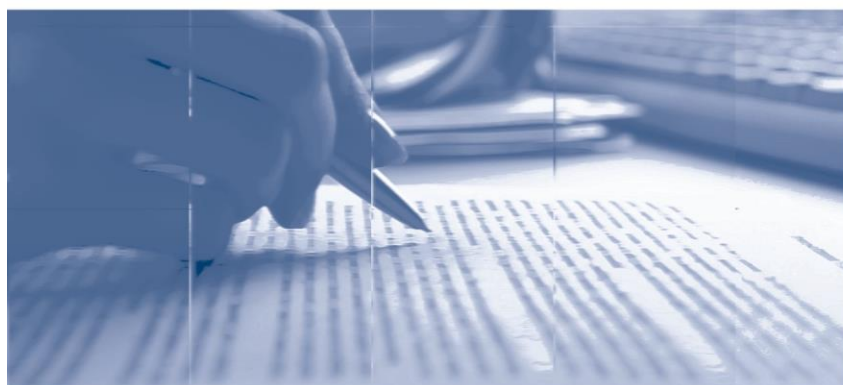


# Financial and Economic Development Nexus: evidence from Brazilian municipalities

Marcos Soares da Silva

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# Financial and Economic Development Nexus: evidence from Brazilian municipalities \*

Marcos Soares da Silva \*\*

## Abstract

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This paper investigates the relationship between financial development and economic development for 5,564 Brazilian municipalities in 2012. Using supply-side information, we propose a way to measure financial development at the municipality level. This composite index is used to evaluate how financial service is distributed throughout the country. Our empirical strategy consists in examining the effect of spatial dependence among municipalities by applying a spatial-autoregressive with spatial-autoregressive disturbance model (SARAR). We find a positive and significant association of the economic development between the municipality and its neighbors, after controlling for relevant factors. The results also suggest that financial development has a large positive impact on local economic development.

**JEL Classification:** C31, E44, O16, R12

**Keywords:** Financial development, economic development, cross-sectional spatial models, economic geography.

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## **1. Introduction**

Financial development undoubtedly plays a constructive role in economic development, largely by improving the quality of financial infrastructure and, to a lesser degree by raising the quality of socioeconomic infrastructure in its wider sense. The presence of banks in a region eases access to sophisticated financial marketplaces. The theoretical connection between financial services and economic prosperity operates through different channels that facilitate the screening and monitoring of investment projects. First, an efficient financial system can adequately mobilize savings and allocate resources by choosing safe and profitable projects (Greenwood et al., 2010). Thus, financial institutions distribute resources from low-growth to modern high-profitable economic sectors. Furthermore, they encourage an entrepreneurial response in these dynamic economic sectors. Second, banks may contribute to reducing agency costs, encouraging innovation and diversification of economic activities (Aghion et al., 2005). Third, it is possible to obtain a high rate of return on investments through risk-sharing (Greenwood and Jovanovic, 1990). Finally, financial institutions provide liquidity to households and enterprises, smoothing consumption cycles. In this sense, banks follow economic growth because of the increased demand for financial services (Friedman and Schwarz, 1963).

The theoretical and empirical literature postulates that the association between financial development and economic development is positive but possibly not monotonic. Indeed, the effect of financial deepening on growth becomes negative once a certain threshold is reached (Arcand et al., 2012 and Cecchetti & Kharroubi, 2012). From a cross country study, Samargandi et al. (2014) find evidence that there is an inverted U-shaped relationship between financial development and economic growth in the long run. This may be due to suboptimal low savings, suboptimal high allocation of labor to the financial sector, overheated economic capacity, or the exertion of inefficiently high cost on the economy (Jappelli and Pagano, 1994; Bolton et al., 2011; Zeira, 1999; Santomero and Seater, 2000). Also, Allen and Carlett (2006) e Gai et al.(2008) claim that financial development may lead to higher systemic risk.

Even though there is an extensive empirical literature available on the relationship between financial development and economic development, the mainstream literature uses datasets with high levels of aggregation. As such spatial dependence is not considered. For example, Ductor and Grechyna (2015) evaluate that link by using a panel

data for developed and developing countries. Moreover, only a few studies, as Crocco et al. (2009) consider spatial dependence.

However, no work has so far focused on financial development as a multidimensional phenomenon that includes both use and availability of a large range of financial services across municipalities in Brazil. Hence, in this paper we take into account geographic space when analyzing the interactions between economic and financial development. We also investigate which Brazilian municipalities' features can strengthen the linkages between financial services and local economic development.

The main purpose of this article is to evaluate whether there is a spatial interdependence between economic development and financial development at a municipal level in Brazil.

We use a dataset maintained by the Central Bank of Brazil that contain detailed information on the access to bank services at the municipal level. These data are joined with the gross domestic product of the municipalities. We also consider a countrywide level survey carried out by the Brazilian Institute of Geography and Statistics (IBGE), which provides information on the economic profile of all the Brazilian municipalities in 2012. Our empirical strategy consists in examining the effect of the spatial dependence among municipalities by applying a spatial-autoregressive with spatial-autoregressive disturbance model (SARAR). See Kelejian and Prucha (1998, 2010) and Drukker et al. (2013).

After controlling for relevant factors, we find a positive and stable correlation between financial development and economic development. In addition, the results suggest that there may be spillover benefits from dynamic municipalities toward their neighbors.

The remainder of this paper is structured as follows. Section 2 provides statistics for the financial sector in Brazil. The empirical strategy is explained in Sections 3 and 4. In Section 5, we discuss the results. In Section 6, conclusions are drawn.

## **2. Brazilian financial development**

Brazil has experienced strong growth of the banking sector in recent years, accompanied by a process of restructuring and modernization of the banking industry. The total financial system credit operations reached R\$3,026.4 billion in February 2015, and the credit/GDP ratio increased to 58.6% from 22.5% in 2002.

The regional credit allocation appears to be quite similar to the spatial distribution of national income. The Southeast region, the most developed, represents 55.0% of the GDP and has 55.4% of the credit. The South region's share of credit is 18.1%, which is slightly higher than its share of GDP (16.0%). The northeastern participation in credit accounts for 13.1%, that is slightly below its share of GDP (13.4%). The Midwest has a bit more credit (10.5%) than its share of GDP (9.6%). Finally, the North region's credit share is 3.8%, representing 5.4% of GDP. These figures suggest that there is low interregional savings mobility in the country.

To understand the access to financial services in Brazil, first, it is important to know how the channels are distributed in the territory. Table 1 shows the main financial service channels by region.

**Table 1. Financial services distribution channels**

Region	Bank branches	PAE	Correspondents	PAB	Other channels*
Midwest	1,851	3,850	6,546	466	321
North	1,053	2,614	4,284	396	288
Northeast	3,759	8,030	25,289	785	1,178
Southeast	12,112	18,611	34,307	3,454	1,623
South	4,376	7,249	10,430	1,344	555
Brazil	23,151	40,354	80,856	6,445	3,965

Sources: BCB/Unicad

Note: (\*) Credit Unions, Cooperative Service Outposts (PAC), and Advanced Service Outposts (PAA).

Correspondents<sup>1</sup> are the dominant financial service channel in Brazil, with more than 80 thousand units (52.2% of all distribution channels), followed by Electronic Service Outposts (PAE<sup>2</sup>) with 26.1% and bank branches (15.0%). All of these channels have a strong presence in the Southeast, with 52.3% of bank branches, 42.4% of correspondents and 46.1% of PAE, respectively, located in this region. Brazil's correspondent model has become a well-established alternative approach to increasing access to financial services and serves as an important instrument for democratizing the delivery and use of these services. Bank Service Outposts (PAB), which is usually installed inside a government agency or private company, is a satellite of a bank that can provide all of the services the financial institution is authorized to run.

1 In this channel, financial institutions hire retailing shops, lottery outlets, post offices, to use them as their agents, known as correspondents. The correspondents carry out diverse financial transactions on the behalf of the hiring financial institution.

2 PAEs offer services exclusively through Automated Teller Machines (ATMs).

In terms of geographical distribution, the country has an average of 2.33 branches per 1,000 km<sup>2</sup>. However, this diverges considerably between the five regions. The Southeast region has approximately five times more branches per 1,000 km<sup>2</sup> than the national average, while the North and Midwest barely have one branch per 1,000 km<sup>2</sup>. The size and low population density of these regions explain these low levels, particularly in the North.

The indicator “number of bank branches per 10,000 adults” reveals that the North region (with 0.9) is 22% below the national average (1.2). The Northeast region, which has higher population density, is equally low (30.9% below the national average). In contrast, the South has the highest rate (58.1% higher than the national average), followed by the Southeast (35.9%) and the Midwest (31.1%).

Although Brazil is above average among developing countries in terms of number of branches per 100,000 adults (27.7), it falls short when compared to developed countries, even when only the Southeast or South Brazilian regions are considered.

### **3. Analytical framework**

Using supply-side information, we calculate a financial development index at the municipality level. Given the availability of data, the following twelve indicators are considered:

a) **Geographic penetration:**

- number of bank branches per thousand kilometer area;
- number of Electronic Service Outposts (PAE) per thousand kilometer area;
- number of bank services outposts per kilometer area;
- number of “advanced service outposts” per kilometer area;
- number of “correspondents” per kilometer area;

b) **Demographic penetration:**

- number of bank branches per 100 thousand people;
- number of Electronic Service Outposts (PAE) per 100 thousand people;
- number of bank services outposts per 100 thousand people;
- number of “advanced service outposts” per 100 thousand people;
- number of “correspondents” per 100 thousand people;

c) **Financial service usage:**



- deposit-GDP ratio;
- credit-GDP ratio.

The normalized variable is therefore bounded between 0 and 1, where the maximum score is attributed to the leading municipality in each considered dimension, which is given by:

$$Z_{k,i} = \frac{(X_{k,i} - m_k)}{(M_k - m_k)} \quad (1)$$

where  $X_{k,i}$  is the k-th indicator for the i-th municipality.  $M_k$  and  $m_k$  are the maximum and the minimum values of each financial indicator, respectively.

We then use factorial analysis (principal-component method) to group the financial indicators into relevant dimensions. It reduces the number of variables in the analysis by describing linear combinations of them that contain most of the information and meaningful interpretations.

As shown in Table 2 below, it is enough to retain the first four factors because they capture almost all of the variance involved in the original dataset.

**Table 2. Factor analysis**

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor 1	4.6348	2.7281	0.5663	0.5663
Factor 2	1.9068	0.7962	0.2330	0.7993
Factor 3	1.1106	0.6098	0.1357	0.9349
Factor 4	0.5508	0.1372	0.0612	0.9961

Source: Author

Table 3 shows orthogonal rotated factor loadings (pattern matrix) and unique variances. Although the first three factors can explain more than 93% of the variance, the fourth factor is required in order to avoid misrepresentation of the variables “Number of PAE/Adult Population” and “Number of Correspondent/Adult Population”.

**Table 3. Factor analysis and unique variances**

Variable	Factor1	Factor 2	Factor 3	Factor 4	Uniqueness
# of bank branches/Km2	<b>0.8518</b>	0.2268	-0.3635	-0.1053	0.0797
# of PAE/Km2	<b>0.8333</b>	-0.0206	<b>-0.4741</b>	0.0887	0.0725
# of BSO/Km2	<b>0.8647</b>	-0.2462	-0.0063	-0.1145	0.1786
# of ASP/Km2	<b>0.7633</b>	-0.4080	0.3276	-0.0004	0.1435
# of Corresp/Km2	<b>0.8420</b>	0.0055	<b>-0.4709</b>	-0.0965	0.0599
# of Branches/Adult Pop	0.3025	<b>0.7153</b>	0.2768	0.1416	0.3003
# of PAE/Adult Pop	0.2106	-0.0201	-0.0596	<b>0.8129</b>	0.2908
# of BSO/Adult Pop	<b>0.6855</b>	-0.2749	<b>0.4149</b>	-0.0410	0.2807
# of ASP/Adult Pop	<b>0.6492</b>	-0.4388	<b>0.5043</b>	0.0417	0.1299
# Corresp/Adult Pop	0.1003	0.1131	0.0064	<b>0.6022</b>	0.6145
Deposit/GDP ratio	<b>0.4078</b>	<b>0.7598</b>	0.1871	-0.1339	0.2035
Credit/GDP ratio	0.3699	<b>0.7673</b>	0.2616	-0.0605	0.2024

Source: Author

To obtain the final score, we consider the weights proportionally to the extracted factors, i.e., factor 1 (0.57), factor 2 (0.23), factor 3 (0.14) and factor 4 (0.06). Thus, the composite index is a proxy for our financial development measure. It involves the dimensions of geographic penetration, population coverage and access to financial services both directly via bank branch and by outreach mechanisms used by the financial institutions.

Table 4 presents the distribution of the “**Financial Development Index**” by region. These figures reveal considerable imbalance between regions as a natural consequence of the diverse socioeconomic conditions that have determinant impacts on the distribution of financial services. Figure 1 details the distribution of financial services by municipalities, highlighting the strong presence of banks in the Southeast and the South regions, and in some big cities throughout the country<sup>3</sup>.

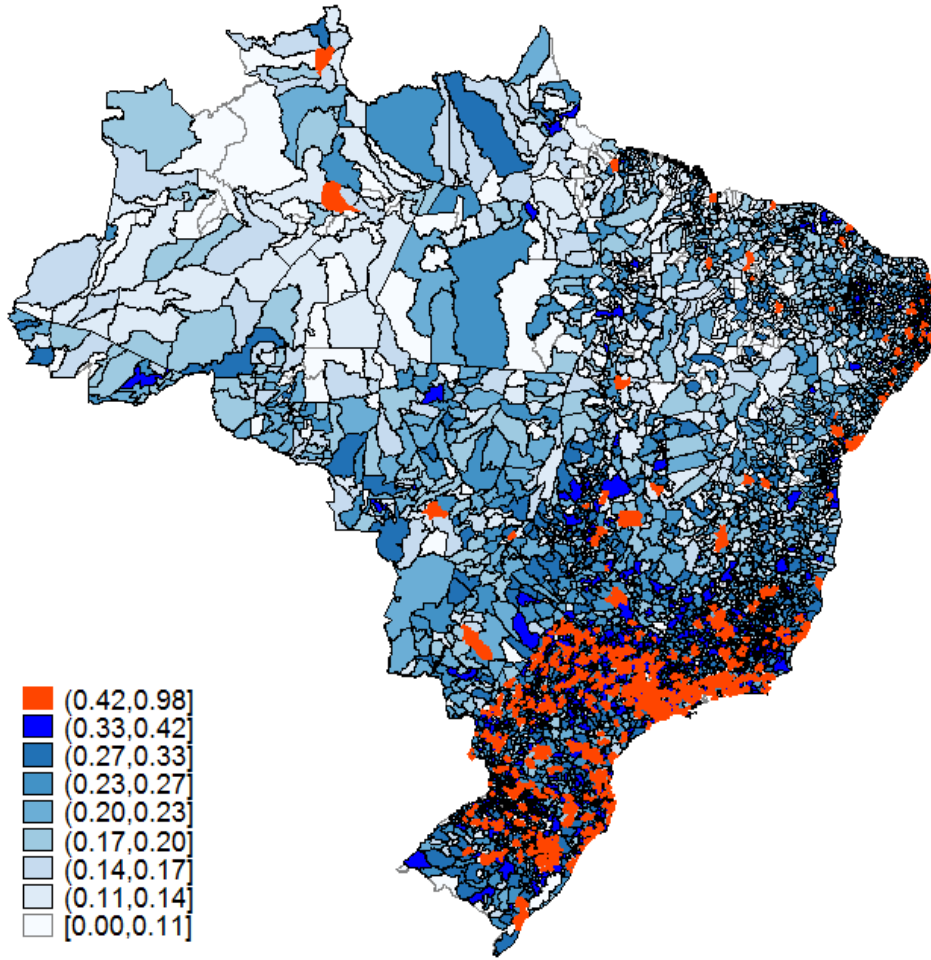
**Table 4. Summary statistics of Financial Development by region**

Statistics	Brazil	North	Northeast	Midwest	Southeast	South
Minimum	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	0.98	0.79	0.86	0.90	0.91	0.98
Mean	0.25	0.16	0.18	0.22	0.31	0.30
Std. Dev.	0.15	0.08	0.10	0.10	0.17	0.16
10-percentile	0.10	0.09	0.10	0.12	0.14	0.12
25-percentile	0.14	0.11	0.12	0.15	0.20	0.19
50-percentile	0.21	0.14	0.16	0.20	0.28	0.29
75-percentile	0.31	0.20	0.22	0.26	0.39	0.37
90-percentile	0.43	0.26	0.28	0.32	0.50	0.51

Source: Author

<sup>3</sup> We divided the sorted data into ten equal parts so that each interval represents the 10<sup>th</sup>, 20<sup>th</sup>, 30<sup>th</sup>, 40<sup>th</sup>, 50<sup>th</sup>, 60<sup>th</sup>, 70<sup>th</sup>, 80<sup>th</sup>, and 90<sup>th</sup> percentiles of the variable Financial Development Index.

**Figure 1. Financial Development Index – Spatial Distribution among Brazilian Municipalities in 2012**



Source: Author

#### 4. Empirical specification and data

We are interested in investigating how financial development can contribute to enhancing economic progress. Our central hypothesis is that credit supply is only effective in locations where there exist favorable conditions for establishing productive activities. Moreover, we suppose that there may be spillover benefits across geographical areas.

We follow Kelejian and Prucha (1998, 2010), and the references cited therein, as well as Drukker et al. (2013), and employ the following econometric model, which allows for cross-unit interactions:

$$Y_i = \lambda \sum_{j=1}^n w_{ij} Y_j + \beta_0 X_i + \beta_k \sum_{l=1}^k Z_l + \alpha + u_i \quad (2a)$$

$$u_i = \rho \sum_{j=1}^n m_{ij} u_j + \varepsilon_i \quad (2b)$$

where  $Y_i$  is an  $(n \times 1)$  vector of observations that represents the Economic Development Index for each Brazilian municipality.  $w_{ij}$  and  $m_{ij}$  are  $(n \times n)$  spatial-weighting matrices (with zero diagonal elements).  $w_{ij}Y_j$  and  $m_{ij}u_j$  are  $(n \times 1)$  vectors referred to as spatial lags<sup>4</sup>.  $\lambda$  and  $\rho$  are the corresponding scalar parameters.  $X_i$  and  $Z_i$  are  $(n \times k)$  matrices of explanatory and control variables, respectively.  $\varepsilon_i$  is an  $(n \times 1)$  vector of innovations, where  $\varepsilon_i \sim N(0, \sigma_\varepsilon^2 I_n)$ , and  $n$  is the sample size.

In this model, the spatial dependence occurs via the error term and the dependent variable so that a shock in any location is transmitted to the remainder of the locations.

Following the United Nations Development Program's methodology, we calculate  $Y_i$ , “**Municipal Economic Development Index**”, as follows:

$$Y_i = \frac{[\ln(GDP_i^{PC}) - \ln(\text{MinRef})]}{[\ln(\text{MaxRef}) - \ln(\text{MinRef})]} \quad (3)$$

where  $GDP_i^{PC}$  is the monthly gross domestic product per capita at a given municipality. MaxRef and MinRef are the maximum and the minimum reference values defined as R\$8.00 and R\$4,033.00, respectively. The later value corresponds to the average income of the richest decile of the population in the richest municipality in Brazil while the former value corresponds to approximately \$100 purchasing power parity (PPP), which is the adopted limit for calculating the Human Development Index (HDI) by the United Nations Development Programme.

The variable explanatory  $X_i$  denotes the **Financial Development Index** for each municipality as discussed in Section 4. Theoretically, it is expected to be positively related to the **Economic Development Index**.

Control variables do not solely help us to account for spurious relationships, but they also measure the impact of any given variable above and beyond the effects of other variables. For controlling and gaining insight in whether a municipality is economic developed, we use the variable described below. To this end, we use a nationwide level survey covering all the Brazilian municipalities carried out by the Brazilian Institute of Geography and Statistics.

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<sup>4</sup> In this study,  $w_{ij}$  and  $m_{ij}$  are identical matrices.

We define the hierarchy of municipalities and delimit the regions of influence associated with them from the aspects of public administration and corporate management and the provision of equipment and services. This is performed in order to identify points of the territory from which decisions are issued. In this study, we categorize the municipalities into four groups, depending on how easily they can reach each other. Hence, we have the following dummies variables: 1) **Centrality Level 1** (national): municipality whose leadership transposes all regions of the country; 2) **Centrality Level 2** (regional): municipality that exerts influence over other municipalities within its administrative region; 3) **Centrality Level 3** (subregional): municipality whose linkages are bounded by others within the same mesoregion; 4) **Centrality Level 4** (local): municipality that is linked only to its nearest neighbors or that it does not have connections. The primary reason for the lack of connection is the existence of a business relationship purely for local purposes. In spatial terms, the locations of disconnected municipalities are scattered throughout Brazil.

Besides the degree of centrality, we can also ask questions about the correlation pattern in the degrees of connected municipalities. Therefore, we use one measure of connection called **Linkage Intensity**, which comprises the sum of companies and branches circumscribed by each symmetrical pair of municipalities.

We also include as covariate the variable **Average Interaction Path**, which shows the average distance between municipalities that have economic connection. The average distance of the interactions between the municipalities is 395 km. São Paulo (815 km), Rio de Janeiro (950 km), and Brasilia (1,062 km) express the extent of its dense network fed by the condition of national metropolis. According to IBGE, more than half of the population in Brazil lives in towns that form clusters of economic conglomerates.

Broadly speaking, a suitable transport infrastructure can promote business activities and reduce the commuting cost, improving the economic conditions. We include as a control the variable **Public Transport**. This covariate is a dummy variable that assumes the value of one if there is regular public transportation that meets displacement between neighborhoods, districts and other localities of the municipality, and zero otherwise.

The dummy variable **Investment Policy** takes on the value of one if the municipality offers incentives to attract productive investments, and zero otherwise.

The strength of linkages between two municipalities is evaluated by the interactions among local and non-local establishments. In this evaluation, we take into account the presence of branches that are attracted to their domains. This process is captured by the explanatory variable **Attracted Business**, which represents the number of firms or branches whose head office is not located in the municipality of reference.

Remote access refers to financial services accessed by personal devices, such as landline or cell telephones and personal computers. These kinds of services may include call centers, internet banking, and mobile banking. Thus, it is vital to narrow the digital gap in the municipalities poorly served with regular financial services. We try to capture this dimension by using the dummy variable **Digital Inclusion**, whose value is one if the municipality develops actions in order to induce digital inclusion, and zero otherwise.

Finally, the variable **Linkage Intensity** represents the degree to which a municipality does business with other municipalities. It is gauged by the sum of the number of local companies that maintain affiliated units in other localities and the number of firms attracted (or branches) to the municipality as well.

While the availability of financial services contributes to raising the local economy, banks may prefer establishing their financial services where income is already higher. This reverse effect could lead to an endogeneity problem in the model specification of Equation 2.

We instrument our financial development index with two instrumental variables. First, the average employed population ratio of the neighboring municipalities in the same economic microregion, excluding the municipality of reference. Second, the payroll of local firm-related employees located outside the municipality. As banks fund productive projects, these variables are expected to be strongly correlated with finance activities. In addition, it is reasonable to consider that the employed population that commutes is negligible as the distance increases due to transportation costs. Consequently, such instrumental variable is not likely to affect the income in the municipality of reference. We use the Hansen J over-identification test of all the instruments to check their validity.

## 5. Regression results

The main purpose of this article is to evaluate whether there is a spatial interdependence between economic development and financial development at a municipal level in Brazil.

This study provides several interesting findings in relation to the role that spatial interdependence plays as a determinant of local economic development. Tables 5 reports the main results of spatial-autoregressive model with spatial-autoregressive disturbances, considering a contiguity matrix of neighborhood. We calculated robust standard errors for robust estimators, where the standard error estimates are designed to be robust against heteroskedasticity and the presence of outliers.

As a robustness test, we also run the regression with two different criteria of neighborhood. One model specification were carried out including a second order neighboring, considering the inverse distance weighting matrix and the cut-off of 80 km (Table 6), while another extends this criterion to 200 kilometers (Table 7). The results are similar to our benchmark specification. Nevertheless, spatial effects are considerably higher when the first order contiguity matrix is taken into account. In addition, as shown in Table 8, where we do not take into account spatial dependence, neither related to the term error nor the dependent variable lag, the correlation between financial development and economic development seems to be overestimated by the two-stage least squares estimator.

The robust Durbin-Wu-Hausman test of endogeneity leads to a strong rejection of the null hypothesis that the variable **Financial Development Index** is exogenous. This confirms the need for using instrumental variable estimators. In contrast, the Hansen's test does not reject the null hypothesis that all of the aforementioned instruments are valid, confirming that they are indeed exogenous.

**Table 5.** Estimation results for the Spatial-autoregressive model with spatial-autoregressive disturbances (matrix – bordering neighbors).

Variable	Specification 1	Specification 2	Specification 3
Spatial Dependence Lag	0.2479*** (0.0465)	0.2581*** (0.0611)	0.1909*** (0.0540)
Financial Development Index	0.3696*** (0.0289)	0.3745*** (0.0366)	0.4072*** (0.0354)
North Region	-0.0146*** (0.0046)	-0.0098** (0.0354)	-0.0152*** (0.0047)
South Region	0.0273*** (0.0030)	0.0254*** (0.0029)	0.0273*** (0.0031)
Northeast Region	-0.0399*** (0.0044)	-0.0372*** (0.0047)	-0.0429*** (0.0044)
Midwest Region	0.0359*** (0.0033)	0.0368*** (0.0041)	0.0380*** (0.0042)
Centrality Level 2		0.0738*** (0.0217)	0.0731*** (0.0243)
Centrality Level 3		0.0482** (0.0194)	0.0479** (0.0354)
Centrality Level 4		0.0742*** (0.0252)	0.0774*** (0.0269)
Public Transport		0.0101*** (0.0022)	0.0094*** (0.0022)
Investment Policy		0.0059*** (0.0014)	0.0051*** (0.0014)
Digital Inclusion		0.0087*** (0.0026)	0.0089*** (0.0026)
Attracted Business			-0.3355 (0.2055)
Average Interaction Path			0.0233*** (0.0070)
<b>Linkage Intensity</b>			0.3893*** (0.1951)
Constant	0.3950*** (0.0565)	0.2949*** (0.0611)	0.3280*** (0.0335)
Rho	0.3105*** (0.0357)	0.2275*** (0.0455)	0.2821*** (0.0335)
Wald Test	482.23 (0.0000)	1,553.73 (0.0000)	1,539.19 (0.0000)
Durbin-Wu-Hausman (test of endogeneity)	189.03 (0.0000)	170.66 (0.0000)	114.7700 (0.0000)
Hansen (p-value)	(0.4058)	(0.4710)	(0.8630)
Observation	5,564	5,564	5,564
R <sup>2</sup> -Adjusted	0.7045	0.7213	0.7683

Note: Robust standard errors reported in parentheses. \*\*\*, \*\*, and \* indicate significance at the 1%, 5%, and 10%, respectively. The Hansen test evaluates the validity of the over-identifying restrictions. Specification 1 is a restricted econometric model in which we include as explanatory variables only the Financial Development Index, the spatial-autoregressive and the spatial-autoregressive disturbance term. Specification 2 adds categorical variables that characterize the economic profile of the Brazilian municipalities. Specification 3 is an extended model in which we include as regressors other similar variables that are measured at the ratio level.



The results indicate a significant and positive association between economic development in a municipality and its neighbors, after controlling for relevant factors. This means that spatial relationship across municipalities is somewhat relevant. The economic progress of the municipality is indeed affected by the performance of its neighbors, and therefore it is influenced by its geographic position. These findings also suggest that the spillover effects among municipalities are essential to economic growth, so that municipalities can gain from increased economic activity in their neighboring municipalities.

As theoretically expected, we find that financial development has a positive and high significant impact on economic development, which suggests that the financial infrastructure that there is both inside and around the municipality matters, in the sense that it can be useful to those communities that do not have such services. This is in line with earlier studies. Research conducted by Raj et al. (2014) has shown that local bank availability is associated with significant increase in enterprises in the informal sector in India. Samargandi et al. (2014) and Ductor and Grechyna (2015) have found empirical evidence in favor of the existence of an optimal level of financial development given by the characteristics of an economy.

The results also confirm that municipalities that establish and develop mechanisms for supporting digital inclusion program are better off than those that do not have any action in this regard. This kind of program provides the ordinary people the skills of modern technology so that they can be reached by strategy adopted by the Brazilian financial institutions, which has been rapidly expanding their banking services through alternative mechanism to traditional bank branch. Indeed, branchless banking services have become widely spread in Brazil. For instance, correspondent banking is present in 93.2% of the Brazilian municipalities, including 1,761 out of 1,932 of those without any bank branch.

Lack of proper public transport can constrain the access to goods and services, particularly in regions where traveling or commuting can be proved extremely lengthy and time-consuming. As a result, it may be an important barrier to financial inclusion in areas sparsely inhabited. Therefore, it is not a surprise that the proxy for public transport services is positively related to economic development.

We find a significant positive association between economic development and the active municipal investment policy implemented to attract new business. This result suggests that, for instance, if one municipality reduces local tax or provides support to

entrepreneurship, in order to encourage new enterprises, it will have relative advantages over its neighbors.

Overall, this study reveals that centrality is important. Therefore, the municipalities that are well located in the network of business relationships have advantages compared to those disconnected or located in peripheral positions. However, we find that local connections are also relevant to economic development, strengthening national and interregional connections.

## **6. Concluding remarks**

In this study, we have tested whether financial development affects economic development. The usual way to do this is to investigate how the availability and usage of financial service are associated with economic progress. By estimating a generalized spatial autoregressive model, we also investigated whether improvements in one municipality will have a spillover effect on its neighboring areas.

We obtained several insightful results. First, the results point to a positive spatial association among municipalities in Brazil. This fact suggests that a developed locality tends to be surrounded by other municipalities that are similarly developed. Likewise, poor regions are connected with undeveloped areas. Second, we find that the municipal financial infrastructure is highly related to the level of local economic development. Finally, from a policy perspective, our findings indicate that economic development can be encouraged by local policy-makers.

This article hopes to bring into the debate the importance of geographical location for studies on financial development. Further research might analyze financial inclusion and focus attention on particular regional areas. Besides, it would be interesting to use network measurement to analyze the topology of the banking network across the country.

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**Table 6. Estimation results for the Spatial-autoregressive model with spatial-autoregressive disturbances (matrix - inverse distance with 80 kilometers cut off)**

Variable	Specification 4	Specification 5	Specification 6
Spatial Dependence Lag	0.0157*** (0.0042)	0.0081** (0.0038)	0.0082** (0.0041)
Financial Development Index	0.4184*** (0.0192)	0.4490*** (0.0325)	0.4523*** (0.0326)
North Region	-0.0236*** (0.0047)	-0.0225*** (0.0049)	-0.0261*** (0.0050)
South Region	0.0177*** (0.0057)	0.0177*** (0.0052)	0.0173*** (0.0052)
Northeast Region	-0.0645*** (0.0037)	-0.0337*** (0.0037)	-0.0651*** (0.0037)
Midwest Region	0.0484*** (0.0039)	0.0454*** (0.0037)	0.0337*** (0.0038)
Centrality Level 2		0.0874*** (0.0205)	0.0769*** (0.0237)
Centrality Level 3		0.0721*** (0.0186)	0.0622** (0.0218)
Centrality Level 4		0.0976*** (0.0233)	0.0873*** (0.0259)
Public Transport		0.0114*** (0.0021)	0.0110*** (0.0022)
Investment Policy		0.0060*** (0.0014)	0.0057*** (0.0015)
Digital Inclusion		0.0073*** (0.0026)	0.0078*** (0.0027)
Attracted Business			-0.3890** (0.1987)
Average Interaction Path			0.0217*** (0.0072)
<b>Linkage Intensity</b>			0.4341** (0.1849)
Constant	0.5442*** (0.0060)	0.4282*** (0.0314)	0.4364*** (0.0328)
Rho	0.6929*** (0.0287)	0.6870*** (0.0038)	0.6889*** (0.0328)
Wald Test	3,481.37 (0.0000)	5,395.25 (0.0000)	4,478.77 (0.0000)
Durbin-Wu-Hausman (test of endogeneity)	135.57 (0.0000)	29.31 (0.0095)	150.23 (0.0000)
Hansen (p-value) (test of overidentification)	(0.3615)	(0.4478)	(0.6235)
Observation	5,564	5,564	5,564
R <sup>2</sup> -Adjusted	0.7021	0.7418	0.7392

Note: Robust standard errors reported in parentheses. \*\*\*, \*\*, and \* indicate significance at the 1%, 5%, and 10%, respectively. The Hansen test evaluates the validity of the over-identifying restrictions. Specification 4 is a restricted econometric model in which we include as explanatory variables only the Financial Development Index, the spatial-autoregressive and the spatial-autoregressive disturbance term. Specification 5 adds categorical variables that characterize the economic profile of the Brazilian municipalities. Specification 6 is an extended model in which we include as regressors other similar variables that are measured at the ratio level.

**Table 7. Estimation results for the Spatial-autoregressive model with spatial-autoregressive disturbances (matrix - inverse distance with 200 kilometers cut off)**

Variable	Specification 7	Specification 8	Specification 9
Spatial Dependence Lag	0.0096*** (0.0021)	0.0056** (0.0019)	0.0062** (0.0021)
Financial Development Index	0.4026*** (0.0178)	0.4339*** (0.0315)	0.4322*** (0.0305)
North Region	-0.0245*** (0.0054)	-0.0201*** (0.0054)	-0.0241*** (0.0054)
South Region	0.0003*** (0.0055)	0.0235*** (0.0050)	0.0229*** (0.0050)
Northeast Region	-0.0633*** (0.0040)	-0.0585*** (0.0040)	-0.0601*** (0.0039)
Midwest Region	0.0472*** (0.0067)	0.0478*** (0.0043)	0.0460*** (0.0043)
Centrality Level 2		0.0841*** (0.0207)	0.0737*** (0.0239)
Centrality Level 3		0.0662*** (0.0186)	0.0563** (0.0218)
Centrality Level 4		0.0925*** (0.0235)	0.0821*** (0.0260)
Public Transport		0.0117*** (0.0021)	0.0113*** (0.0022)
Investment Policy		0.0064*** (0.0014)	0.0060*** (0.0014)
Digital Inclusion		0.0065*** (0.0026)	0.0070*** (0.0026)
Attracted Business			-0.3495* (0.1915)
Average Interaction Path			0.0259*** (0.0071)
<b>Linkage Intensity</b>			0.3787* (0.1849)
Constant	0.5462*** (0.0067)	0.4321*** (0.0319)	0.4405*** (0.0020)
Rho	0.4289*** (0.0174)	0.4304*** (0.0209)	0.4316*** (0.0207)
Wald Test	3,076.69 (0.0000)	3,855.37 (0.0000)	4,042.04 (0.0000)
Durbin-Wu-Hausman (test of endogeneity)	173.74 (0.0000)	215.68 (0.0000)	760.41 (0.0000)
Hansen (p-value) (test of overidentification)	(0.3471)	(0.4613)	(0.6681)
Observation	5,564	5,564	5,564
R <sup>2</sup> -Adjusted	0.6681	0.6913	0.7292

Note: Robust standard errors reported in parentheses. \*\*\*, \*\*, and \* indicate significance at the 1%, 5%, and 10%, respectively. The Hansen test evaluates the validity of the over-identifying restrictions. Specification 7 is a restricted econometric model in which we include as explanatory variables only the Financial Development Index, the spatial-autoregressive and the spatial-autoregressive disturbance term. Specification 8 adds categorical variables that characterize the economic profile of the Brazilian municipalities. Specification 9 is an extended model in which we include as regressors other similar variables that are measured at the ratio level.

**Table 8. Estimation results for the Linear Instrumental-Variables Regression**

Variable	Specification 10	Specification 11	Specification 12
Financial Development Index	0.4119*** (0.0139)	0.5092*** (0.0187)	0.5134*** (0.0262)
North Region	-0.0277*** (0.0035)	-0.0131*** (0.0038)	-0.0110** (0.0046)
South Region	0.0344*** (0.0023)	0.0325*** (0.0021)	0.0302*** (0.0046)
Northeast Region	-0.0643*** (0.0023)	-0.0531*** (0.0028)	-0.0511*** (0.0032)
Midwest Region	0.0438*** (0.0026)	0.0504*** (0.0032)	0.0525*** (0.0038)
Centrality Level 2		0.1121*** (0.0084)	0.0787*** (0.0087)
Centrality Level 3		0.0722*** (0.0073)	0.0419*** (0.0079)
Centrality Level 4		0.1271*** (0.0094)	0.0940*** (0.0089)
Public Transport		0.0093*** (0.0022)	0.0090*** (0.0023)
Investment Policy		0.0065*** (0.0017)	0.0062*** (0.0017)
Digital Inclusion		0.0085*** (0.0025)	0.0089*** (0.0026)
Attracted Business			-0.9506*** (0.1585)
Average Interaction Path			0.0061 (0.0074)
<b>Linkage Intensity</b>			0.8742*** (0.1676)
Constant	0.5506*** (0.0044)	0.3828*** (0.0133)	0.4082*** (0.0123)
Wald Test	11,293.38 (0.0000)	8,928.21 (0.0000)	10,119.18 (0.0000)
Durbin-Wu-Hausman (test of endogeneity)	454.13 (0.0000)	532.65 (0.0000)	395.86 (0.0000)
Hansen (p-value) (test of overidentification)	(0.37141)	(0.4406)	(0.4742)
Observation	5,564	5,564	5,564
R <sup>2</sup> -Adjusted	0.5119	0.5464	0.5690

Note: Robust standard errors reported in parentheses. \*\*\*, \*\*, and \* indicate significance at the 1%, 5%, and 10%, respectively. The Hansen test evaluates the validity of the over-identifying restrictions. Specification 10 is a restricted econometric model in which we include as explanatory variables only the Financial Development Index, the spatial-autoregressive and the spatial-autoregressive disturbance term. Specification 11 adds categorical variables that characterize the economic profile of the Brazilian municipalities. Specification 12 is an extended model in which we include as regressors other similar variables that are measured at the ratio level.