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THE SPATIAL STRUCTURE OF THE FINANCIAL DEVELOPMENT IN BRAZIL

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THE SPATIAL STRUCTURE OF THE FINANCIAL DEVELOPMENT IN BRAZIL

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RESUMO

Este trabalho analisa a distribuição e transbordamentos espaciais do desenvolvimento do sistema financeiro à luz da Teoria do Lugar Central e do conceito pós-keynesiano de preferência pela liquidez regional. Os dados de operações de crédito e imposto sobre operações financeiras (IOF) utilizados foram extraídos dos balanços consolidados dos municípios brasileiros de 1995 a 2007 fornecidos pelo Banco Central do Brasil. Para investigar a estrutura espacial do sistema financeiro no Brasil foram utilizados métodos GM para a estimação de um painel espacial com defasagem espacial e erros de média móvel. Os resultados sugerem uma associação espacial negativa do sistema financeiro dos municípios brasileiros, de modo que um município com sistema mais desenvolvido em geral se encontre inserido em meio a sistemas financeiros menos desenvolvidos.

Palavras-chave: desenvolvimento financeiro, estrutura espacial, estratégia bancária, Brasil.

Classificação JEL: O16, R12, G21

ABSTRACT

This paper explores the financial development in Brazil. It focuses on the impacts of the development level of a municipality's financial system over its neighborhood, under the light of the Central Place Theory. Using a GMM estimator for a spatial panel model with an endogenous spatial lag and spatial moving average errors we investigate the spatial structure of the financial system in Brazil. The results point to a negative spatial association between the Brazilian municipalities' financial system, in the way that a municipality with more developed financial system tends to be surrounded by municipalities with less developed financial systems.

Keywords: financial development, spatial structure, bank strategy, Brazil.

JEL Classification: O16, R12, G21

INTRODUCTION

Studies on regional issues in Brazil have focused on the behaviour of the economy's real variables (production, employment, wages, etc.), whilst monetary variables have been overlooked. The paper aims to investigate the spatial distribution of the financial system by exploring the impacts of the development level of a municipality's financial system over its neighborhood.

Based on the Post Keynesian concept of regional liquidity preference (Dow, 1993) and the Central Place Theory (Christaller, 1966), the paper analyses tax on financial operations and credit operations drawn from consolidated balance sheets of bank branches spread across Brazilian municipalities in order to verify the spatial structure of the financial system in Brazil.

It is argued that there is substantial evidence that the Brazilian Bank System operates differentiated strategies across space. Specifically, the results point to a negative spatial association between the Brazilian municipalities' financial system, in the way that a municipality with more developed financial system tends to be surrounded by municipalities with less developed financial systems.

Our model uses a GMM estimator for a spatial panel model with an endogenous spatial lag and spatial moving average errors to investigate the spatial structure of the financial system in Brazil. The yearly municipal data on financial assets for 1995-2007 is from a database compiled by the Laboratory of Studies in Money and Space (LEMTe) of CEDEPLAR/UFMG from data provided by the Brazilian Central Bank. The social variables are extracted from the Annual Relation of Social Variables (RAIS), a Brazilian census of formal firms and its employees.

Apart from this brief introduction, the paper is organized in the following way. The next section (I), lays out the main theoretical contributions to the understanding of the financial systems' regional dynamics. In Section II, the estimation strategy is presented. It allows us to estimate not only the relation between the financial system at one locality and its own attributes, but also the relation with the financial system at the neighborhood, taking into account omitted variables assumed time-invariant and its spatial interaction in a moving average process. In Section III, the exploratory analysis of the evolution of the Brazilian financial system and its regional dynamics is carried out, considering the evolution of selected variables and indicators and the spatial distribution of the financial system in 2006. Section IV shows the results of the estimations over the dependent variables IOF and Credit. In the last section, some conclusions are drawn.

I. FINANCIAL DEVELOPMENT AND THE CENTRAL-PLACE THEORY

I.1. Regional Aspects of the Financial System

The theoretical discussion about regional aspects of the financial system has received different treatments from regional economists, economic geographers and experts in financial development. Generally speaking, in the literature of regional economics little attention is given to money and financial systems and their role in regional development. Most of them assume that the financial system is neutral in relation to its influence on regional performance.

The mainstream literature on financial development, by contrast, has focus for the last 30 years or so on the so-called ‘finance – growth nexus’. The emphasis is placed on the correlation between financial variables (and the degree of development of the financial system) and economic growth. Most mainstream economists state that the direction of causality runs from the former to the latter, although unambiguous evidence is hard to bring about. In this literature, the issue of regional aspects of the financial system development has been virtually neglected. Indeed, in an extensive review of the main contributions in this research area, made by Levine (2004), the word “regional” appears only once on the 118 pages of the review; the word “regions”, twice and the word “geography”, none. There is only one paper reviewed by Levine that focuses on regions inside a specific country. This paper - written by Guiso et al. (2002) - shows that local financial conditions influence economic performance across different regions in Italy. The most important conclusion of the authors was that national (and regional) financial systems have an important role to play despite the advance of international financial integration.

Nevertheless, our review of the literature has shown that in fact there has been over the years important contributions to show the non-neutrality of money and financial systems in terms of their effects on the real side of the economy, and, therefore, in regional development, as can be found in the new-Keynesian¹ and post-Keynesian theories of financial system.

Overall, the main areas of research of the New-Keynesians have been related to the investigation of:

- i. whether or not regional financial markets exist (Amos and Wingender, 1993; Bias, 1992);
- ii. how market failures – i.e. asymmetric information and scale-sensitive transaction and information costs - affect the efficiency of the financial system in the allocation of credit - and hence the performance of real variables - among regions of a country (Koo and Moon, 2004, Miyakoshi and Tsukuda, 2004);
- iii. whether or not the distribution of different types of banks across regions of a country (or local banking systems) explains disparities in regional economic growth (Usai and Vannini, 2005; Ozyildirim and Older, 2008; Valverde and Fernández, 2004);
- iv. whether or not local/regional economic conditions have an impact on local/regional banks’ performance (Meyer and Yeager, 2001; Yeager, 2004; Emmons et al., 2004; Furlong and Kreiner, 2007; Daly et al., 2008);
- v. how geographic diversification affects banks’ performance (Demsetz and Strahan, 1997; Acharya et al., 2002; Morgan and Samolyk, 2005);
- vi. how distance between branches and headquarters or between lenders and borrowers influences credit allocation and availability (Alessandrini and Zazzaro, 1999; Berger and DeYoung, 2001; Carling and Lundenberg, 2005; Brevoort and Hannan, 2006; Alessandrini et al., 2007).

¹ Roberts and Fishkind (1979), Moore and Hill (1982) are authors who first attempted to identify factors that could lead to credit rationing in regional markets. Recently, neo-Keynesian authors, as Faini et al. (1993) and Samolyk (1994), have explored the argument of asymmetric information in regional credit markets.

As the latter line of enquiry bears directly on the subject of this paper, we will discuss it in more detail here. The analysis of the relationship between distance and credit allocation/availability has followed distinct perspectives. A first line of work analyses the distance between banks' headquarters and branches. Berger and DeYoung (2001) pointed out that inefficiencies tend to increase with the distance between a bank's headquarter and its subsidiaries "presumably because the managers at a faraway subsidiary have more leeway for mismanagement or shirking". Carling and Lundenberg (2005) explored whether or the proximity between borrowers and lenders influences the degree of asymmetric information and thus affects credit availability. They found no evidence that asymmetric information increases with distance, leading them to conclude that the locational strategy of banks should be based on factors other than credit risk management. Alessandrini et. al. (2007) investigated how the distance between bank's branches and headquarters influences the likelihood of introducing innovations and credit rationing. They forged the concept of "functional distance"² to capture the differences among the functions carried out by headquarters and branches. Their results showed that bank branches of higher functional distance are less likely to introduce innovations and are more likely to be credit rationed. Alessandrini et. al. (2008), in turn, examine the impact of *operational and functional distance*³ on the financial constraints of Italian firms. They found out that although greater *functional distance* has negative impacts over credit availability, especially for small firms, lower *operational distance* do not necessarily improve this availability.

A second line of work explores the effects of distance between borrowers and lenders. A first perspective enquires into screening and monitoring aspects related to the distance between borrowers and lenders. In this case, distance would work to increase the difficulty of collecting and processing soft information about borrowers and this would make the process of screening and monitoring loans more costly. Brevoort and Hannan (2006) investigated the relationship between lending and distance, especially commercial lending. Their findings suggested that distance between borrowers and lenders works as restriction to lending. A second perspective delves into the travel costs incurred by a borrower to meet a lender, as found in Park and Pennacchi (2009). It is worthwhile noticing that this is what Alessandrini et al. (2008) later termed as "*operational distance*".

Now, the post-Keynesian researchers have also made significant contributions to the analysis of the regional aspects of financial systems. Their analyses differ from the others discussed previously as they approach both the supply side and the demand side in the regional credit market. According to this view, the supply of and demand for credit are interdependent and affected by the *liquidity preference*, linked to the expectations of economic agents in an uncertain environment.⁴ From the viewpoint of the banking system, a high liquidity preference will negatively affect its disposition to lend money in the region, as it shows pessimistic or less reliable expectations of its economic

² The term "functional distance" means the distance between hierarchical levels of a bank organization. According to Alessandrini et al. 2008 (p. 5), "by functional distance we refer to the distance between a local branch, where information is collected and lending relationships are established, and its headquarter, where lending policies and ultimate decisions are typically taken. From a theoretical point of view, the importance of functional distance for the lending policies of local branches has its roots in (i) the asymmetric distribution of information and the costs of communication within an organisation, and (ii) the economic, social and cultural differences across communities."

³ Operational distance refers to the proximity between the borrower and its lending office.

⁴ For a further understanding of the use of such a concept in Keynesian economics, see Davidson (1982/1983, 1995), Dow (1995) and Crocco (1999, 2003).

performance. On the demand side for credit, the liquidity preference of the public or the firms will affect its respective portfolio decisions. The greater the liquidity preference, the greater is the demand for net assets and the lesser the demand for credit.

Dow (1982) has added up to the concept of liquidity preference the contributions of Myrdal (1957) on cumulative causation and the dependence theory to show how their simultaneous operation can lead to unequal regional development patterns. According to her, the liquidity preference of residents (banks, entrepreneurs and the public) of less developed regions will be greater than that of more developed regions. This is related to the specific features of each of these regions, which in turn, influence the liquidity preference of their residents. The less developed regions are extremely dependent on the centre for the provision of sophisticated goods and services as their income level and shallow productive structure are usually insufficient to sustain a dynamic modern economic system⁵. Moreover, some institutions are still to be built or (at least) strengthened, markets are feeble and financial institutions unsophisticated. These regions are also subject to significant economic volatility and (new) investment opportunities are limited. Consequently, banks would face a higher default risk of loans and of capital loss and hence charge higher interest rates. Firms, in turn, would experience a change in the marginal efficiency of investment as it is affected by the smaller availability of loans and higher bank interest rates. The public would face considerable uncertainty regarding their earnings, given the volatility of the local economy and its low level of diversification and sophistication. Through the mechanism of cumulative causation, such weaknesses of the peripheral regions would be reinforced over time, while the central regions would grow more diversified and sophisticated. The peripheral region would experience a “funding gap” and the financial system would become heavily spatially-centralized in the centre. First, the national banks would lend less money to peripheral regions, due to their economic structure and the remote control over the branches located in them. Secondly, local banks of peripheral regions, in turn, would behave defensively by maintaining high reserve level and restraining local loans. Thirdly, the higher liquidity preference of the public resident in the peripheral region would be translated into a higher proportion of demand deposits than of time deposits, which would force banks to curtail their loans terms in order to adjust them to the smaller portion of time deposits. Fourth, higher demand for centre securities and thick central financial markets would encourage the concentration of capital (or loan) markets as well as the agglomeration of financial activities, institutions and functions in the centre. This, in turn, would work against the capacity of the peripheral regions to attract bank branches (let alone bank headquarters). At the economy level, these interdependent and mutually reinforcing processes, left to their own course, would increase regional disparities, turn the space more fragmented or fractured and the financial system spatially-centralized into a core-periphery structure (Chick and Dow 1988; Dow 1996, 1999).

In a similar vein, Martin (1999) and Klagge and Martin (2005) bring theoretical and empirical evidence on the spatial bias on the allocation of funds between peripheral and central regions, which would contribute to uneven regional development. They advocate the non-neutrality of the relationship between the financial and the real side of the economic apparatus. According to them financial systems do not function in a “space-neutral way”.

⁵ This also means, as noticed by Klagge and Martin (2005), that the peripheral reserve base “is diminished as funds leak out in payment for centre goods and securities”.

That is to say, financial markets across regions within a country would not be perfectly integrated, so that investment in any given region is dependent of local savings and local demand for finance is constrained by local supply and residents (the firms and the public) cannot access funds from anywhere in the national system. Thus, the geographical proximity to the financial centre does matters. The result is the occurrence of concentration of the financial institutions and functions in central locations and of sectoral, spatial-funding gaps between the core and the periphery.

Martin (1999) brings to the discussion the importance of “central places” and “centrality”, as found in Christaller (1933)⁶. According to him, as centrality helps to concentrate people and increases the income of the region, it is possible to argue that the higher the centrality the higher will be the possibility of a bank deciding to locate a branch in this region.

Let us now turn to the analysis of the relationship between the centrality of a region (city) and the financial system spatial structure.

I.2. The Central-Place Theory and the Financial System Spatial Structure

The ‘centrality’ characteristic of a central place stems from a region’s high population density and economic activities so as to allow this region to supply central goods and services, such as wholesale and retail trade, banking and other financial services, business organizations, administrative services, education and entertainment facilities, etc.. That is to say, a central place would play the role of the locus of central services for itself and for the immediately neighboring areas (supplementary region). From this definition of central place, Christaller admits the existence of a hierarchy of central places, according to smaller or greater availability of goods and services that need to be centrally localized (central goods and functions). The rank of a central good or service is the greater the more essential it is and its market area.

A high centrality implies a high supply of central goods, which, in turn, will stimulate the diversification of the industry and of the tertiary sector. Such diversification opens new major possibilities of investments for banks, as they can diversify their portfolio, not only in relation to liquid or illiquid assets, but also in relation to different kinds of illiquid assets (with different maturity profiles, intersectoral differences, market insertion, etc.). This is a key difference between a central-place and its hinterland. Moreover, the economies of agglomeration derived from the scale economies, localization economies and urbanization economies associated with the diversified industry and service sector⁷ create another element to reduce the uncertainty of that specific region. This is pointed out by Jacobs (1966) with the label of *economic reciprocating system*, which is the process of diversification of the productive system associated with the introduction of new kinds of products in

⁶ As noted by Parr and Budd (2000), the concept of central-place can be applied to those economic activities (services and manufacturing) that have a locational orientation to the market, as in the case of financial services. The supply points of the services or manufacturing, according to this theory, is “centrally located with regard to their respective market areas; hence the designation of supply points as “central places”” (p. 594). Here we rely more on Christaller’s contribution due to its emphasis on the hierarchical differentiation of centres.

⁷ Since urbanization economies tend to increase with the size of the urban concentration, financial system firms tend to be attracted to a big-city or metropolitan region.

different kinds of sectors. This process is possible due to the development of the exportation sector and allows the city to increase its economic performance as it increases its exports of goods and service. This will attract diversified firms to the city, working to increase the externalities of the local, transforming the region more attractive.

From the financial system point of view, not only will its costs be reduced by the externalities generated by the economies of agglomeration, but also opportunities of investment among these diversified industries and service sector will increase. Therefore, it might be expected that the higher the centrality the lower the liquidity preference of the banks and the higher the supply of credit to different kinds of projects. This would unleash a virtuous circle between agglomeration economies, supply of and demand for credit, thereby reinforcing the concentration of financial credit in central places. Furthermore, the financial system would seek to increase the number of branches and the provision of services in central-places as its operations are subject to economies of scale and scope and information spillovers and its main costs (information, coordination and transaction costs) are scale-sensitive⁸.

The previous arguments raise the question about the role of the financial system, and of its liquidity preference on the construction of the centrality of a region. Is it an outcome of this development or can it work as a facilitator of it? In what follows, we suggest that it is a self-reproducing process.

I.3. Liquidity Preference and Centrality

The centrality of a region is important to stimulate the locational decision of a retail bank. As pointed out by Martin (1999), in the case of retail bank system, the decision of where to locate a new branch is positively influenced by the level of income and the size of the population in a specific region. As centrality helps to concentrate people and increases the income of the region, it is possible to argue that the higher the centrality the higher will the possibility of a bank deciding to locate a branch in this region.

However, the financial system is not passive in relation to the development of a region. The liquidity preference of the banks can ease the development of a region as they will be more willing to supply credit in that region. But, by the same token, it contains strong elements that work to reinforce regional disparities.

On the one hand, it is possible to assume that the higher the centrality of a place the higher will be the liquidity preference of its hinterland, as the latter does not have the services supplied by the centre and, hence, it becomes less attractive to industries and banks. This will make it more difficult to the periphery to diversify its industrial and tertiary sectors, reinforcing its peripheral condition.

On the other hand, peripheral conditions are supposed to be reproduced as they are linked to the centrality of central places. The logic of the production system in the periphery is conditioned and reinforced by the logic of the production system in the centre. It is not a question of being developed

⁸ Transport-costs also assume an importance for the financial system because of the need for face-to-face contact.

or underdeveloped as two different, and maybe sequential, stages. It is related to the logic of the reproduction (and accumulation) of capital over the space. Hence, central places are not equally distributed over space because the process of accumulation and reproduction of capital in the tertiary sector implies the existence of hierarchy among urban places.

Leaving the markets forces to work freely, uneven regional development will result. In this sense, it is possible to argue that regional development also means the distribution of centralities, or the construction of many centralities over the space. What has been argued here is that the financial system plays a critical role in this process.

To test the theoretical hypothesis described above, a model has been set up to capture the main feature of central place theory: the constraint imposed on the hinterland to have inside of it the same supply of central services that central places have.

Two financial variables will be used: taxes on financial operations and total credit supplied. These financial data used were made available by the Laboratory of Studies on Money and Territory (LEMTe), at CEDEPLAR/UFG. The primary source is the System of Accounting Information of Financial System (COSIF), provided by the Brazilian Central Bank. This system makes mandatory to all bank branches the supply to the Central Bank of information regarding their balance sheet of monthly operations. The Central Bank published the data through the SISBACEN, aggregated by municipality. The LEMTe organized the information for the period between 1988 and 2006 for all Brazilian municipalities. However, due to availability of other data sources, in this paper we focus on the period that goes from 1996 to 2006.

Formally the model could be described as follows:

$$\begin{aligned} IOF &= \lambda W_{-IOF} + \gamma(1 + agencies + workforce + wage) + u \\ Credit &= \lambda W_{-credit} + \gamma(1 + agencies + workforce + wage) + u \end{aligned} \quad (1)$$

in which W defines the spatial interdependence across areas.

Hence, by the Central Place Theory, it is expected a negative spatial correlation between any city and its neighborhood. To estimate these models, we used the methodological approach proposed by Fingleton (2008).

II. ESTIMATION STRATEGY

Fingleton (2008) presents a model of panel data with spatial lag and components of the error correlated in space as well as in time. The model presented by Fingleton (2008) is closely related to the spatial panel model presented by Kapoor et al (2007). Fingleton's (2008) main innovations lie in two different assumptions regarding the spatial interaction for panel data. Kapoor et al (2007) assume a spatial autoregressive (AR) error process, which implies a complex interdependence between locations, so that a shock in any location is transmitted to all other – or global effect. However, Fingleton (2008) assumes a moving average (MA) error process, which implies that a shock in any location is transmitted only to its neighbours.

The second main difference between the two models is that Fingleton (2008) extends the methodology in order to incorporate an endogenous spatial lag. Therefore, the spatial dependence is not restricted to the error process, but may occur via the dependent variable as well.

The analysis of panel data allows us to control the time-invariant effects specific to each region, mainly those that we omit in our model. Therefore, the regional heterogeneity is modelled by this methodology as random effects. Besides, with the spatial interaction – whether it is in the error or the dependent variable – we try to identify the effect of the possible spillover that can happen between the regions throughout the analysed period.

The spatial panel model presented by Fingleton (2008) is based on the generalizations of the Generalized Moments Method (GMM) proposed by Kapoor et al. (2007) and Kelejian and Prucha (1999). The modelling proposed by the author considers a linear regression of panel data that allows for disturbance correlation throughout space and time and for spatial interaction of the dependent variable. Fingleton (2008) assumes that in each period of time t the data is generated in accordance with the following model:

$$Y(t) = \lambda WY(t) + H(t)\gamma + u(t) \quad (2)$$

in which $Y(t)$ is a $N \times 1$ vector of observations of the dependent variable in time t , W is a $N \times N$ matrix of constant weights independent of t which defines the spatial interdependence across areas, $H(t)$ is a $N \times K$ matrix of regressors with full column rank that can contain the constant term, γ is the $K \times 1$ vector correspondent to the parameters of the regression and $u(t)$ denotes the $N \times 1$ vector of the disturbances generated by a random error process.

Usually, to model the spatial dependence of the disturbances, it is considered the spatial first order auto-regressive (AR) process for each period of time:

$$u(t) = \rho W u(t) + \varepsilon(t) \quad (3)$$

where W is a $N \times N$ matrix of constant weight independent of t , ρ is a scalar auto-regressive parameter and $\varepsilon(t)$ is a $N \times 1$ vector of innovation in the period t .

Solving the disturbance vector in terms of the innovation vector, equation 3 results in:

$$u(t) = (I - \rho W)^{-1} \varepsilon(t) \quad (4)$$

In contrast, the moving average (MA) error process which considers local rather than global shock-effects is:

$$u(t) = (I - \rho W)\varepsilon(t) \quad (5)$$

Stacking the observations for the T time periods, we have:

$$\begin{aligned}
Y &= \lambda(I_T \otimes W)Y + H\gamma + u = X\beta + u \\
X &= ((I_T \otimes W)Y, H) \\
\beta' &= (\lambda, \gamma')
\end{aligned} \tag{6}$$

in which Y is a $TN \times 1$ vector of observations of the dependent variable, X is a $TN \times (1+k)$ matrix of regressors, comprising the endogenous spatial lag $(I_T \otimes W)Y$, H is a $TN \times k$ matrix of exogenous regressors, I_T is a $T \times T$ identity matrix and u is a $TN \times 1$ vector of disturbances given by the MA process:

$$u = [I_{TN} - \rho(I_T \otimes W)]\varepsilon = \varepsilon - \rho\bar{\varepsilon} \tag{7}$$

To allow for the innovations ε to be correlated over time, we assume the following error component structure for the innovation vector:

$$\varepsilon = (e_T \otimes I_N)\mu + v \tag{8}$$

in which e_T is a $T \times 1$ vector of 1s, μ is the $N \times 1$ vector of unit specific error components of each locality and v is the $TN \times 1$ vector of error components which vary in space and time.

In this way, the innovations are correlated in time, but not in space. However, as presented in (10), the disturbance of any locality is affected by the weighted disturbances of its neighbours. Hence, even the innovations, i.e. the spatial heterogeneities, spillover. We consider that this approach is more suitable to our analysis of the Brazilian municipalities because the interactions at this level are very high.

In such a way, for areas i, j and times t, s :

$$E[\varepsilon'\varepsilon] = \begin{bmatrix} (\sigma_\mu^2 + \sigma_v^2) & \text{if } i = j, t = s \\ \sigma_\mu^2 & \text{if } i = j, t \neq s \\ 0 & \text{if } i \neq j, t \neq s \end{bmatrix} \tag{9}$$

The estimation procedure involves three stages. In the first, considered here as Estimation 1 and 3, we used the instrumental variables model to estimate the residuals from equation (1). In the second, those residuals were used to estimate, through a non-linear optimization routine, a moments equation that gave us estimates for the parameters ρ , σ_v^2 e σ_1^2 , and hence to the covariance matrix Ω_ε :

$$\hat{\Omega}_\varepsilon = E(\varepsilon\varepsilon') = \hat{\sigma}_\mu^2(J_T \otimes I_N) + \hat{\sigma}_v^2 I_{TN} = \hat{\sigma}_v^2 Q_0 + \hat{\sigma}_1^2 Q_1 \tag{10}$$

in which $\sigma_1^2 = \sigma_v^2 + T\sigma_\mu^2$, J_T is a T x T unity matrix and Q_0 and Q_1 are standard transformation matrices, symmetrical, idempotent and orthogonal between themselves.

The third stage uses the estimated values of ρ , σ_v^2 and σ_1^2 . With another instrumental variables estimation we can finally reach the estimated values of the parameters and their standard deviations. In this stage, the data is transformed via a Cochrane-Orcutt type of procedure in order to consider the spatial dependence of the residuals.

Usually, the AR error process implies a pre-multiplication of the variables by $I_T \otimes (I_N - \hat{\rho}W)$ to account for the spatial dependence in the residuals. In contrast, the MA error process implies a pre-multiplication by the inverse:

$$\begin{aligned} Y^* &= (I_T \otimes (I_N - \hat{\rho}W))^{-1} Y \\ X^* &= (I_T \otimes (I_N - \hat{\rho}W))^{-1} X \end{aligned} \quad (11)$$

As our model presents heteroscedasticity and correlated errors, we cannot follow the standard assumption of a spherical errors structure. Therefore, we adopted the estimation of an instrumental variables model with non-spherical disturbances (Bowden and Turkington 1990). In both the first and third stages, a set of linearly independent exogenous variables were used as instruments. Considering Z as the matrix of instruments, we have:

$$P_z \equiv Z(Z'\hat{\Omega}Z)^{-1}Z'$$

Thus:

$$\hat{b}^* = (X^*{}'P_zX^*)^{-1}X^*{}'P_zY^* \quad (12)$$

The estimated variance-covariance matrix of the parameter is given by:

$$\hat{C} = (X^*{}'P_zX^*)^{-1} \quad (13)$$

In this way, the square root of the constant values in the main diagonal line of the variance-covariance matrix is equivalent to the standard errors of the estimated parameters. However, this methodology does not provide the standard error of $\hat{\rho}$, the statistical significance of which can be tested by Bootstrap methods (Fingleton 2006).

As instruments for the endogenous spatial lag, we follow Kelejian and Prucha (1998) and use the exogenous variables H and their first spatial lag $(I_T \otimes W)H$, so $Z = (H, (I_T \otimes W)H)$. It is important to emphasize that, as in stage 1 we assume that $\rho = 0$, in this case, we have $Y^* = Y$ and $X^* = X$. Besides, we also assume that $\sigma_v^2 = 1$ and $\sigma_1^2 = \sigma_v^2 + T\sigma_\mu^2 = 1$, then, in stage 1, the estimation with non-spherical disturbances corresponds to the estimation by standard instrumental variables.

Hence, the model proposed by Fingleton (2008) allows us to estimate not only the relation between the financial system at one locality and its own attributes, but also the relation with the financial system at the neighborhood, taking into account omitted variables assumed time-invariant and its spatial interaction in a moving average process.

In order to estimate the spatial interaction derived from the development of the financial system we use yearly municipal data on financial assets for 1996-2006. The data is collected by the Brazilian Central Bank and was compiled and provided by the LEMTe. The social variables are extracted from the Annual Relation of Social Variables (RAIS), a Brazilian census of the formal firms and its employees conducted by the Brazilian Minister of Work and Employment.

Since the data for the Northern region of Brazil is very truncated and its regional spatial regime is very distinct – the Amazon Rainforest is located on this region – we exclude it from our analysis. Brasilia, the national capital, is also excluded since the government accounts have a major role on its financial data.

The variables used at municipal level to measure the financial development are the amount of tax over financial (credit, foreign exchange, insurance, investments in bonds, equity and Treasury bills) operations retained per capita (*IOF*) and the amount of credit supplied by the bank agencies per capita (*credit*). The controlling variables are the total number of the workforce formally employed in all activity sectors (*workforce*), the number of bank agencies per capita (*agencies*) and the average wage level (*wage*). All variables used were under logarithms.

Therefore, two equations were estimated using the GMM estimator for a spatial panel model proposed by Fingleton (2008), as presented in equation 1:

$$IOF = \lambda W _ IOF + \gamma(1 + agencies + workforce + wage) + u$$

$$Credit = \lambda W _ credit + \gamma(1 + agencies + workforce + wage) + u$$

The weight matrix W which defines the spatial interdependence across areas was defined restricting the spatial interaction to the nearest eight neighbouring municipalities.

III. EXPLORATORY ANALYSIS

The national financial system in the early 2000s was made up of 162 universal banks, 4 state-owned development banks and 20 investment banks. Table 1 shows the reduction in the number of banks in Brazil between 1989 and 2003 resulting from the restructuring of the financial system linked to the financial crisis of 1995. The financial system that emerged from this process was more internationalized, concentrated and competitive. However, it remained functionally underdeveloped, meaning that they were still averse to long-term credit operations and speculative in their asset management.

TABLE 1
Evolution of the Number of Banks in Brazil, 1989 – 2003

Year	Number	Year	Number
1989	179	1997	217
1990	216	1998	203
1992	234	1999	193
1993	243	2000	192
1994	246	2001	182
1995	242	2002	167
1996	231	2003	164

Source: LEMTe.

The evolution of the number of branches shows a slightly different pattern. It declines in the immediate aftermath of the restructuring process and starts to increase again in the 2000s. It is noteworthy that there has been an intensification of spatial concentration of bank branches in the richest regions of the countries at the expenses of the poorest (Tables 3 and 4). In 2006, 74% of the bank branches were located in the rich Southeast and South regions (Crocco and Figueiredo, 2008)

TABLE 2
Evolution of the Number of Bank Branches by Region and their % Participation on the Total of Brazil, 1990-2006

Region/ Year	Centre-West		Northeast		North		Southeast		South		Brazil Number
	Number	(%)	Number	(%)	Number	(%)	Number	(%)	Number	(%)	
1990	1.169	7,89	2.556	17,26	634	4,28	7.391	49,91	3.059	20,66	14.808
1991	1.220	8,19	2.499	16,77	649	4,35	7.382	49,54	3.152	21,15	14.901
1992	1.231	8,19	2.474	16,47	647	4,31	7.468	49,71	3.201	21,31	15.021
1993	1.235	8,16	2.486	16,43	642	4,24	7.543	49,85	3.225	21,32	15.132
1994	1.252	8,16	2.481	16,17	647	4,22	7.711	50,26	3.252	21,19	15.343
1995	1.402	8,21	2.758	16,16	695	4,07	8.568	50,19	3.648	21,37	17.070
1996	1.291	8,07	2.548	15,93	659	4,12	8.133	50,85	3.365	21,04	15.994
1997	1.288	7,97	2.519	15,58	634	3,92	8.360	51,70	3.371	20,84	16.172
1998	1.193	7,56	2.346	14,87	574	3,64	8.339	52,86	3.323	21,07	15.775
1999	1.173	7,43	2.289	14,51	549	3,48	8.453	53,57	3.316	21,01	15.780
2000	1.184	7,35	2.308	14,33	547	3,40	8.727	54,20	3.336	20,72	16.101
2001	1.211	7,29	2.361	14,20	556	3,35	9.095	54,71	3.401	20,46	16.624
2002	1.240	7,34	2.378	14,08	571	3,38	9.279	54,95	3.419	20,24	16.887
2003	1.266	7,47	2.373	14,01	581	3,43	9.297	54,88	3.425	20,22	16.942
2004	1.283	7,51	2.466	14,44	627	3,67	9.261	54,22	3.443	20,16	17.081
2005	1.320	7,71	2.522	14,73	660	3,85	9.104	53,18	3.512	20,52	17.117
2006	1.338	7,66	2.551	14,60	688	3,94	9.322	53,37	3.570	20,43	17.468

Source: LEMTe.

TABLE 3
Geographical Area, GDP, GDP per capita and Illiteracy Rate in Brazil per Regions, 2002

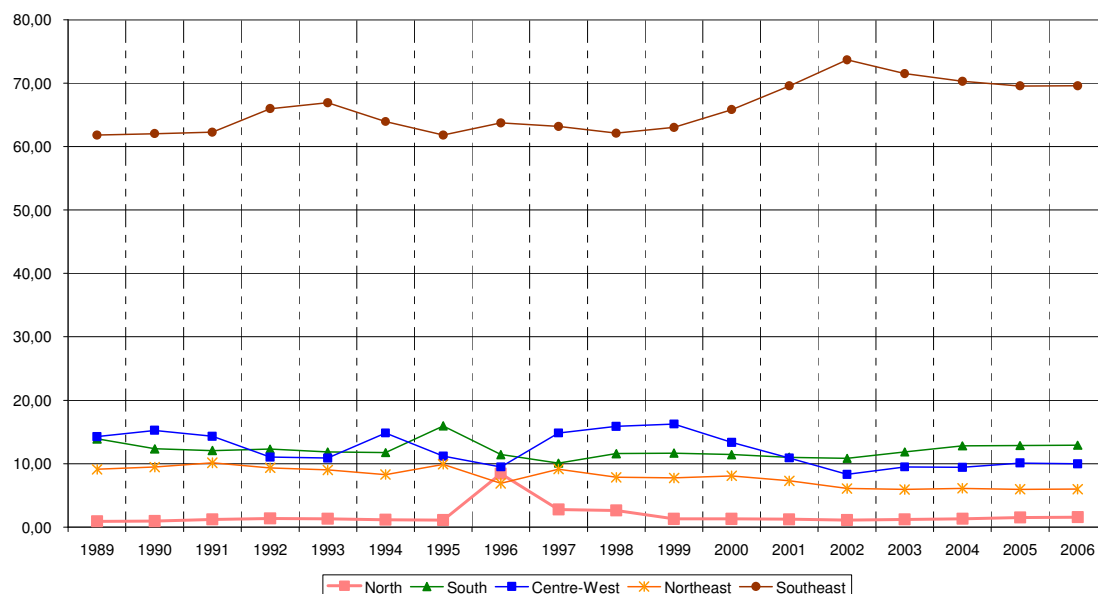
Region	Area (%)	GDP	Per capita GDP (\$ Reais)	Illiteracy Rate*
North	45,4	5	R\$ 4.939,00	9,8
Northeast	18,3	13,5	R\$ 3.694,00	23,4
Southeast	10,9	56,3	R\$ 10.084,00	7,2
South	6,6	17,7	R\$ 9.157,00	6,7
Middle-West	18,9	7,4	R\$ 8.166,00	9,6
Brazil	100	100	R\$ 7.631,00	11,8

* Population over 15 years old.
Source: IBGE.

Brazil continues to show a poor record in terms of credit operations and its term profile. In aggregate terms, considering the total credit as a percentage of GDP, Brazil shows one of the lowest ratio in the world (around 35% in 2005), while this ratio for the US, Japan, South Korea and Chile reaches respectively 249.2%; 99.5%; 98.2% and 63.1% in the same year (World Development Indicators 2006). In addition, 48% of the long-term credit to productive investments is offered by the BNDES, while 34% is offered by domestic private banks and 19% by foreign-owned banks. In terms of banks' asset management strategy, credit operations as a share of total assets reached 38% while securities, equities and government bonds added up to 26.6%. Most of the credit operations are of short-term nature or directed to consumption. Moreover, in the case of the domestic and foreign private banks, there is a clear preference for very short-term bonds and securities (respectively 67.7% and 43% of total investment in bonds and securities), whilst in the case of state-owned banks, their preference is lower (26%). Both indicators corroborate the speculative nature of private banks in Brazil and their high liquidity preference (Santos and Crocco, 2006).

Again, there exists an uneven pattern of credit distribution among Brazilian regions. And this pattern seems to be worsening over the years, with credit operations being increasingly concentrated in the richest regions as predicted by the post-Keynesian theory. It is important to note that the banking reforms virtually eliminated regional banks, thereby aggravating credit restrictions to the less developed regions and hindering their development (Graph 1). Furthermore, whereas the assets to GDP ratio of the banking sector of the Southeast region is between 1.5 and 2 times bigger than that of the remaining regions, the relative share of credit is over 5 times higher.

GRAPH 1
Spatial Distribution of Credit among Brazilian Regions, 1989-2006



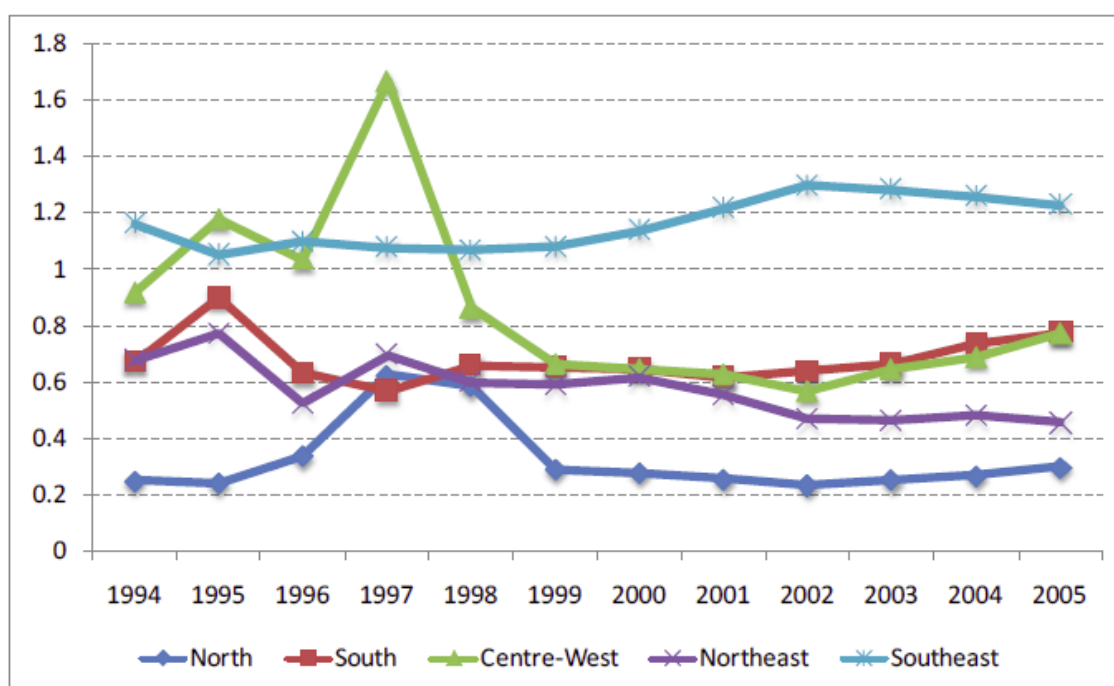
Source: LEMTe.

We also calculated the Regional Credit Quocient (QCR), which consists of the ratio between the relative share of a region on the total volume of credit conceded in the country and the relative share of the same region in the GDP.⁹ If the index is larger than one, the region's credit concession is proportionally larger than what it would be expect given its weight on GDP. Hence, the index allows us to assess whether the Southeast's share in total credit is a mere reflection of its economic weight. The evolution of the QCR is shown in Graph 2 below. It is evident that the North, Northeast and South regions' share in credit distribution is lower than their respective contributions to the GDP¹⁰. On the other hand, the contrary can be observed for the Southeast and Centre-West, the latter being influenced by the presence of federal banks.

⁹ The index is a modified version of the location quotient, commonly found in the regional economics literature.

¹⁰ The only exception is the North region in 1997, which is explained by isolated facts, most likely the privatization of Electricity Company of Pará and mining investments in Carajás.

GRAPH 2
Regional Quocient of Credit (QRC, %Credit/%GDP)



Source: LEMTe.

TABLE 4
Average Workforce, Bank Branches per capita, Credit Supply per capita, Taxes on Financial Operations (IOF) per capita and Average Wage in Brazil per Regions, 2002

Region	Average workforce	Branches per capita	Credit per capita	IOF per capita	Average wage
Northeast	4251	3.70	167.87	32.07	550.09
Southeast	12740	14.49	912.77	133.76	761.01
South	7882	22.43	1693.79	115.20	790.00
Centre-West	5474	11.32	1570.81	107.88	723.52

Note: The Northern region was excluded as explained in section II.
 Source: Authors' elaboration based on data from LEMTe and RAIS/MTE.

In order to further investigate the spatial distribution of the financial system in 2006 we present in Illustrations 1 to 5 the Local Indicator of Spatial Association i.e. the local Moran's I at 5% of significance level (Anselin, 1995).

Illustration 1 shows that there is no clear spatial pattern in the spatial distribution of taxes on financial operations per capita in 2006. At the Southeastern portion of Brazil there are some small areas where a positive spatial association with high values can be found. Meanwhile, at the Northeastern portion, most significant spatial patterns represent a negative spatial association, of the High-Low type, indicating that municipalities with high values of taxes on financial operations tend to be surrounded by municipalities with low values, i.e. the financial operations tend to be concentrated into one locality only in a small region.

Illustration 1
Local Moran's I of the taxes on financial operations per capita, year 2006

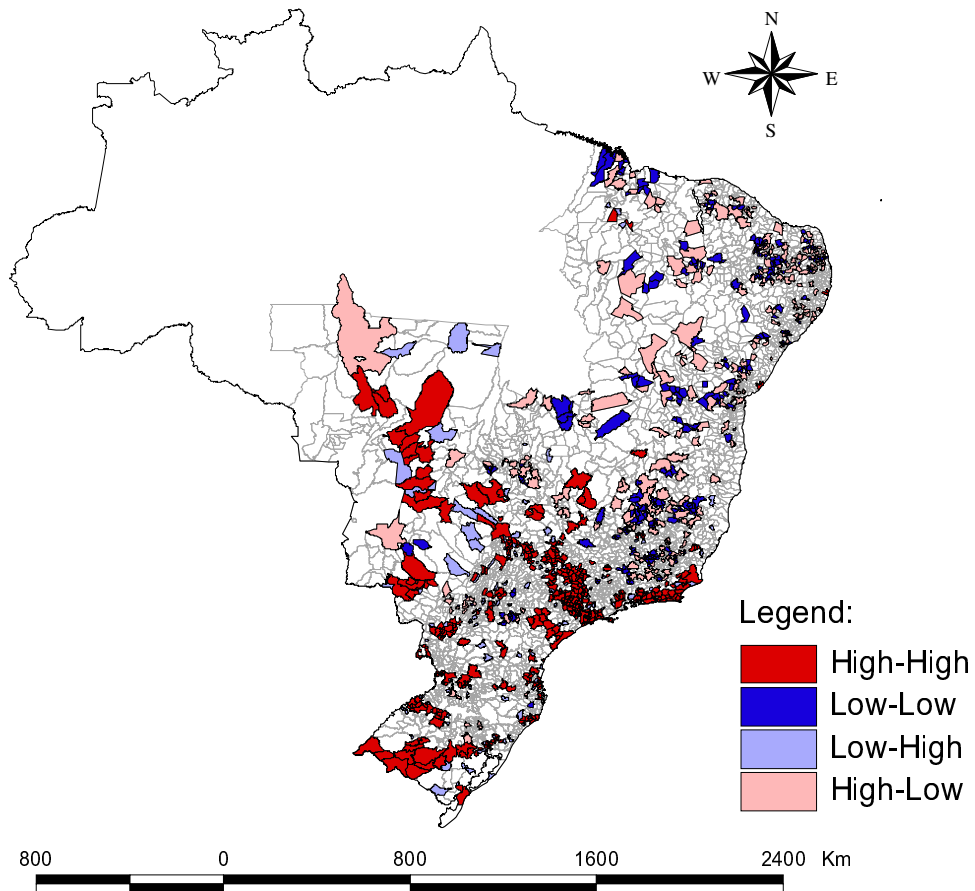


Illustration 2 presents a clearer spatial pattern of positive association of credit supply per capita at the Brazilian Southeastern region in 2006 while the Northeastern region once again presents a negative spatial association pattern. This result indicates that the credit supply tends to be less concentrated in unique localities at the Southeast, spreading with high values over some regions, like the regions surrounding Rio de Janeiro, the state of São Paulo, among others. However, as it was for the taxes on financial operations, the credit supply at the Northeast is highly concentrated on single municipalities in a High-Low pattern.

Illustration 2
 – Local Moran's I of the credit supply per capita, year 2006

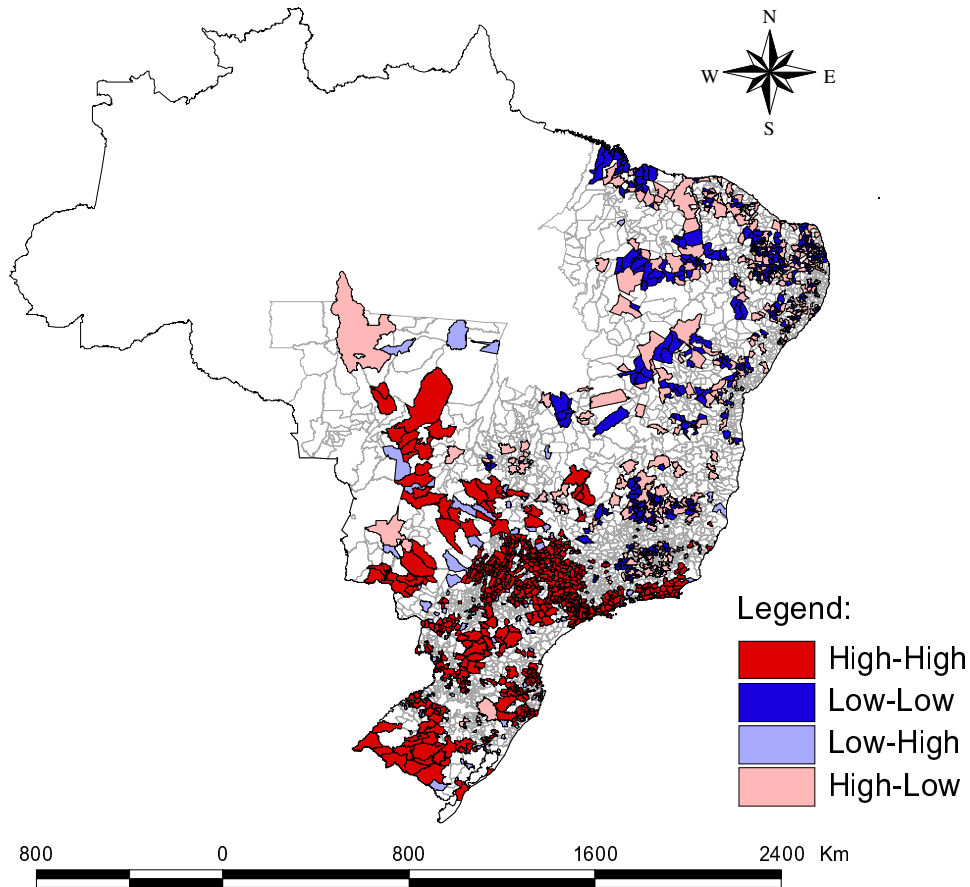


Illustration 3 presents the spatial association of the number of bank branches per capita in 2006. While the spatial association pattern at the Southeastern region is much similar to the credit supply, there is a positive spatial association of low values at the Northeastern region. Hence, regarding the number of bank branches per capita we have a spatial concentration of high values at the Southeastern region and a spatial concentration of low values at the Northeastern region, with some High-Low outliers which concentrate the bank agencies. As presented in Table 3, the South and Southeast regions concentrate almost 74% of all bank branches in Brazil.

ILLUSTRATION 3

– Local Moran's I of the number of bank agencies per capita, year 2006

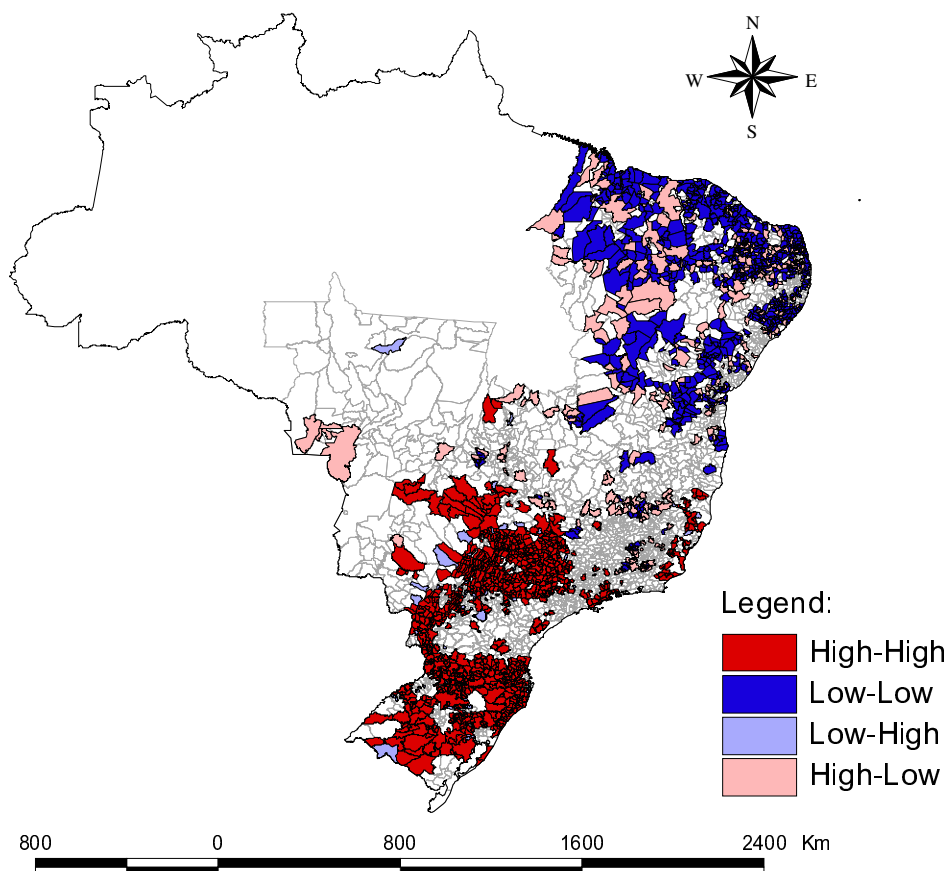


Illustration 4 and 5 show the spatial association of the number of employees in the formal sector and the average wage. Illustration 4 shows a clear imbalance in the spatial distribution of the average wage in Brazil. While the Southeastern region presents a spatial pattern of high wages, the Northeastern municipalities represent a cluster of low wages.

Regarding the spatial association of the number of employees in the formal sector, Illustration 5 presents a fuzzy spatial pattern. Some small areas present clusters of high values while others present cluster of low values surrounded by a large number of outliers presenting a negative spatial association.

ILLUSTRATION 4

Local Moran's I of the average wage, year 2006

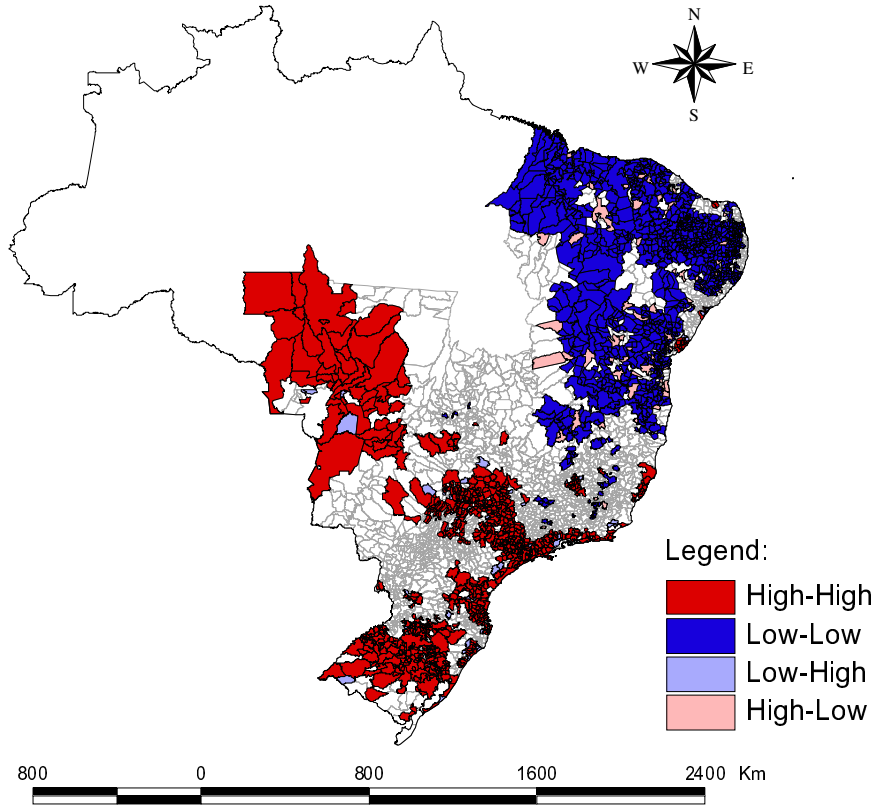
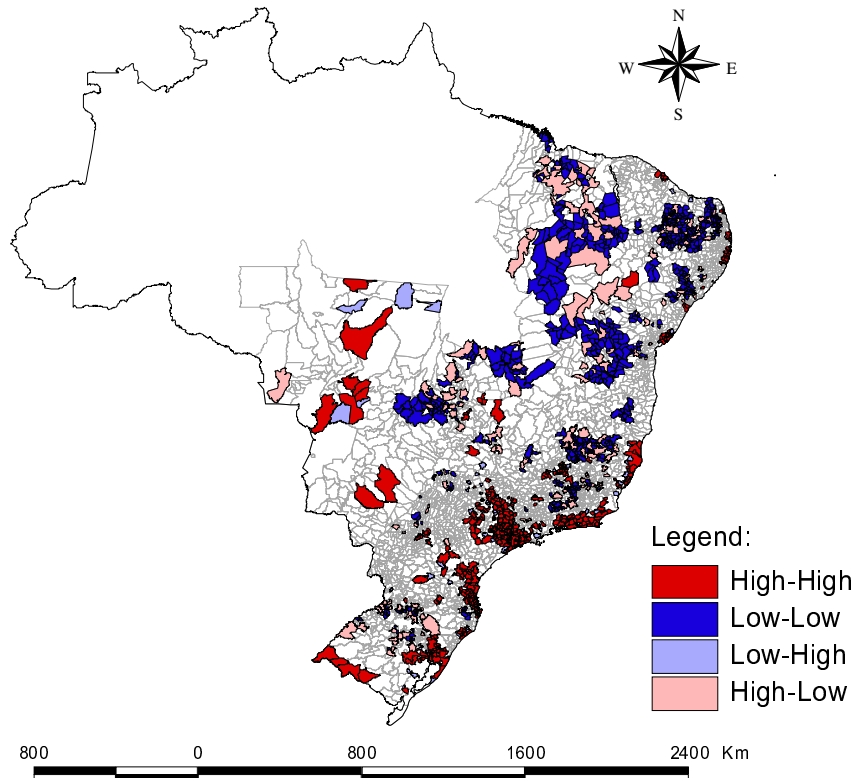


ILLUSTRATION 5

Local Moran's I of the general workforce, year 2006



From these statistical analyses made above a first conclusion emerges. The financial variables related to the management of the bank system (taxes on financial operations and the supply of credit) have a clear regional pattern which is different from the spatial pattern verified for the variables that captures the economy as a whole (average wage and number of employees). The high-low pattern in the northeast (both for financial operations and for credit) is an evidence that bank system in that region has a higher degree of centrality than that observed in the other regions, specially the southeast. This degree of centrality is manifested in the high level of spatial concentration of the financial variables.

IV. ESTIMATIVE AND INFERENCE

The first estimated model is related to the tax on financial operations (IOF). The model captures the relationship between the per capita amount of tax paid at the bank branches in a municipality and the amount paid at branches in the neighborhood. The controlling variables are the number of employees in the municipality, the number of bank branches for each 100,000 citizens, the average wage and average schooling.

For reference only, Estimation 1 presents the results of a simple IV estimation. This estimation does not consider the spatial dependence in the error process nor the time-invariant effects.

Meanwhile, Estimation 2 presents the results of the spatial panel model. The results suggest a negative relationship between the amount of taxes paid in a municipality and the amount paid in the 8 nearest neighbors. This suggests a negative spatial association of the amount of financial operations. If one municipality has a high level of financial operations, its neighborhood tends to have a lower level, indicating a spatial concentration of the financial activities. More specifically, an increase of 1% in the amount of taxes on financial operations paid in the neighborhood is related to a decrease of 0,29% of the amount paid in one municipality. All the controlling variables presented the expected signs and are very statistically significant as well. The number of employees and number of bank branches are positively related to the amount of financial operations, as is the average wage level.

TABLE 5
Results of the estimations over the dependent variables *IOF* and *Credit*

	Estimation 1	Estimation 2	Estimation 3	Estimation 4
	<i>Ln_IOF</i>	<i>Ln_IOF</i>	<i>Ln_Credit</i>	<i>Ln_Credit</i>
Intercept	-6.4537 (0.1507)	-6.3542 (0.3429)	-7.6624 (0.1675)	-7.7603 (0.4251)
<i>W_Ln_IOF</i>	-0.3863 (0.0113)	-0.2955 (0.0330)	-	-
<i>W_Ln_credit</i>	-	-	-0.1506 (0.0079)	-0.1452 (0.0274)
<i>Ln_agencies</i>	0.8138 (0.0082)	0.7385 (0.0202)	1.2731 (0.0092)	1.1945 (0.0251)
<i>Ln_workforce</i>	0.7221 (0.0063)	0.7852 (0.0169)	0.8847 (0.0070)	0.9605 (0.0209)
<i>Ln_wage</i>	0.5198 (0.0272)	0.4244 (0.0577)	0.5391 (0.0301)	0.4931 (0.0715)
Lambda	-	-0.8517	-	-0.6314
Σv	-	0.8997	-	0.5316
σ_1	-	24.1286	-	37.3908
R²	0.4899	0.5010	0.6102	0.6108

Instruments: *Ln_agencies*, *Ln_workforce*, *Ln_wage*, *W_Ln_agencies*, *W_Ln_workforce*, *W_Ln_wage*.

Considering the amount of credit supplied by the banks, the negative spatial association pattern remains, although with a lesser intensity (Estimation 3 and 4). Estimation 3 is for reference only and presents the results of an IV estimation disregarding the timely and spatial dependence in the error. Estimation 4 presents the results of the spatial panel estimation. The results suggest a negative relationship between the amount of credit per capita in a municipality and the amount of credit in the 8 nearest neighbors. As with the financial operations, if one municipality has a high level of credit release, its neighborhood tends to have a lower level, indicating a spatial concentration of the financial activities. More specifically, an increase of 1% of the credit in the neighborhood is related to a decrease of 0,14% of the amount lent in one municipality. Once again, the number of employees and number of bank branches for each 100,000 citizens are positively related to the amount of credit, as is the average wage. All variables are statistically significant at a 5% level.

Comparing both results we conclude that the taxes on financial operations (IOF) and the credit supply present a negative spatial association pattern, in the way that both are spatially concentrated as would be expected by the propositions of the Central Place Theory. However, it is worthy of mention that the parameter which measures this spatial association is lower for the IOF. This suggests that the spatial concentration of financial operations is even higher than the spatial concentration of credit supply. Hence, under the light of the Central Place Theory, the financial operations have a higher centrality than the credit supply.

FINAL REMARKS

Our theoretical and empirical analyses do not intend to be comprehensive or definitive, but rather to stimulate further research in this somewhat neglected area. However, they point to important conclusions and new themes for future research.

1. The spatial structure of financial system was shown to be capable of being understood by combining the contributions of the New-Keynesian and Post-Keynesian theories with Central-Place theory;
2. The existence of a negative spatial association between the Brazilian municipalities' financial system (in the way that a municipality with more developed financial system tends to be surrounded by municipalities with less developed financial systems) shows the validity of the Central Place theory to explain the spatial configuration of the Brazilian financial system;
3. Taking both methods of analyses into consideration (Moran's-I and the spatial econometrics) it is possible to state that the Brazilian bank system has a regional pattern of balance sheet management. The Moran's I shows a similar spatial pattern for the taxes on financial operations (IOF) and the supply of credit, with a clear distinctive pattern between the Northeast and the Southeast regions. This statement is more evident when the econometric results are taken into consideration. The fact that both the IOF and the supply of credit show negative spatial correlation reinforces the understanding of these variables as having a strong centrality feature, which, in turn, is essentially a regional phenomenon.
4. Even recognising that new electronic and information and communication technologies have dramatically reduced the costs of the exchange of information and thus the friction of distance, uneven patterns of spatial distribution of credit and financial services (approximated by IOF) within a country are still observed. In this case as the New-Keynesian and Post-Keynesian theories have shown, the scale-sensitiveness of the transaction and information costs in the financial system and the importance of liquidity preference and fundamental uncertainty has discouraged the proliferation of central-points and led the concentration of financial system activities, institutions and functions in a few centres at the expense of its periphery;
5. The configuration of the Brazilian financial system may compromise the flow of information between the firms and the public of the periphery and the financial system in the centre. This may adversely affect the periphery's awareness of financing options in the centre and the collection of information by the centre about the periphery;
6. The results of the model may be interpreted as indicating that the costs of financial activities vary substantially across municipalities, most notably among different hierarchical levels. Further research is necessary to explore this aspect.
7. The fact that our results indicate that the Central Place Theory may fit well to explain the spatial configuration of the Brazilian financial system opens a line of enquiry regarding the development of a method to create a hierarchy of central places based upon the spatial structure and development of financial institutions.

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