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Investment and the Banking System: a Kaleckian approach for regions in Brazil.

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Resumo

Este artigo analisa os efeitos da distribuição do sistema bancário sobre as taxas de investimento regionais no Brasil. A investigação depende de uma perspectiva kaleckiana, onde o papel dos recursos externos com indutores do investimento é submetido a uma avaliação marcada por uma distribuição regional desigual do sistema bancário. Esta abordagem vem da consideração de um conceito de desenvolvimento financeiro que é orientado para a região, segundo o qual os portfolios regionais dos bancos e, assim, o financiamento local, é afetado pela concentração e centralização do sistema bancário. Os resultados empíricos a partir de um modelo multinível indicam que a taxa de lucro regional e as taxas de juros são relevantes (mas relativamente inelásticas) para explicar o investimento regional. Há também evidências de que a concentração financeira regional e centralização são importantes para a escolha de investimento das firmas. Mais importante ainda, a adequação do modelo multinível aponta para a importância relativa de se considerar que as taxas de investimento têm diferentes níveis regionais e que os parâmetros variam de acordo com uma estrutura regional hierárquica (centro vs. periferia).

Abstract

This paper analyses the effects of the regional distribution of the banking system on regional investment rates in Brazil. The investigation relies on a Kaleckian perspective, where the role of external funds to induce investment is submitted to an appreciation characterised by a disparate regional distribution of the banking system. The latter approach comes from considering a financial development concept that is regionally oriented, whereby banks' regional portfolios and, thus, finance is affected by concentration and centralisation of the banking system. Empirical results from a multilevel model indicate that the rate of regional profits and interest rates are relevant to explain regional investment. There is also evidence that regional financial concentration and centralisation are important for firms' investment choices. More importantly, the fitness of the multilevel model points to the relative significance of considering that investment rates have different regional levels and that parameters vary according to a regional hierarchical structure (centre vs. periphery).

Keywords: Rate of Investment, Banks, Regions, Concentration, Centralisation.

JEL classification: O16, R12, R15

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1. Introduction

This paper aims at studying the regional pattern of investment in the period 1994-2007 and how it was affected by the regional distribution of the banking system. This subject of study is relevant from three standpoints. Firstly, from a theoretical point of view, it is important to gather evidence of a regional financial development process affecting investment rates. Financial development is understood as the smooth operation of finance and funding facilities, which are primarily rooted in transactions occurring at the regional level (Studart, 1995; Cavalcante, 2011). If such view is accredited, 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.

Secondly, references to the Kaleckian approach to the investment function also add a new character to this paper. From our best knowledge, there are few studies that estimate investment rate functions that assume the parameters envisaged by Kalecki (1971), and even less or none that take such appreciation to the regional level. This regional empirical appreciation is the third novelty in this paper: the use of a hierarchical model to empirically estimate the regional investment functions is also not contemplated by the literature. A multilevel model fits perfectly to the paper's purpose by considering, a priori, that regions have different levels of investment rates and may present different sensibilities to changes in interest rates.

In line with this view, this paper includes this introduction and other two sections. The first section explores some current works on regional investment, highlighting the usual lack of monetary variables as explanatory factors. The section also introduces the main concepts used to understand the regional effects of the banking system on the determination of investment, including a preliminary investigation over the concentration and centralisation of banking activity in Brazil. Section 3.1 presents the function to be estimated, dataset, variables, estimation methodology and the results. The following subsections specifically bring the estimation results, which are separated by different empirical model specifications. The specification in subsection 4.1 introduces random intercepts and random slopes in the estimation. In subsection 4.2, considers the possibility of heterogeneity between estimated coefficients for central and peripheral regions. Section 5 concludes.

2. The literature on Investment, the Banking System and Regions

Regional studies over investment usually follow macro theories about growth and investment. This is the case in studies using the accelerator idea, whereby investment is proportionally determined by changes in production levels. The dynamic developments on Keynes' (1936) approach brought by

Harrod (1937) is inspired by the (in)stability characteristics of the investment and growth relationship. These types of models are usually parsimonious, assuming that significant determinants of investment such as capital cost, profitability and lags of time for the implementation of investment are given. On the other hand, models of investment pioneered by Jorgenson and Hall (1971) have partly covered the missing points of discussion by including real rates of interest, depreciation costs and prices of capital goods.

Tobin's (1969) model assumes that investment is determined by the Q ratio, which is affected by the marginal cost of new investment and the prompt availability of capital goods. According to Hayashi (1982), the irreversibility of investment imposes a problem to the model, as the costs of disinvesting could be higher than the costs of investing (Britto, 2010). In the investment model of Sneessens (1987), demand restrictions are included and the firm has two crucial decisions to make: whether they will produce or not, given the utilised capacity in the economy; and how much capital they 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's (1971), whereby investment is closely related to the dynamics of the distribution of income. The latter is divided between capitalists and workers, with the former considering growth expectations to make capital accumulation plans (Arestis, 1996). This is reflected in an investment rate function that is determined by the profits accruing to capitalists and interest rates.[1] The level of profits affects investment in two ways: as a source of internal funds that enables investment to be realised and as a sign whether future growth expectations will materialise. Interest rates affect investment through changes in the marginal efficiency of investment.

Investment decisions by firms are also studied from the viewpoint of imperfect markets. Fazzari et al. (1988) point out that the complexity of investment precludes the use of rules-of-thumb by firms. Stiglitz and Weiss (1981) stress the effects of information asymmetry on credit markets. For these authors, the use of external funds for investment increase the firms' efficiency in managing available funds, but it also comes at the expense of increasing the costs of bankruptcy. In a more recent work, Kalatzis et al. (2006) have focused on the importance of internal funds for firms' investment, stressing the role of liquidity variables (cash flow, profitability, etc.).

External funds are also prominent in explaining firms' investment in studies concerned with institutional parameters of financial development (Levine and Zervos, 1998). By studying the relation between financial development and the growth rates of production, capital, and productivity, it is straightforward to consider the effects of the efficient provision of financial

services on firms' investment constraints. Beck and Demirgüc-Kunt (2006) conclude that recent empirical studies indicate the importance of access to finance for firms' growth. 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 et al. (2004) reiterate this view, stressing the importance of integrated financial markets. Agarwal and Mohtadi (2004) analyse the differences between equity and debt financing in markets with underdeveloped financial institutions. Overall, studies point out that banking sector development propels debt financing by affecting capital costs, availability of long term loans and collateral requirements (Russo and Rossi, 2001; Shen and Wang, 2005).

In general, the regional context of investment is studied by reductionist forms of the abovementioned models (Britto, 2010), taking regions instead of countries as the main subjects of study. According to Carbó et al. (2006), the focus on regions has the advantage of presenting fewer cultural, institutional and legal differences in relation to countries. By assuming that capital is not perfect mobile between regions, Amos and Wingender (1993) show that financial activity is spatially segmented, giving rise to regional interest rates' differentials that affect firms' investment decisions. In the regional case, the financial system spatial segmentation has nurtured the development of three fields of study (Guevara and Maudos, 2009) in regional finance: a) regional monetary multipliers, whereby the regional quantity of money has short term impacts on growth; b) interregional flows of funds, a field which assumes that regional funds moves around regions to adjust regional interest rate differentials; and c) regional financial markets, whereby the financial structure is assumed to differ between regions, especially in relation to available information, generating diverse effects in the availability of credit and interest rates (Samolyk, 1994).

These studies are crucial to understand the dynamics of regions, investment and financial markets. Carbó et al. (2006) find evidence that banking sector development positively affects to regional output growth and investment. Once the development of the financial system is related to its regional performance and structure (Dow, 1993; Dow and Rodriguez-Fuentes, 1997; Crocco et al., 2010; Cavalcante, 2011), further issues on the distribution, size and functionality of regional financial markets arise as important topics of study. Cetorelli and Gambera (2001) show that arguments range from market inefficiencies to banks' monopoly power altering regional credit allocation. Banks have a direct influence on the regional investment decisions because information is unequally available through the space, leading financial institutions to set diverse regional charges over the required financial services for investment (Maúdos and Guevara, 2004; Hirakawa and Bueno, 2009; Alessandrini et al., 2009).

Not only does the financial system provide the required finance for the realisation of firms' investment plans, but it does also support such plans with financial intermediation services (Guiso et al., 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, where the behaviour of the banking system is conditioned by regional agglomeration features, as advocated by the works of Dow (1993), Rodriguez-Fuentes (1998), Martin (1999), and Crocco (2010). By mixing up the relevance of money to the economic process together with the comprehension of the region as the basic locus to the development of this relationship, these authors have opened a new avenue to explore the links between the liquidity preference of regional agents, the regional distribution of credit, the effects of central regions over this distribution, and the differences in regional patterns of development.

In this paper, the object of investigation follows the above theoretical approach by suggesting that the regional pattern of a Kaleckian investment function is related to the regional concentration of the banking system activity and its hierarchy. Moreover, this work also 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.

Cavalcante (2011) has introduced a post-Keynesian model where regional firms take internal (profits) and external funds (represented by the regional interest rates on financial services and the available financial structure) to realize investment plans, generating income growth that is distributed towards profits and wages. Subsequent changes in the rate of profits induce adjustments in the regional financial market structure (concentration, centralisation, and polarisation) via the intensification of the use of financial services, which in turn propel banks to adjust their regional portfolios, altering mark-ups and interest rates. The model sets up an investment function, as in Kalecki (1971), which has a central role in determining short-run changes. Firms are, thus, the main drivers of growth, adjusting their investment plans in the region according to the local levels of the profit rate, the real interest rates and, in the specific case, regional financial attributes (financial concentration and centralisation). The novelty in this approach is to assume that firms will not only take retained profits as important drivers for future accumulation plans, but that the prompt availability of external funds will also be fundamental to the process. This availability is measured by the regional presence of banks and the complex services their offer locally.

Therefore, banks are important players in the regional growth process, since they take 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) they set on financial services

they offer, directly affecting the availability of investment facilities to firms. The concentration of banks in a specific region improves the availability of financial services to firms.[2] In concentrated areas, the volume of services is large, which propels economies of scale to banks and agglomeration economies to firms. In its turn, banking centralisation indicates that a wider array of complex financial services is available to firms in agglomerated areas, which increasingly supports investment decisions by firms. Moreover, the polarisation of resources in specific regions strengthens the link between finance, investment and funding (Cavalcante, 2011), contributing to falling interest rates and higher marginal efficiency of investment. 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 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 such claim.

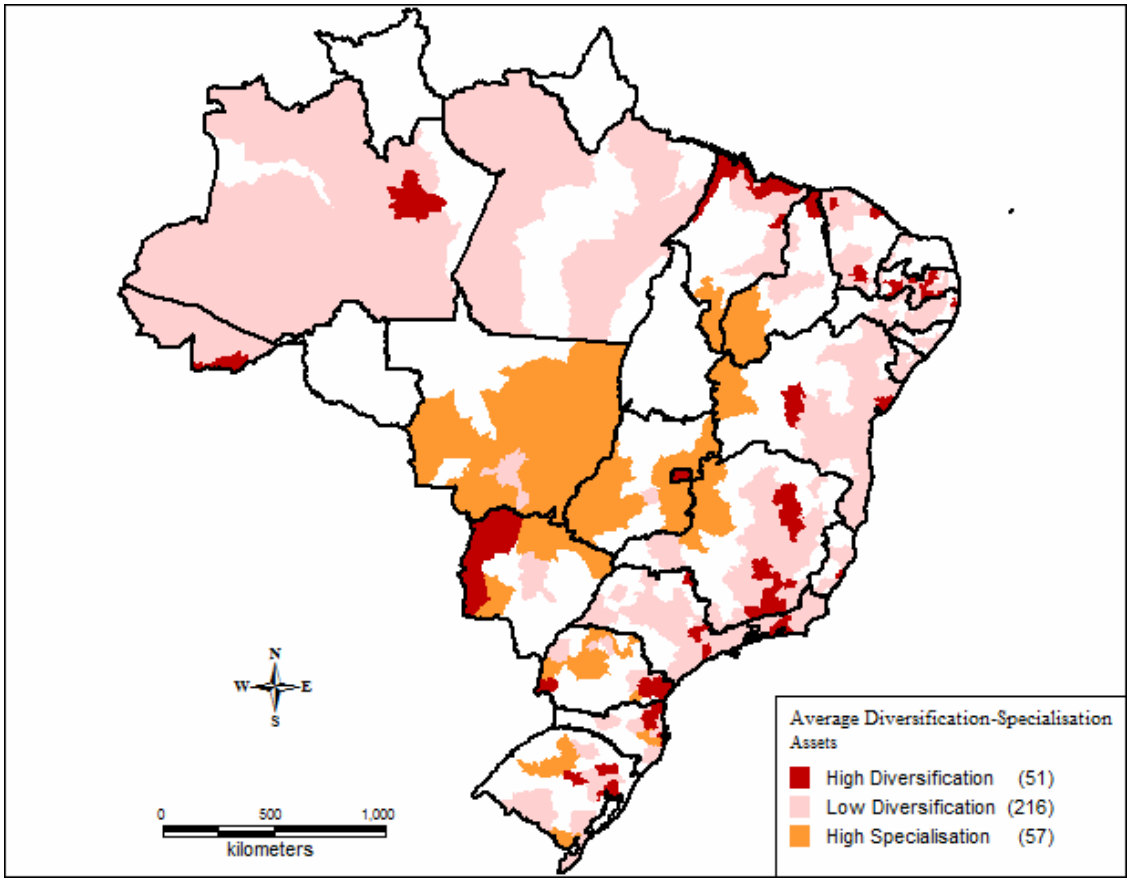
2.1. Banking regional concentration and centralisation in Brazil: some preliminary evidence

In this section, we suggest an indicator for financial concentration-centralisation at the level of microregions. The suggested index is analysed from the perspective of the agglomeration of diversified financial activity (loans and deposits) in each region, being relative to the share of bank lending and to the level of deposits in total assets in the banking system.

The Banking Concentration-Centralisation Index (*BCCI*) gathers three different relative measures of regional banking activity. A locational quotient (*LQ*) measures the share of the microregions' financial activity in total asset activity in relation to the same indicator for the country as a whole. Values higher than one indicate that the region has a proportion of a specific financial activity that is higher than the national average. A Hirschman-Herfindhal index (*HHm*) is also computed, which relates the regional shares in national financial activity to the regional shares in other asset activities. Lastly, the relative proportions (*RP*) of financial activity are compiled for each region. These three regional concentration indicators are then combined in a multivariate analysis to extract the factors explaining their mutual variance (Johnson and Wichern, 2002). This methodology allows the computation of standardised concentration-centralisation indexes for each region, which captures the maximum group variance. It follows from Crocco et al. (2006) study on the identification of regional clusters.

The usual methods of cluster identification concern the level of specialisation in a specific economic activity (Crocco et al., op.cit.). Thus, when computing the *BCCIs,* we are actually selecting regions with high specialisation in one specific financial asset (or liability). By using local loan and deposit shares in total banks' assets as the main variables, the *BCI* reflects the concentration in loans and deposits in local banks' total assets. Therefore, a high *BCI* in one region indicates that portfolio of banks in the region are highly specialised in these variables. Since our aim is to analyse the regional potential in concentrating general banking activity, with respect to *BCI* for bank loans, we select regions with low *BCI* as an indicative of higher diversification in banking assets. Figure 4 shows the spatial distribution of regional diversification and specialisation in terms of banks' assets.

Figure 1 – Regional Diversification vs. Specialisation in Bank Assets: 1994-2007



Source: Own computation

The regions in the figure above are separated by high and low concentration of total loans in the banking system, with no distinctions on the size of the local banking system. Since the *BCCI* provides standardised values for the indicators, the legend separates regions according to values that

are above or below the national average. Thus, a region marked by High (or Low) 'Diversification' is characterised by a more diversified composition of banks' assets (or low asset specialisation). Regional financial activity is, thus, more prominent in these areas. Alternatively, a 'High Specialisation' region contains an elevated level of concentration in a single banking asset (e.g. loans) and, thus, a lower rank in relation to agglomeration of general financial activity. Table 1 brings average indicators for the groupings provided in Figure 4.

Table 1. Regional Banking Average Concentration Indicators: 1994-2007

Banking Assets	Number of Regions	Branches Per Capita to National Average	Mean BCI	Standard Deviation BCI	Regions' Mean % of National Pop	% of National Pop	Regions' Mean Total Employment	% of National Employment
High Diversification	51	0.89	-1.35	0.43	0.68	35.2	284,800	51.8
Low Diversification	216	0.90	-0.46	0.26	0.18	39.0	43,271	32.8
High Specialisation	57	1.40	1.31	0.25	0.07	3.9	12,372	2.5

Source: Own Computations from Rais (2007), IBGE (2007) and Lemte-Cedeplar (2007)

Table 1 shows that regions containing banks with high diversification in assets are usually more developed in its urban and economic structures. These regions have shares of population, in average, around 0.7% of the total national population and bank branching below the national average (0.89). Table 1 also indicates that banks' branches in these regions are above the national potential for bank access, which is a clear indication of the large size of the population in these areas. We refer to this indicator as 'bank access potential' because the number of banks' branches is divided by total population in each region, which overestimates the actual population access to banks in each region. This group of regions also represent 35% of the national population and 52% of national employment, whereas the regions with low asset diversification represent 39% of total population and 33% of total employment. This latter group of regions are usually represented by medium-sized regions, with an individual average of population around 0.2% of the national population. In relation to the high and low financially diversified areas, most of them comprise urbanised regions and their surrounding areas. Figure 1 shows the location of these two groups (red and pink marks). We can see that the red spots in Figure 1 are usually surrounded by pink zones, which indicate some financial integration in these areas. This result should be seen with some

caution because the *BCCI* for low diversified regions can be singling out regions with very low levels of banks' total assets. This is probably the case in the North, where the microregion of Manaus is surrounded by poorly developed regions where the banking system has low presence rates.

These two groups contrast with the regions that have banks with a high level of concentration on loans. Highly specialised regions have a potential bank access above the national average (1.40), which indicates the poor usage of banks by the population. These regions also only represent 2.5% of national employment. We can see from Figure 1 that these regions are mostly located in the Centre-West region (the orange spots in the centre of the map). This group of regions forms the new agriculture frontier in Brazil, with intense specialisation in the production of primary products for exports. The export of commodities in Brazil has been growing strongly in the last years, and production is carried in large areas with increasing intensity in capital use. These characteristics contribute to the concentration of income within the area. Moreover, in relation to the financial activity, the agriculture sector in the Centre-West region is heavily dependent on financial services linked to the finance of crops and the necessary capital purchases. Given the low labour to capital ratios, the activity in the area concentrates income, and the finance advanced by banks is not likely to propel sufficient local funding, which intensifies monetary outflows, making the regions highly polarised by other centres. Thus, the orange areas in the centre of Figure 1 are likely to contain poorly functional revolving funds, and intense outflow of resources to central areas.

Given these characteristics, it is important to consider, in a Kaleckian type investment function, how the unbalanced distribution of banking activities in the Brazilian territory might affect the firms' investment decisions. The next section introduces the functional relation to be studied and the variables used.

3. The Local Investment Function: Data, Estimation Technique and Results

The aim of this section is to empirically investigate the following investment rate function:

$$g^d = \alpha_0 + \alpha_1 r_p - \alpha_2 \left(i_l - \hat{p}\right) + \alpha_3 fcc + \alpha_4 fct \qquad (1)$$

The function is derived from the usual specifications of Post-Kaleckian models (Lima and Meirelles, 2003). The investment rate by firms ($g^d = \frac{I}{K}$) is given positively by rising rates of firms' regional profits (r_p) and the regional financial attributes, namely banking concentration (fcc) and centralisation (fct). Equation 1 also poses a negative relationship between real interest rates ($i_l - \hat{p}$) and the investment rate.

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

3.1. Data and Variables

The dataset comprises information on the level of firms by region in Brazil. Data come from the Annual Industrial Survey (PIA - Pesquisa Anual Industrial) managed by the Instituto Brasileiro de Geografia e Estatistica (IBGE), which is available for the years 1996 to 2005. The estimation analyses in this paper refer to investment functions in 128 mesoregions in Brazil.[3] Data from the banking system was gathered from the LEMTe-Cedeplar (2007) dataset. This set of information allows the computation of indicators for local financial concentration and centralisation. Financial concentration (*fcc*) is computed as the sum of the regional share of banks' branches in the region to the share of banks' regional fixed assets. This variable is directly related to the volume of banking services provided in the region, since it is assumed that investment plans by firms may benefit from the promptly support of the local banking structure.

Financial centralisation (*fct*) was also computed for all the regions. In this case, to capture the regional availability of complex (central) financial services, it was used a variable that weights banks' special liabilities by the total banks' liabilities in the region. The variable *special liabilities* refers to intermediation services with foreign currencies - imports and exports-, acquisition, underwriting and capitalisation of bonds and equities, payments of bonuses and profit shares, capital subscription; third-part owned values from debt-asset transactions, etc. All the intermediation services included in the *fct* variable can be assumed highly complex in relation to the other liabilities available in the dataset. The *fct* index also includes the shares of bonds and equities to total asset of banks' regional branches.[4]

In relation to specific variables, local firms' investment rate levels are the amount of new purchases of capital (I) in each year at a specific mesoregion divided by the total amount of capital owned by firms (K). Likewise, profit (R) is computed by the difference between total revenues with sales and total expenses at the local firm level, which is a proxy for firms' operational profits. Profits are also weighted by the amount of firms' total regional capital assets (K).

Local interest rates (*i*) were computed strictly following the banking mark-up idea contained in Rousseas (1985), Lima and Meirelles (2003), and Cavalcante (2011). Thus, the share of the region's total net revenues (interest and non-interest margins) in total asset is taken as a proxy for *ex-post* banking regional mark-ups. Regional interest rates are then computed as the regional banking mark-up over interest rates on deposits. However, given that data on regional deposit rates are not available, the interest rate on deposits is substituted by the national short-term interest rate given by the National Monetary Authority. Information on the national short term interest rate is available from the Central Bank of Brazil (CBB).

Local inflation (*p*) was available, at IBGE, for a limited number of metropolitan areas in Brazil. Since the idea of this empirical exercise is to investigate the highest number of regions possible, problems with missing values for local inflation were sorted out by assuming that inflation in region *i* would be the same as the one in the closest metropolitan area. This takes into consideration that inflation in metropolitan areas is correlated to inflation in larger surrounding areas (Robert-Nicoud, 2004; Kosfeld et al., 2008). This assumption reduces variability in the effects of prices, but at least it provides enough 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*) is the proportion relating the difference between the shares of employment in each specific activity in the region in relation to total employment in each activity.[5] The lower the *rdi* index, the less diversified is the regional economy. Regional population shares (*pop*) were also obtained from IBGE. The population share accounts for the level of urbanisation in the region. Lastly, economies of agglomeration (*aggecon*) are computed at the state level as the ratio between industry and services gross domestic output to total domestic output in each state. 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 allude to better economic activity linkages among sectors, which propel the firms' propensity to invest.

Finally, in order to build connections among banks mark-ups, interest rates and investment, a regional financial polarisation (*fpolar*) index was included in the estimations. Financial polarisation indexes were computed following specifications from Ezcurra and Pascual (2007). The index is a modified Gini coefficient, where banking asset rates are used as weights while the shares of total deposits are the main variable. The inequality in distribution of deposits has an impact on the determination of the banking mark-up (Cavalcante, 2011). Since deposits are a source of funding for banks, their regional distribution has an impact on the management of banks' portfolios, which in turn affects liquidity and the set-up of the banking regional mark-up and interest rates. The

polarisation indicators are aggregated in states' scales. Table 1 brings a summary of the variables and indicators used.

Variables in the table refer to the variables' average in the estimation period (1996 to 2005). It can be seen that the average regional rate of investment was around 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 concentration in mesoregions (banks' regional branches) were around 1.6% of the proportion of fixed assets, which indicates low average levels of regional financial concentration. Regional financial centralisation remained at a regional average of 6% in the period. The next section describes the chosen estimation technique.

Table 1. Summary of Data – 1996 to 2005

Variable	Obs	Mean	Std. Dev.
I/K	1264	0.046	0.034
R/K	1264	0.325	0.601
i	1264	0.234	0.038
p	1264	0.170	0.601
fcc	1264	0.016	0.077
fct	1264	0.060	0.161
rdi	1264	0.083	0.135
pop	1264	0.002	0.005
fpolar	1264	0.0004	0.003
fpolar_state	1264	0.0004	0.001
aggecon_state	1264	0.008	0.010

Source: Own calculations from Lemte-Cedeplar (2007)

3.2 Estimation Technique: Multilevel Models

In order to stress the relevance of different regional structures for investment decisions, the multilevel (hierarchical or mixed) linear model is the chosen econometric technique for the empirical investigation in this paper. Multilevel models are able to describe the nested structure of panel data by including the representation of diverse regional levels of the variables through a specific underlying model (Hox, 2010). Under such settings, the dependent variable (investment rate) is represented at the lowest regional hierarchical level (mesoregion) and the independent variables may assume different aggregation levels (for mesoregions or states).

Specifically to this empirical investigation, the multilevel model is important because it allows for the estimation of investment variability at different mesoregions in Brazil *vis-a-vis* the consideration of local and state-level effects of banking agglomeration and polarisation. This is crucial in a context where banks concentrate and centralise their operations according to differences in the

regional markets (level of income, distribution of economic activities, etc.) and where the banking regional structure has impacts on the availability and prices of financial services.

Hence, the objective of the empirical investigation in this chapter consists in testing three hypotheses. First, it is investigated whether the regional financial attributes (concentration and centralisation) and interest rates are relevant in explaining investment rates from a Kaleckian point of view for the selected sample of regions. Second, it is checked whether polarisation at the state level affects the variability of local interest rates. This investigation can give inferences on the relation between regional financial polarisation and interest rates, a hypothesis raised by some authors such as Dow (1993), Amado (1997) and Cavalcante (2011). Finally, different regional scales are checked. In this case, the relationship between the degree of urban development (centrality) and the variability in interest rate coefficients is also 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 generalisation 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 dataset 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 mesoregions' level, instead of trying to figure this random effect from the data as a whole. Moreover, random effects can also be analysed at the mesoregions-within-states levels. To analyse these data, separate panel regression equations are set up to predict firms' investment in each mesoregions using the set of explanatory variables X as follows

$$g^{d}_{ij} = \beta_{0j} + \beta_{1j} r_{ij} + \beta_{2j} i_{ij} + \beta_{3j} P_{ij} + \beta_{4j} fcc_{ij} + \beta_{5j} fct_{ij} + e_{ij} \qquad (2)$$

Where $\mathbf{g^{d}_{ij}}$ is the local investment rate, $\mathbf{r_{ij}}$ is the local rate of profits, $\mathbf{i_{ij}}$ is the local interest rates, $\mathbf{P_{ij}}$ is the local level of prices, and $\mathbf{fcc_{ij}}$ and $\mathbf{fct_{ij}}$ are the local financial agglomeration attributes (concentration and centralisation). In each panel from 1996 to 2005, the subscript *j* is for the states (j = 1...J) and the subscript *i* is for individual mesoregions ($i = 1, ..., n_j$). As showed above, this model stresses the departure from a usual panel regression model by assuming that each mesoregion may have a different intercept coefficient β_{0j} and also may have different slope coefficients (β_{1j} *to* β_{4j}). The residual errors $\mathbf{e_{ij}}$ have zero mean and variance to be estimated.

The following step is to consider different representations of the multilevel model in order to estimate the relationships described in equation 2. By assumption, regression coefficients β_j have a

multivariate normal distribution among all mesoregions. As such, in order to explain the variation of the regression coefficients β_j, the model includes explanatory variables for the intercept in equation 2 as

$$\beta_{0j} = \gamma_{00} + u_{0j} \quad (2.1)$$

And, for different slopes in equation 2, we have

$$\beta_{2j} = \gamma_{20} + u_{2j} \quad (2.2) \text{ or}$$

$$\beta_{2j} = \gamma_{20} + \gamma_{21} Z_j + u_{2j} \quad (2.3)$$

Equations 2.1 to 2.3 are functions modelling variance in intercepts and coefficients. Equation 2.1 decomposes the variance of the dependent variable into two independent components: σ_e^2, which is the overall variance of the errors $\mathbf{e_{ij}}$, and σ_{u0}^2, which is the variance of the mesoregion-level errors $\mathbf{u_{0j}}$ (as in equation 3 below). This allows the method to extract the effects of regional variances in the estimation results. Hence, a first mixed model specification may take equation 2 and include a pre-determined specification for a random intercept. By assuming this predetermined function, for instance, variance in individual mesoregions' average investment rates are allowed by inserting equation 2.1 in 2.

The empirical investigation proceeds by adding a random slope specification for the local interest effects on investment. In this case, equations 2.2 and 2.3 can be taken as reciprocates of equation 2.1, only now they allow specific variance in coefficients (slopes) in equation 2. Given that the coefficient β_{1j} (equation 2.2) assumes this new specification form, we substitute equations 2.2 and 2.3 into 2 to form

$$g_{ij}^{\delta} = \gamma_{00} + \beta_{1j} r_{ij} + \gamma_{20}\, i_{ij} + \beta_{2j} P_{ij} + \beta_{4j} FA_{ij} + u_{0j} + u_{2j}\, i_{ij} + e_{ij} \quad (3)$$

One can note that the intercept γ_{00} now refers to the average investment rate, while $\mathbf{u_{0j}}$ introduces a variance term in the equation. Also, the consideration of a random slope γ_{20} allows for within-groups variation in the sensibility of investment to local interest rates. In such model, mesoregions are allowed to present their own degree of variance in the effects of interest rates on local firms' investment rates. In our case, this specification is in line with the approach presented in section 2, which assumes that different mesoregions may be under different processes of interest rate determination, which affects the sensibility 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 polarisation in the state level as a co-determinant of interest rates and local investment

level. In order to do that, a state-level variable Z accounting for the degree of financial polarisation is included as an additional explanatory variable for the variance in the intercept β_{2j} (as in equation 2.3). Formally, we have equation 2.1 and 2.3 substituted into equation 2 as

$$g_{ij}^{d} = \gamma_{00} + \beta_{1j} r_{ij} + \gamma_{20}\, i_{ij} + \gamma_{21} FPol_j\, i_{ij} + \gamma_{11} FPol_j + \beta_{3j} P_{ij} + \beta_{4j} fA_{ij} + \beta_{5j} fct_{ij} + u_{0j} + u_{2j}\, i_{ij} + e_{ij} \quad (4)$$

where $\mathbf{FPol}_j$ is the financial polarisation in state j. Equation 4 now contains financial polarisation at the state level as a explanatory factor for the intercept and the interest rate coefficient. The next section presents the estimation results.

4. Estimation Results

4.1. Random Intercepts and Random Slopes for Local Interest Rates

Table 2 below shows the estimation results for five different mixed model specifications.[6] All variables used in the estimation were standardised. The first column in Table 2 brings the results when intercepts are allowed to individually vary among mesoregions (the random intercept model). Results indicate that the variance of the class-level (regions) residual errors is estimated significantly as 0.213. This means that intra-class (regional) correlation explains 21% of the variance of average local investment rates, which is fairly high. The evidence in favour of regional correlation in the sample indicates that regional factors must be accounted for in order to explain investment variability. The deviance reported in the bottom of the column is a measure of model misfit, which is expected to fall when other explanatory variables are added to the model. The second column in Table 2 reports the same random intercept model of column 1, only now with the addition of polarisation and state agglomeration economies as controls. Intra-class correlation explains 19% of investment rates variance, which is still high. The other three specifications (columns 3-5) account for random slopes to interest rates.

The second model specification (column 2) in Table 2, which includes variables at the state-level, shows that such variables are significant and that their signs behaved as expected. Rising polarisation would put an upward pressure on the average level of regional interest rates, since the poor regional distribution of financial resources contributes to concentration of revolving funds in polarising regions, improving finance and funding conditions in these regions at the expense of peripheral areas. The regional disparities in interest rates are, thus, enlarged, with peripheral regions holding the burden of higher local interest rates and lower investment rates.

Table 2. Linear Mixed Models for Local Investment Rates

	1	2	3	4	5
Model Specification	**random intercept**	**random intercept + state variables**	**random slope for i**	**random slope for i + state variables**	**random slope for i with local polarisation + state variables**
r	0.091***	0.088***	0.086***	0.084***	0.083***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
i	-0.180***	-0.183***	-0.185***	-0.187***	-0.189***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
p	0.038	0.037	0.041	0.039	0.039
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
fcc	0.389*	0.381	0.412*	0.396*	0.328
	(0.24)	(0.25)	(0.24)	(0.25)	(0.25)
fcc_fct	-0.075	-0.077	-0.079*	-0.079*	-0.066
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
fct	0.090*	0.106**	0.092*	0.108**	0.114**
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
rdi	0.057	0.058	0.061	0.061	0.063
	(0.05)	(0.05)	(0.05)	(0.04)	(0.04)
pop	0.021	0.017	0.006	0.005	0.008
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
fpolar_state		-0.141***		-0.134***	-0.128***
		(0.05)		(0.05)	(0.05)
aggecon_state		0.196***		0.189***	0.184***
		(0.04)		(0.04)	(0.04)
fpolar_state_i					0.0474*
					(0.03)
const	0.034	0.032	0.032	0.030	0.022
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Var(cons)	0.213***	0.195***	0.213***	0.196***	0.197***
	(0.04)	(0.03)	(0.04)	(0.03)	(0.03)
Var(resid)	0.719***	0.712***	0.674***	0.670***	0.670***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Var(iloc)			0.044***	0.040***	0.039***
			(0.01)	(0.01)	(0.01)
N	1264	1264	1264	1264	1264
Deviance	3380	3367	3364	3353	3356

Note: *** p<.01, ** p<.05, * p<.10
Source: Own calculations from Lemte-Cedeplar (2007)

Overall, coefficients for local profit rates and interest rates remained significant throughout diverse model specifications (columns 1 to 5). Signs for the coefficients were also the expected ones. As the variables are standardised, we can make use of the standard deviations presented in Table 1 to analyse the standard coefficients of regressions in Table 2. While a rise of one standard deviation (s.d.) in the profit rate (approximately a 60% change in the profit rate) raises investment, in average, by 0.09 s.d. (0.3%), an increase of 1 s.d. in local interest rates (3.8%) reduces investment rates by

0.18 s.d. (0.6%). These relationships are in line with the model assumed in equation 1. Overall, firms' decision over investment is, in average, fairly insensitive in relation to the latter variables, being relatively less inelastic to changes in profit rather than interest rates. This indicates that banks' charges (fees and interest rates) over funds for investment in different regions are important for local investment. This is an expected result, given that the Brazilian banking system is composed by hierarchically distributed branches that, despite some independence to allocate their local portfolios, have to respond to portfolio allocation decisions coming from centralised headquarters. This, in turn, contributes to the reduced average effects of profits and interest rates on investment.

Financial concentration and centralisation have also significant coefficients. In average, one standard deviation in financial concentration raises investment by 1.3%. This is an indication that a larger regional presence of banks fosters the financial possibilities offered to firms. Also, an increased offer of specialised services (*fct*) in the mesoregions raises investment rates by 0.3%, which shows the relative 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 concentration and centralisation was not robust through the different specifications. This is evidence against the average effects accruing from the interrelation between regional financial concentration and centralisation. However, some inference is possible in models 3 and 4, where coefficients of interest rates are allowed vary regionally. In highly concentrated banking environments, the impact of an increased offer of complex banking services is actually lower than in less bank concentrated regions.[7] This means that, in regions with higher banking concentration, and when coefficients are allowed to regionally vary, the marginal effects of centralisation are lower, since these regions present, in general, more developed (financial) institutions.

Another result indicates that, once financial polarisation falls at the state-level, financial resources are better distributed, imprinting a negative effect on the average regional banking mark-up rates (a fall in interest rates), which raises average regional investment rates. In average, a fall of 1 s.d. in financial polarisation at the state-level (7%) will increase local investment rates by 0.48%. Deviance has progressively fallen in the specifications when compared to the first model in column 1 of Table 2, with intra-class (regional) correlation responding for 21.5% of the variance in local investment rates. This result suggests the models marginally improve their fitness to the data.

Columns 3, 4 and 5 in Table 2 introduce specifications where it is assumed that mesoregions have different investment-sensibility to changes in local interest rates due to different banking institutional and structural features. Results indicate that some variance in investment rates can be explained by regional variation in coefficients of interest rates. The value of -0.185 (column 3) for

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

Column 5 in Table 2 expands the specification assumed in column 4 by including financial polarisation at the mesoregion level to explain variability in the coefficient of local interest rates. It is important to allow financial polarisation to explain regional differences in the impact of interest rates on investment rate. In order to explain differences in the local slopes of interest rates, an interaction term between financial polarisation (state level) and local interest rates is included in the fixed part of the empirical model in column 5. As such, the interaction term is significant at a 10% level, which means that at mesoregions embedded in states with higher than average levels of financial polarisation, the effects of interest rates changes over investment are lower than in regions belonging to low polarised states. In other words, investment is more sensitive to regional interest rates changes in low polarised states. This result indicates the importance of a more equal distribution of financial attributes over the territory for regional growth.

Given the inferences so far, there are some indications that firms' investment decisions are conditioned by the banking structure 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.

4.2. Variability in Interest Rates' Impacts in Central and Peripheral Regions

Our final estimation takes into consideration the possibility of different effects between central and peripheral regions. Firstly, in order to account for such hypothesis, a 'centre' effect is included into the fixed part of the model by adding a centre dummy and a centre-interest rate interaction to assist modelling the overall investment rates' mean. This is the primary specification in this subsection, which assumes that the variability in meso-specific 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 in order to account for possible heteroskedasticity (due to central regions) between groups. Table 3 reports the results.

In overall, the models accounting for different variability between central and peripheral regions (Table 3) perform slightly better in terms of the significance of the coefficients in comparison to the models in Table 2. For instance, the effects of price changes, despite being rather small, are indeed significant within the specification in this section. Also, the model in column 1 of Table 3 has a

positive and significant interaction term *centre_i*, which indicates that effects of local interest rates are different between central and peripheral regions.[8] However, the main *centre* (dummy) effect is not significant, which indicates that, on average, central and/or peripheral regions do not have a established pattern of higher or lower investment rate levels when the regional banking structure is controlled for. This means that there are other factors affecting the firms' investment decisions that are not covered by the model in this paper.[9]

Table 3. Linear Mixed Model for Local Investment Rates – Hetero vs Homoskedasticity

	1	2
Model Specifications	**random slope – Homokedastic**	**random slope – Heterokedastic**
r	0.062**	0.065***
	(0.03)	(0.02)
i	-0.102***	-0.107***
	(0.04)	(0.04)
p	0.0005***	0.0005***
	(0.0001)	(0.00)
fcc	0.649***	0.422**
	(0.20)	(0.21)
fcc_fct	-0.142***	-0.095**
	(0.04)	(0.04)
fct	0.121***	0.100**
	(0.04)	(0.04)
fpolar_state	-0.151***	-0.134***
	(0.03)	(0.04)
aggecon_state	0.184***	0.184***
	(0.03)	(0.04)
centre_i	0.135*	0.144**
	(0.08)	(0.07)
centre	0.050	0.115
	(0.09)	(0.11)
cons	-0.855***	-0.847***
	(0.13)	(0.13)
sd(periph)		0.474***
		(0.04)
sd(periph_i)		0.199***
		(0.04)
sd(centre)		0.232***
		(0.08)
sd(centre_i)		0.180***
		(0.08)
sd(iloc)	0.161***	
	(0.04)	
sd(Residual)	0.913***	0.795***
	(0.02)	(0.02)
N	1264	1264
Deviance	3392	3238

Note: *** p<.01, ** p<.05, * p<.10
Source: Own calculations from Lemte-Cedeplar (2007)

Nonetheless, results in column 2 of Table 3 corroborate the idea of diverse variability of interest rates coefficients between central and peripheral mesoregions. A peripheral region in the sample has wider variability in the coefficients of interest rates, indicating that investment in such regions is more sensitive to changes in local interest rates than investment in central regions. This is in accordance with results obtained in the previous section, which have showed that in regions with higher interest rate coefficients, the effects of financial concentration are statistically more prominent as well. In addition to this feature, it should be noted from Table 3 that peripheral regions have higher interest impacts on local investment rates than central regions.

5. Conclusions

In studying firms' decisions over investment under a Kaleckian perspective, where internal and external funds are crucial variables to their decisional process, it becomes fundamental to analyse the different territorial contexts the firms are included in. In these contexts, the banking structure (banking agglomeration and polarisation) has a major role in the determination of interest rates and thus the price of external funds. This paper aims to collect evidence to reinforce the theoretical link between regional banking structure, interest rates and the local investment by firms.

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

One of the main contributions advanced by this paper is the focus on the financial agglomeration as supportive of the development of a regional financial network that enables a more or less balanced regional growth. It can be seen from the estimations in this paper that local banking agglomerations are indeed essential to the accumulation plans of local firms. Furthermore, the degree of financial polarisation is also confirmed as relevant for investment in the period and regions analysed. Overall, these evidences suggest that finance and growth studies must account for the specificities and contexts of regions as fundamental parameters shaping the evolution of growth-inducer institutions.

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Endnotes

[1] According to Arestis (1996), whilst it is expected from profitability to induce capital accumulation, it is the realised investment that creates the profitability which makes investment possible.
[2] The term concentration here refers to 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 the works of Maúdos and Guevara (2006), Carbó et al. (2006) among others. For a more explicit discussion, see Cavalcante (2011).
[3] The dataset contains 128 mesoregions from a total of 133. In four of them, information was not available.
[4] Since intermediation with bonds and equities is highly concentrated in specific central regions, only some branches in few regions in the sample actually register bonds and equities in their balance sheets. As such, this indicator will be skewed towards central regions, an unbalance that will be specifically modelled in section 4.2.
[5] The economic activity sectoral division followed the specification set up by IBGE, which splits economic real activity in 25 sectors, ranging from agriculture to services.
[6] Usual panel data models were also estimated and results are available upon request. It should be noted that results for Hausman and Breusch-Pagan tests corroborate the use of a random effects 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.
[7] It should be noted that the analysis must be carried by adding the *fct* and *fcc* coefficients.
[8] A Likelihood Ratio test confirms that, at the 10% significance level, the hypothesis of no difference between the interaction terms for centre and periphery is rejected.
[9] This is mostly due to poor availability of data under the stipulated time and spatial conditions.