in i; and D_{biz_b} is the distance indicator between the branch location (i) and its bank headquarters location (z), measured by the travel distance by car (hours) between i and z. It is assumed that branches that are far from their headquarters are less likely to gather information and thus operate under more restrictions (less functionality) than branches closer to their headquarters.

In relation to other variables in the model, local firms' investment rates (I/K) are the value of new purchases of capital (I) in each year for a specific mesoregion divided by the total amount of capital owned by firms (K).[7] Similarly, the profit rate (R/K) is computed by the difference

between firms' total revenues and total expenses with sales (R) at the local level, which is a proxy for firms' local operational profits. The latter is also weighted by the value of firms' total regional capital assets (K).

Local interest rates (i) were computed strictly following the banking mark-up idea contained in Lima and Meirelles (2003) and Cavalcante (2012). Thus, the ratio of the region's banks' net revenues (interest and non-interest earnings) to total assets (*bmkup*) is used as a proxy for *ex post* banking regional mark-ups. Regional interest rates are then computed as the regional banking mark-ups over interest rates on deposits ($bmkup.i_{\text{dep}}$). However, given that data on regional deposit rates are not available, the interest rate on deposits (i_{dep}) is substituted by the national short-term interest rate given by the National Monetary Authority (i_n). Information on the national short-term interest rate is available from the Central Bank of Brazil (CBB).

Local inflation (p) was available from the IBGE for a limited number of metropolitan areas in Brazil. Since the plan for the empirical exercise is to investigate the greatest number of regions possible, problems with missing values for local inflation were resolved by assuming that inflation in region i would be proportional to the Euclidian distance from the region's core to its closest metropolitan area. This practice considers that inflation in metropolitan areas is correlated with inflation in neighbouring areas (Kosfeld, Eckey, & Türk, 2008). The proxy for local inflation reduces variability in the effects of prices, but at least it provides sufficient information to perform estimations for a larger set of regions.

Indicators are also computed to control for urban and agglomeration economies in each region. The relative diversification index (*rdi*), as in Duranton and Puga (2000), is the sum of the differences among the shares of employment in each specific economic activity (j) in the region (i) to total employment (n) in the country (RAIS, 2007).[8] The index can be summarized as:

$$rdi_i = \sum_j |s_{ij} - s_{jn}| \tag{5}$$

The lower the *rdi* index, the less diversified the regional economy. Regional shares of the total population (*pop*) were obtained from the IBGE. The population share accounts for the level of urbanization in the region. Finally, economies of agglomeration (*aggecon*) are computed at the state level as the ratio of the sum of industry (ind) and services (sv) in gross domestic output to total domestic output in each state:

$$(\text{GDP}_{\text{ind}} + \text{GDP}_{\text{sv}}/\text{total GDP})$$

A positive relationship is expected between the level of agglomeration economies in the states and the rates of investment in their constituent mesoregions since higher secondary and tertiary economies indicate better economic activity linkages among sectors, which propel the firms' propensity to invest.

Finally, to build connections among banks' mark-ups, interest rates and investments, a regional financial polarization (*fpolar*) index was included in the estimations. Financial polarization indices were computed following specifications from Ezcurra and Pascual (2007). The index is a modified Gini coefficient, in which banking asset rates are used as weights, while the shares of total deposits are the main inequality variables. According to the index, the polarization of a given distribution f is formally given by a function (Fperg) describing relative differences in the rates of regional banking activity. Formally, one has:

$$\text{Fperg}(f, \delta) = \sum_{j=1}^{m} \sum_{k=1}^{m} a_j^{1+\delta} a_k |\text{dep}_j - \text{dep}_k| \tag{6}$$

Equation (6) describes the regional financial polarization of a given distribution f as determined by the differentials between various places (j and k) in terms of average rates of regional deposits (funding) and the relative sizes of the assets in the local banks. Here a_j and dep_j denote the ratio of financial assets to the region's total assets and the local rate of bank deposits in a regional place j respectively. The parameter values are aggregated banks' deposits and loans at the state level. Fperg then describes the states' total amount of bank deposits weighed by the relative sizes of local assets. The term δ denotes the degree of sensitivity to polarization, with higher values indicating a more elastic index.[9]

The regional inequality in the distribution of deposits has an impact on the determination of the banking mark-up (Cavalcante, 2012). Since deposits are a source of funding for banks, their regional distribution has an effect on the management of banks' portfolios, in turn affecting liquidity and the establishment of the regional banking mark-up and interest rates. The polarization indicators are aggregated using states' scales. Table A2 in Appendix A in the supplemental data online provides a summary of the variables and indicators used. It can be seen that the average regional rate of investment was approximately 4.6% of total capital among firms in mesoregions, while profit rates' averages (operational profits) were roughly at 32%, with a standard deviation of 60%. The average shares of financial concentrations in mesoregions (banks' regional branches and fixed assets) were approximately 1.6%, indicating low average levels of regional financial concentration. Regional financial centralization remained at the regional average of 6% in the period. The next section describes the chosen estimation technique.

Estimation technique: multilevel models

To stress the relevance of different regional structures for investment decisions and banking structures, the multilevel (hierarchical or mixed) linear model is the main econometric technique for the empirical investigation in this paper. Multilevel models can describe the nested structure of panel data by including the representation of the diverse regional levels of the variables through a specific underlying model (Hox, Moerbeek, & Schoot, 2017). Under these settings, the dependent variable (investment rate) is

represented at the lowest regional hierarchical level (mesoregion), and the independent variables could assume different aggregation levels (for mesoregions or states).

Specific to this empirical investigation, the multilevel model is important because it allows for the estimation of investment variability in different mesoregions in Brazil vis-à-vis the consideration of local and state-level effects of banking activity agglomeration and polarization, which is crucial in a context in which banks concentrate and centralize their operations according to differences in the regional markets (level of income, distribution of economic activities etc.) and the banking structure has impacts on the regional availability and prices of financial services.

Hence, the objective of the empirical investigation in this section consists of testing three hypotheses. First, it is investigated whether the regional BA (concentration and centralization) and interest rates are relevant to explaining investment rates from a Kaleckian point of view for the selected sample of regions. Multilevel models are introduced to allow for greater flexibility in the estimation of the parameters, making it possible to check whether polarization at the state level affects the variability of local interest rates. The investigation of this hypothesis might allow for inferences about the relations between regional financial polarization and interest rates – a hypothesis raised, for example, by Dow (1993) and Cavalcante (2012). Finally, different regional scales are also checked from multilevel models. In this case, the relationship between the degree of urban development (centrality) and the variability in interest rate coefficients can be investigated. It is expected that central and peripheral regions will present diverse investment sensitivity to changes in local interest rates.

In general, multilevel panel data models are a generalization of panel regression, allowing for the inclusion of random deviations (effects) other than those associated with the overall error term (Goldenstein, 1995). The multilevel panel data representation is thus extended to include nested levels. Specifically, in the case of this section, the data set comprises investment rates in 128 mesoregions in 25 Brazilian states. Therefore, the model can be specified to include, among other multilevel interactions, interest rates as a random effect at the mesoregion level, instead of attempting to determine this random effect from the data as a whole. Moreover, random effects can also be analyzed at the mesoregions-within-states levels. To analyze these data, separate panel regression equations are established to predict firms' investments in each mesoregion using the set of explanatory variables, as follows:

$$g_{ij}^{d} = \beta_{0j} + \beta_{1j} r_{ij} + \beta_{2j} i_{ij} + \beta_{3j} P_{ij} + \beta_{4j} BA_{ij} + \beta_{5j} z_{ij} + e_{ij} \quad (7)$$

where g_{ij}^{d} is the local investment rate (I/K); r_{ij} is the local rate of profits (R/K); i_{ij} is the local interest rate; P_{ij} is the local level of prices; and BA_{ij} is local banking agglomeration attributes (concentration, bcc_{ij}, and centralization, bct_{ij}). The model also includes a set of control variables z_{ij} (population and local economic diversification). In each panel between 1996 and 2005, the subscript j represents the states ($j = 1, \ldots, J$), and the subscript i represents individual mesoregions ($i = 1, \ldots, n_j$). As shown above, this model stresses the departure from a usual panel regression model by assuming that each mesoregion might have a different intercept coefficient β_{0j} and also might have different slope coefficients (β_{1j} to β_{4j}). The residual errors e_{ij} have zero mean and variance to be estimated.

The following analytical step considers different representations of the multilevel model to estimate the relationships described in equation (7). By assumption, regression coefficients β_j have a multivariate normal distribution among all the mesoregions. As such, to explain the variation of the regression coefficients β_j, the model includes explanatory variables for the intercept in equation (7) as:

$$\beta_{0j} = \gamma_{00} + u_{0j} \quad (7.1)$$

and for different slopes in equation (7), we have:

$$\beta_{2j} = \gamma_{20} + u_{2j} \quad (7.2)$$

$$\text{or} \qquad \beta_{2j} = \gamma_{20} + \gamma_{21} Z_j + u_{2j} \quad (7.3)$$

Equations (7.1–7.3) are functions modelling the variance in the intercepts and coefficients. Equation (7.1) decomposes the variance of the dependent variable into two independent components: σ_e^2, which is the overall variance of the errors e_{ij}; and σ_{u0}^2, which is the variance of the mesoregion-level errors u_{0j} (as in equation 8 below). This process allows the method to extract the effects of regional variances from the estimation results. Hence, a first mixed-model specification can take equation (7) and include a predetermined specification for a random intercept. By assuming this predetermined function, for instance, variance in individual mesoregions' average investment rates are allowed by inserting equation (7.1) into equation (7).

The empirical investigation proceeds by adding a random slope specification for the local interest effects on investment. In this case, equations (7.2) and (7.3) can be considered reciprocates of equation (7.1), only now they allow for specific variance in the coefficients (slopes) in equation (7). Given that the coefficient β_{2j} (equation 7.2) assumes this new specification form, we substitute equations (7.2) and (7.3) into equation (7) to form:

$$g_{ij}^{d} = \gamma_{00} + \beta_{1j} r_{ij} + \gamma_{20} i_{ij} + \beta_{3j} P_{ij} + \beta_{4j} BA_{ij} + \beta_{5j} z_{ij} + u_{0j} + u_{2j} i_{ij} + e_{ij} \quad (8)$$

Note that the intercept γ_{00} now refers to the average investment rate, while u_{0j} introduces a variance term into the equation. Also, the consideration of a random slope γ_{20} allows for within-groups variation in the sensitivity of investment to local interest rates. In such a model, mesoregions are allowed to present their own degree of variance in the effects of interest rates on local firms' investment rates. In the present case, this specification is in line with the approach presented in theoretical section, which assumes that different mesoregions might be under different processes of interest rate determination, affecting the

sensitivity of local firms' investment and growth to locally determined interest rates.

Moreover, by assuming this hypothesis, it is straightforward to test the impact of the degree of financial polarization at the state level as a co-determinant of interest rates and local investment levels. To do so, a state-level variable accounting for the degree of financial polarization is included as an additional explanatory variable for the variance in intercept β_{2j} (as in equation 7.3). Formally, we have equations (7.1) and (7.3) substituted into equation (7) as:

$$g_{ij}^{d} = \gamma_{00} + \beta_{1j} r_{ij} + \gamma_{20} i_{ij} + \gamma_{11} \mathrm{FPol}_j + \gamma_{21} \mathrm{FPol}_j\, i_{ij} + \beta_{3j} P_{ij} + \beta_{4j} BA_{ij} + \beta_{5j} z_{ij} + u_{0j} + u_{2j} i_{ij} + e_{ij} \quad (9)$$

where FPol_j is the financial polarization (FPerg) in state j. Equation (9) now contains financial polarization at the state level as an explanatory factor for the intercept and the interest rate coefficient.

For the sake of comparison with the overall results, the estimation also includes traditional panel data models (fixed and random effects). Moreover, to analyze further the effects of alternative indicators on banks' concentration and centralization, hierarchical models were estimated with alternative indicators of these local attributes. The results are reported in Appendix A in the supplemental data online. Finally, because the model might be affected by problems of endogeneity (both reverse causality and omitted variables), a model was estimated with lagged independent variables, as in Degryse et al. (2015). The next section presents the results from the estimations.

ESTIMATION RESULTS

Random intercepts and random slopes for local interest rates

Table 1 shows the main estimation results, including traditional panel data (fixed and random effects), seven different mixed-model specifications and a model with lagged independent variables.[10] All the variables used in the estimation were standardized. Models 1 and 2 report the results from traditional panel data models (fixed and random effects). Model 3 shows the results when intercepts are allowed to vary individually among mesoregions (the random intercept model). The results indicate that the variance in the class-level (regions) residual errors is estimated significantly as 0.213, indicating that intra-class (regional) correlation explains 21% of the variance in average local investment rates, which is fairly high. The deviance reported at the bottom of model 3 is a measurement of model misfit, which is expected to decrease when other explanatory variables are added to the model.

The fourth model specification in Table 1, which includes variables at the state level, shows that these variables are significant and that their signs behave as expected. Rising polarization would exert upward pressure on the average level of regional interest rates since the worst regional distribution of financial resources contributes to the concentration of revolving funds in some polarizing regions (states), improving finance and funding conditions in these regions at the expense of peripheral regions. The regional disparities in interest rates are thus enlarged, with peripheral regions carrying the burden of higher local interest rates and lower investment rates.

Model 6 in Table 1 reports the same random intercept model from model 5, with the only difference being the addition of polarization and state agglomeration economies as controls. These random slope models (5–7) assume variability in the coefficients of local interest rates. Intra-class correlation in regional interest rates explains approximately 20% of the investment rates' variance, which is also fairly high.

Overall, the coefficients for local profit rates and interest rates remained significant throughout diverse model specifications (models 1–5). The signs for the coefficients were also the expected ones. Because the variables are standardized, one can use the standard deviations (SDs) presented in Table A2 in Appendix A in the supplemental data online to analyze the standard coefficients of regressions in Table 1. While an increase of 1 SD in the profit rate (60%) raises investment, on average by 0.09 SD (0.3%), an increase of 1 SD in local interest rates (3.8%) reduces investment rates by 0.18 SD (0.6%). These relationships are in line with the model assumed in previous sections and equation (1). Overall, these results indicate that banks' charges on funds for investment in different regions are important for local investment. Overall, changes in interest rates affect the marginal efficiency of local investment, contributing to the relatively greater sensitivity of investment to interest changes.

Banking regional weight (concentration) and centralization also have significant coefficients. On average, 1 SD in banking regional weight (*brw*) raises investment by 1.3%, indicating that a greater regional presence of banks fosters the financial possibilities offered to firms. Also, an increased offer of specialized services (*bct*) in mesoregions increases investment rates by 0.3%, confirming the importance of the banking system and the availability of complex financial services to the promotion of investment and growth. However, the interaction term between banking regional weight (concentration) and centralization (*brw_bct*) was not robustly significant through the different specifications. Nonetheless, some inference is possible in models 5 and 6, in which the coefficients of interest rates can vary regionally. In highly locally concentrated banking environments, the impact of an increased offer of complex banking services is actually less than in less bank-concentrated regions,[11] indicating that, in regions with higher banking concentration, the marginal effects of a change in centralization are less since these regions present, in general, more developed (financial) institutions.

Models 5–7 in Table 1 introduce specifications in which it is assumed that mesoregions have different investment sensitivity to changes in local interest rates due to different banking institutional and structural features. The results indicate that some variance in investment rates can be explained by regional variations in the coefficients of interest rates. The value of –0.18 (model 5) for

Table 1. Main estimation results.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
	FE	RE	Random intercept	Random intercept plus state variables	Random slope for *i*	Random slope for *i* plus state variables	Random slope for *i* plus local polarization plus state variables	Random slope homoskedastic	Random slope heteroskedastic	RE lagged independent variables
r	0.09***	0.09***	0.09***	0.09***	0.09***	0.08***	0.08***	0.06**	0.06***	0.05***
	(0.01)	(0.01)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)	(0.005)
i	–0.18***	–0.18***	–0.18***	–0.18***	–0.18***	–0.19***	–0.19***	–0.10***	–0.11***	–0.14**
	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)	(0.04)	(0.01)
P	0.046***	0.038***	0.038	0.037	0.041	0.039	0.039	0.0005***	0.0005***	0.046***
	(0.002)	(0.002)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.0001)	(0.0001)	(0.001)
brw	0.042	0.381	0.39*	0.381	0.41*	0.40*	0.33	0.65***	0.42**	0.36
	(0.25)	(0.24)	(0.24)	(0.25)	(0.24)	(0.25)	(0.25)	(0.20)	(0.21)	(0.23)
brw_bct	0.001	–0.074	–0.075	–0.077	–0.08*	–0.08*	–0.07	–0.14***	–0.09**	–0.07
	(0.03)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.04)	(0.04)	(0.04)
bct	0.05	0.09**	0.09*	0.11**	0.09*	0.11**	0.11**	0.12**	0.10**	0.09*
	(0.07)	(0.04)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.04)	(0.04)	(0.05)
rdi	–0.03	0.06***	0.06	0.06	0.06	0.06	0.06			0.06***
	(0.03)	(0.01)	(0.05)	(0.05)	(0.05)	(0.04)	(0.04)			(0.02)
pop	0.048***	0.021	0.021	0.017	0.006	0.005	0.008			0.006
	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)			(0.07)
fperg_state				–0.14***		–0.13***	–0.13***	–0.15***	–0.13***	
				(0.05)		(0.05)	(0.05)	(0.03)	(0.04)	
aggec_state				0.20***		0.19***	0.18***	0.18***	0.18***	
				(0.04)		(0.04)	(0.04)	(0.03)	(0.04)	
fperg_i							0.05*			
							(0.03)			
centre dum								0.050	0.115	
								(0.09)	(0.11)	
centre_i								0.13*	0.14**	
								(0.08)	(0.07)	
Const	–0.005	0.033	0.034	0.032	0.032	0.030	0.022	–0.855***	–0.847***	0.072**
	(0.01)	(0.03)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.13)	(0.13)	(0.03)
Var(cons)[a]			0.213***	0.195***	0.213***	0.196***	0.197***			
			(0.04)	(0.03)	(0.04)	(0.03)	(0.03)			
Var(resid)[a]			0.719***	0.712***	0.674***	0.670***	0.670***			
			(0.03)	(0.03)	(0.03)	(0.03)	(0.03)			
Var(iloc)[a]					0.044***	0.040***	0.039***			
					(0.01)	(0.01)	(0.01)			
sd(periph)[a]									0.48***	
									(0.04)	
sd(periph_i)[a]									0.22***	
									(0.04)	
sd(centre)[a]									0.23***	
									(0.08)	
sd(centre_i)[a]									0.18***	
									(0.08)	
sd(iloc)[a]								0.161***		
								(0.04)		
sd(Resid)[a]								0.913***	0.795***	
								(0.02)	(0.02)	
Observations	1264	1264	1264	1264	1264	1264	1264	1264	1264	1264
Variance group	0.58	0.47								0.56
Variance error	0.85	0.85								0.86

(*Continued*)

Table 1. Continued.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
	FE	RE	Random intercept	Random intercept plus state variables	Random slope for *i*	Random slope for *i* plus state variables	Random slope for *i* plus local polarization plus state variables	Random slope homoskedastic	Random slope heteroskedastic	RE lagged independent variables
Hausman test		145.3 [.00]								
BPLM_RE[b]		254.5 [.00]								204.0 [.00]
Deviance			3380	3367	3364	3353	3356	3392	3238	

Notes: [a]sd, Standard deviation; Var, variance.
[b]BPLM_RE = Breusch–Pagan Lagrange multiplier test for random effects.
***$p < .01$; **$p < .05$; *$p < .10$.
Source: Author's own calculations from LEMTe-CEDEPLAR (2007), IBGE (2015) and RAIS (2007).

the local interest rate coefficient (*i*) in the fixed portion of the model must be interpreted by the confidence interval given by the estimated variance for the coefficient. Thus, in 95% of the cases, it is expected that the coefficient for interest rates lies between –0.14 and –0.23, indicating that interest effects on investment rates range from –0.5% to –0.8% in different regions. This variability in the magnitude of interest effects on firms' investment plans is partly explained by the regional diversification of financial and banking processes in Brazil.

Following the analysis, in model 6, once financial polarization declines at the state level, financial resources are better distributed, prompting a negative effect on the average regional banking mark-up rates (a fall in interest rates), which raises average regional investment rates. On average, a decrease of 1 SD in financial polarization at the state level (7%) will increase local investment rates by 0.48%. Deviance (shown at the bottom of Table 1) has progressively fallen in specifications compared with model 3 of Table 1, with intra-class (regional) correlation explaining approximately 20% of the variance in local investment rates. This result suggests that the models marginally improve their fitness to the data.

Model 7 in Table 1 expands the specification assumed in model 6 by including financial polarization at the mesoregion level to explain variability in the estimated coefficients of local interest rates. According to the discussion in previous sections, it is paramount to allow financial polarization to explain the regional differences in the impacts of interest rates on investment rates. Thus, to explain differences in the interest rate slopes for individuals (regions), an interaction term between financial polarization (state level) and local interest rates (fperg_*i*) is included in the fixed part of the empirical model 7. As such, the interaction term is significant at the 10% level, indicating that, in mesoregions embedded in states with higher-than-average levels of financial polarization, the effects of interest rate changes on investment are lower than in regions belonging to less polarizing states. In other words, investment is more sensitive to regional interest rates changes in states with lower financial polarization. This result indicates the importance for regional growth of more equal distribution of banking financial attributes over a territory.

As discussed above, the empirical exercise was extended to include other banking concentration and centralization indicators. For the results, see Tables A3 and A4 in Appendix A in the supplemental data online. Overall, the parameters estimated in the multilevel models are robust. However, the results for the concentration index are mixed (see Table A3 online). On the one hand, the regional share of banks' branches (*bcc2*) yields the same quantitative results as our *brw* indicator, which was expected. The efficiency indicator (*eff*) was also significant through the different models, and the estimated coefficients all have positive signs. They are, however, of a lesser magnitude than the *brw* parameters. This result is rather informative since it indicates that the bank branches' increased capacity to fund their loans locally (through the collection of deposits) might enable some leverage for reductions in liquidity preference, increasing banks' efficiency in providing services in the region, which in turn increases local investment rates. Finally, other concentration indices (total bank branches in regions, HH for bank branches and the financial operation taxes per local branch) were not statistically significant. However, in these cases, the estimated parameters for the main regressors remained robust through the different models.

In the models in Table A4 in Appendix A in the supplemental data online, *bct* (our indicator for centralization and regional hierarchy) was substituted for an indicator of branches' functional distance (*bfd*). The general results for the mixed models remained unchanged, reaffirming the significance of intra-regional variance for the explanation of investment rates. The profit and interest rate parameters remained unchanged, as well as state-level variables (polarization and agglomeration economies). The functional distance indicator (*bfd*), although not completely robust over different model specificities, remains capable of providing some support for the centralization argument in this

paper. In general, *bfd* has an expected negative sign, indicating that increases in functional distance (or a lesser degree of banking centralization) reduce investment rates in the region. This result is in agreement with the literature.

Given the inferences so far, there are indications that firms' investment decisions are conditioned by the banking structures and local interest rates of different regions in Brazil. In the next section, the empirical estimations test whether there are significant differences in investment rates between central and peripheral regions.

Variability in interest rates' impacts on central and peripheral regions

In this section, the empirical investigation considers the possibility of different effects between central and peripheral regions (model specifications 8 and 9 in Table 1). Firstly, to account for such a hypothesis, a 'centre' effect is included in the fixed part of the model by adding a centre dummy and a centre-interest rate interaction to assist in modelling the overall investment rates' mean (model 8). This addition is the primary specification in this subsection, assuming that the variability in mesospecific deviations from the average is the same for central and peripheral regions (homoskedastic). Secondly, a centre dummy is introduced into the random component of the model to account for possible heteroskedasticity (due to central regions) between groups (model 9). Finally, for general comparison purposes, model 10 reports results when the profit rate is assumed endogenous.

Overall, the models accounting for different variability between central and peripheral regions perform slightly better in terms of the significance of the coefficients, compared with the models analyzed in the previous section. For instance, the effects of price changes, despite being rather small, are indeed significant within the specifications in this section. Also, model 8 has a positive and significant interaction term *centre_i*, which indicates that the effects of local interest rates are different between the central and peripheral regions.[12] However, the main *centre* (dummy) effect is not significant, which might indicate that, on average, central and/or peripheral regions do not have an established pattern of higher or lower investment rate levels when the regional banking structure is controlled for. However, in estimations with functional distance as a proxy for centralization (see Table A4 in Appendix A in the supplemental data online), the *centre* dummy is significant and positive. One cannot, therefore, dismiss the importance of a centre–periphery pattern, although a more careful examination is required, indicating that there are other factors affecting the firms' investment decisions that are not covered by the model in this paper. Note that models 3–9 are specifically tailored to permit regional variability in intercepts and slopes, rendering their results more attuned to the argument that diverse financial structures can affect regional economic performance differently.

The results in models 8 and 9 in Table 1 corroborate the idea of the diverse variability of interest rate coefficients between central and peripheral mesoregions. A peripheral region in the sample has a greater variability in the coefficients for interest rates, indicating that investment in such regions is more sensitive to changes in local interest rates than investment in central regions. This finding is in accordance with the results obtained in the previous section, which showed that, in regions with higher interest rate coefficients, the effects of banking concentration are statistically more prominent as well. In addition to this feature, it should be noted from Table 1 that peripheral regions have higher interest effects on local investment rates than central regions.

CONCLUSIONS

In studying firms' decisions about investment under a Kaleckian perspective, in which internal and external funds are crucial variables in their decisional processes, it becomes fundamental to analyze the different territorial contexts in which firms are embedded. In these contexts, the banking structure (banking agglomeration and polarization) plays a role in the determination of interest rates and thus the price of external funds locally available. This paper's objective was to gather evidence to reinforce the theoretical links among regional banking structure, interest rates and local investment by firms.

The results obtained from the sample of Brazilian firms in mesoregions validate the Kaleckian investment function used in this paper. A mixed-model estimation technique was used to verify that the selected predictors are, in fact, statistically significant for local investment functions. The results indicate not only that local interest rates are fundamental for firms' investment plans but also that such plans and the sensitivity to their predictors might change depending on the regions in which firms are located. Investment in peripheral regions is more sensitive to changes in financial conditions, alluding to the importance of paying special attention to local financial attributes as a tool for regional development in Brazil.

One main contribution advanced by this paper is the focus on the banking agglomeration as supportive of the development of regional financial networks that enable more balanced regional growth. Note that the discussion here, despite emphasizing banks' supply of services as paramount to investment, does not exclude the importance of local demand factors (liquidity preference). Therefore, the main findings of this study provide an opportunity for policy-makers and local administrators to evaluate and design more appropriate policies and actions in support of more inclusive and balanced regional growth. Accordingly, the most relevant parameters for public policy design would be the structure of the local banking system and the overall regional financial polarization. It can be seen from the estimations in this paper that local banking agglomerations are indeed essential to the accumulation plans of local firms because they can provide the support needed for stable financing and funding of economic development activities. Furthermore, the degree of banking polarization is also confirmed as relevant for investment in the

regions and periods analyzed, indicating that income leakages can harm any plan for local development because they would reduce banks' local functionality and redirect demand to other more developed (central) regions. A policy-maker should thus consider a more encompassing regional policy, which includes a very thorough analysis of regional interconnections, linkages and the strength of interconnected processes of economic and financial growth.

Overall, the evidence in the paper also suggests that finance and growth studies must consider the specificities and contexts of regions as fundamental parameters shaping the evolution of growth-inducing institutions. Public investment in regional networks and local agglomerations should thus consider how the expected changes in income in central and peripheral areas are related to the development of local financial activities since the latter can be very supportive of growth. Moreover, sustained growth in local financial functionality might enable the breakdown of long-standing dependency on public funds for local growth in some regions because a regional economic growth process sustained by improved financial conditions has a greater likelihood of generating returns that are compatible with the needs of local firms, prompting a more independent growth path.

Finally, regional diverse sensitivities to interest rates and financial (banking) structures can also better inform policy-makers when devising instruments for financing of local growth. As indicated in the results section, diverse local settings with their own economic and financial capabilities are nonetheless interconnected. In developed urban settings of higher centrality, where a broader range of complex financial services are paired with lower investment rate sensitivity to interest rates, the greatest challenge is to create financial instruments that can attract private funding for diverse sustainable projects, such as those related to infrastructure (roads, water, transit) and technologically driven products and services (smart urbanism).

A growth policy, however, might not consider these central regions as isolated units since their growth can be severely concentrated, raising local congestion costs and deepening urban structural problems. Regional development plans naturally assume a more balanced regional set as their main objective. However, the very concentrating and centralizing nature of the financial system is almost never considered in these plans. The challenges are thus twofold: firstly, it must be recognized that the financial system is highly concentrated and centralized, and thus policies directed to lagging regions must be carefully considered; and secondly, in such a hierarchical system, in which the private logic of the lowest risk and highest returns dominates, less developed regions might not possess the appeal and drawing power of other more developed regions, which in turn require the greater presence of government initiatives. In developing regions with low financial concentration and centralization and higher investment sensitivity to interest rates, a growth plan should focus on both extending local competitive activities and creating new capabilities that are attuned to a more equilibrating and interconnected regional network. In this case, public funding, if correctly channelled to sustainable, inclusive and inequality-reducing activities, should serve as the main lead in local development. Public sources of funding are therefore paramount for growth in lagging regions, at least in its initial stages.

DISCLOSURE STATEMENT

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NOTES

1. Care should be taken when referring to loan-to-GDP ratios because they involve computing stock and flow variables using the same index. In the case of Brazil, rising loan-to-GDP ratios might not be perfectly correlated with economic growth since the ratio rapidly expands during booms but does not fall at the same rate during recessions. We used the index only to indicate the expansion of credit and loans in the Brazilian economy during the period.
2. The term 'concentration' here refers to the level of financial intermediation in the region (level of financial services offered in a specific region), thus differing from the usual studies of regional financial market structure (competition) contained in Guevara and Maudos (2009) and Carbó et al. (2006), among others. For a more explicit discussion, see Cavalcante (2012).
3. The data set contains 128 mesoregions from a total of 133. Information was not available in four of the mesoregions.
4. HH indices, as originally discussed in the literature on microeconomics, are computed by summing the (squares of) market shares of each firm in a given market. The market (and its limits) must then be defined a priori, which can pose difficulties for the computation of the index. When the HH index is applied in regional economics, a region (and its territorial limits) is assumed a priori as the 'market'. However, in a national context, with no boundaries for firm activities, defining a region and its limits as a market would be problematic. Different territorial limits can produce different results. The problem is even worse for financial services, given that agents with different specificities might be present in a region (commercial/investment/development banks, insurance companies, and others), making it difficult to tag their markets and to compute and analyze HH indexes.
5. The objective of the *brw* index is generally to capture one local attribute of the banking system. However, given the manner in which the index is defined, it implicitly assumes that its components (branches and fixed assets)

share a degree of substitutability between them. Note that the share of branches has, on average, a slightly larger contribution to *brw* index variability than fixed assets.

6. Since intermediation with bonds and equities is highly concentrated in specific central regions, only some branches in a few regions in the sample actually register bonds and equities on their balance sheets. As such, this indicator will be skewed towards central regions – an unbalance that will be specifically modelled in the fourth section. Moreover, as discussed above in note 5, given the two components of the *bct* index, one should note that special liabilities make a larger contribution to variability in the index than bonds and equities.

7. The variable capital (K) refers to capital goods (equipment and machinery) owned by firms, which are directly related to production.

8. The sectoral division of economic activity followed the specification of the IBGE, which splits real economic activity into 25 groups, ranging from agriculture to services.

9. This study has opted to maximize the polarization sensitivity in each Brazilian state to enhance the weight of local variables. To achieve this goal, the highest value of δ given by Ezcurra and Pascual (2007) was used for the computation. The polarization index also has a correction term accounting for distortions between possible diverse groups of regions, a term omitted from the presentation.

10. Results for the Hausman and Breusch–Pagan tests corroborate the use of a random-effects model rather than a fixed-effects model, signalling the importance of allowing for an idiosyncratic error term for each region. These tests also corroborate the further use of mixed models in the remainder of the section.

11. The analysis must be performed by adding the *brw* and *bcc* estimated parameters.

12. A likelihood ratio test confirms that, at the 10% significance level, the hypothesis of no difference between the centre and periphery interaction terms is rejected.

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