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RELATIONSHIP BETWEEN FINANCIAL COOPERATIVISM AND RURAL CREDIT WITH GAUCHO GDP: A SPATIAL ANALYSIS

RELAÇÃO ENTRE COOPERATIVISMO FINANCEIRO E CRÉDITO RURAL COM O PIB GAÚCHO: UMA ANÁLISE ESPACIAL

Ricardo Höher[1]
Osmar Tomaz de Souza[2]
Adelar Fochezatto[3]

Abstract

The objective of this article was to analyze the spatial distribution of credit cooperatives and the rural credit concession in the municipalities of Rio Grande do Sul, as well as to verify the relation with the GDP of each city. An Exploratory Analysis of Spatial Data – AEDE – was conducted, and the results of the research confirmed the existence of a spatial dependence for the variables of interest to the study. The credit cooperatives' attendance stations variable presented spatial autocorrelation in 148 municipalities, and for the concession of rural credit in 179 towns. In the bivariate analysis GDP/Rural Credit, 179 municipalities show spatial autocorrelation, same number for the relation between credit cooperative attendance stations and rural credit, and 148 towns for the GDP/Credit Cooperatives' Attendance Stations ratio. According to the acquired results, it is observed that the geographic aspect plays an important role in the economic growth potential (GDP), as well as the existence of clusters of the studied variables and the existence of the overflow effect, which demonstrates the interference of the spatial factor in the rural credit concession and in the work of credit cooperatives.

Keywords: Credit cooperatives; spatial distribution; economic growth.

Resumo

O presente artigo teve como objetivo analisar a distribuição espacial das cooperativas de crédito e da concessão de crédito rural nos municípios do Rio Grande do Sul, bem como verificar a relação com o PIB de cada cidade. Foi realizada uma Análise Exploratória de Dados Espaciais – AEDE, onde

[1]Doutor em Economia do Desenvolvimento (PUCRS). Professor da Universidade Federal de Santa Maria (UFSM), Santa Maria – RS, Brasil. E-mail: ricardo.hoher@ufsm.br
[2]Doutor em Desenvolvimento e Meio Ambiente (UFPR). Professor da Pontifícia Universidade Católica do Rio Grande do Sul (PUCRS), Porta Alegre – RS. E-mail: osmar.souza@pucrs.br
[3]Doutor em Economia (UFRGS). Professor da Pontifícia Universidade Católica do Rio Grande do Sul (PUCRS), Porta Alegre – RS. E-mail: adelar@pucrs.br

os resultados da pesquisa confirmaram a existência de dependência espacial para as variáveis de interesse do estudo. A variável postos de atendimentos de cooperativas de crédito apresentou autocorrelação espacial em 148 municípios e para a concessão de crédito rural em 179 cidades. Na análise bivariada, PIB/crédito rural 179 municípios possuem autocorrelação espacial, mesmo número para relação PAs cooperativas de crédito/crédito rural e 148 cidades para relação PIB/PAs de cooperativas de crédito.De acordo com os resultados obtidos, observa-se que o aspecto geográfico desempenha importante papel quanto ao potencial de crescimento econômico (PIB), bem como a existência de *clusters* das variáveis estudadas e a existência do efeito de transbordamento, o que demonstra a interferência do fator espacial na concessão de crédito rural e na atuação das cooperativas de crédito.

Palavras-chave: Cooperativas de crédito; distribuição espacial; crescimento econômico.

Introduction

Financial development promotes a positive effect on economic growth, financial credit being an essential mechanism for the dynamics of economic activity. Regions with no banking services, or where such are precarious, may not reach satisfactory standards pertaining to economic growth. According to Goldsmith (1969), differences in the quality of banking services are among the leading causes of disparity in growth indexes across countries.

In Brazil, financial credit is one of the primary services offered by banking institutions, often becoming embedded into business plans as a frequent alternative to make projects more economically viable. Levine (2004) argues that banks promote economic growth through the concession of credit. Financial credit has a relevant standing in the economy as it contributes to two ends of economic activity, promoting both the consumption of products and encouraging investments, which in a way collaborates with increasing Gross Domestic Product (GDP).

Agriculture plays a substantial role in the Brazilian economy, and in the economy of the state of Rio Grande do Sul, such comprised 9.4% of the state's GDP in 2015, according to the Fundação de Economia e Estatística - FEE. The agricultural sector generally has its production financed by financial agents, which offer lines of credit tailored to this economic practice. Rural credit is a financing mechanism destined for rural producers and directed towards defrayal, investment, or commercialization of agricultural practices.

Credit cooperatives, besides acting as intermediary agents for the concession of rural credit, also issue their own lines of credit for rural producers through the Banco Nacional de Desenvolvimento - BNDES, this practice strengthens the relationship these institutions have with practitioners of agricultural activity.

Per the Banco Central do Brasil (BCB), Rio Grande do Sul features 113 credit cooperatives, which host offices[4] in 92% of municipalities. This distribution, when compounded with the concession of credit, can impact the economic development in the regions where they are established.

In this context, the purpose of this study is to analyze the spatial distribution of credit cooperatives, and rural credit concession in the cities of Rio Grande do Sul, as well as studying the relationship of such with the GDP of each municipality through an Exploratory Spatial Data Analysis (ESDA).

In lieu of the information presented above, this paper seeks to, in an unprecedented manner, through an ESDA, test the hypothesis that cities with a high number of credit cooperatives and rural credit concession display elevated GDP per person, and are surrounded by neighbors in similar conditions, confirming the existence of a spatial dependency for the variables of interest in this study. In addition to these aspects, this study also hopes to evaluate the spatial spillover effect for studied variables and identify relevant geographical clusters.

In order to achieve such, this paper addresses the following research questions: does the distribution of credit cooperatives in Rio Grande do Sul display spatial concentration? Does the concession of rural credit in Rio Grande do Sul display spatial concentration? Is there spatial dependency in the distribution of financial cooperatives within the state? Is there spatial dependency in the distribution of rural credit in Rio Grande do Sul and the state GDP?

[4] Includes financial agencies and general offices.

The article is sectioned into four parts, excluding this introduction, which presents the study's objectives and hypotheses as well as the research questions to be addressed. The subsequent section presents a theoretical framework that addresses aspects of financial systems and economic growth. Methodological aspects are later introduced, followed by the results, discussion, and finally, conclusion.

Financial system and economic growth

Financial credit is an essential factor in fostering economic growth; it facilitates the financing of innovation and the conduction of industrial processes (SCHUMPETERE, 1928). Regions deprived of financial agents or suppliers of banking services can have limited regional economic growth or restricted growth in particular sectors with lesser access to credit. These elements can lead to a reduction in the productive capacity of that region.

Crocco, Santos, and Figueiredo (2013) define financial exclusion as belonging to either of two classifications, as a result of scarce banking agents and the difficulty of being included in the financial system. The first incorporates regions that do not have agencies or correspondents to offer financial services. The second is characterized by difficult access to the existing financial services, generally caused by social exclusion, lack of education/information on financial services, or inability to provide guarantees required by the financial bodies to complete the transaction.

Credit concession in peripheral regions where markets are not as dynamic, and the economy is volatile, can generate a positive effect in the economic development of such locations as these lead to increased investment, which amplifies productive factors (SILVA; JAYME, 2013).

Abundant money supply and optimism concerning economic prospects, gradually, reduce the public's preference for liquidity, increasing preference for alternative assets, which are less liquid and reduce the retention of currency. With this, the financing of innovative activities is benefited. The increase of aggregate demand, on the other hand, raises optimism in producers, which in turn idealize profits, consequently incentivizing a new round of investments, creation of jobs and income. (SILVA; JAYME, 2013, authors translation).

After conducting an empirical study in 80 countries, which analyzed the relationship between GDP and financial sector presence between 1960 and 1989, King and Levine (1993) stated that the correlation between variables was confirmed. The study also observed that the growth of the financial sector was related to the number of investments and general productivity. Through a similar lense, Levine and Zervos (1998), in analyzing 47 countries between 1976 and 1993, observed that the development of the banking system promoted economic growth. In both studies, economic development was found to be heavily linked to the health of the financial system.

The empirical study applied to the Brazilian context, by Matos (2002), reported similar results to those referenced above, pointing out that the development of the financial system contributes to economic growth. Similarly, the study presented by Marques Junior and Porto Junior (2004) identified that the concession of credit promotes the offering of goods and services. In this particular case, the relationship between banking development and economic growth was observed starting in the second half of the 20th century.

In contrast, the study conducted in 10 countries by Shanet et al. (2001) proposed that the relationship between the development of the financial system and economic growth is bidirectional. Half of the studied countries demonstrated an inverse situation to those mentioned before; in these cases, economic growth in other areas promoted the development of the financial system.

The research paper by Reichsul and Lima (2006) was dedicated to the regional aspects, they investigated the metropolitan region of the city of São Paulo and observed a bidirectional relationship between the issuing of financial credit and economic growth. Such characteristics can be explained by the agglomeration of financial institutions in this region. These issue credit lines for a diverse range of economic activities that promote the development of the local economy, in turn, this elevated development index in the region attracts other financial agents.

Pires (2006) evaluated the geographical regions of Brazil independently, analyzing both the modalities of credit concession in each region as well as the effects these had on regional economic development of each location. The results indicated that for the South and Central regions of Brazil, the varying forms of credit were not significant to economic growth, but the Southeastern region did have a positive correlation between credit concession and economic growth.

There is a vast number of entities that offer banking services and supply financial credit, and this contributes to a wide array of economic activities. Credit cooperatives have been an exciting alternative to traditional financial institutions, and they have singular importance in this respect since they employ private resources and assume corresponding risks in favor of its own community (JACQUES; GONÇALVES, 2016).

Within the scope of themes discussed in this section, few studies dedicate themselves to verifying the relationship between the strength of credit cooperative activity and economic growth. Some case studies debate isolated instances of financial cooperatives on local economic growth. Rodrigues (2004) described the situation of the city of São Roque de Minas, where the creation of a credit cooperative modified the local economy, increasing agricultural production, in particular by coffee bean industries financed by the cooperative. Another case study was presented by Búrgio (2010), where the constitutive process of a cooperative in the rural region of the state of Amazonas was described. This study demonstrated that even isolated regions could have their economic practices benefited by the implementation of banking services by means of credit cooperatives.

Countless papers have dealt with the theme of growth and economic development. It is consistently observed that over the course of the past years, the number of studies using spatial econometrics has increased, especially those that direct their research towards the study of regional aspects. According to Golgher (2015), the availability of georeferenced data, and access to software with capabilities for statistical analysis and georeferencing have added depth to studies which include spatial aspects as an analytical tool. Spatial econometrics is now used across several areas of knowledge, this being no different in the applied social sciences.

Some studies conducted in Brazil which featured spatial econometrics as an analytical tool are worth noting: Evaluation of human development indices in Rio Grande do Norte (COSTA et al., 2007); Analysis of health development indicators in the state of Paraná (LIMA et al., 2014); Verification of spatial autocorrelation of the Municipal Human Development Index (MHDI) for the state of Espirito Santo (LORENA et al., 2011); Study on the spatial dependency of MHDI in the Northeastern region of Brazil by Lins et al. (2015).

In lieu of the aforementioned, it is evident that there is a void of studies that use quantitative methods, in particular those directed at spatial econometrics topics, dedicated to researching the spatial distribution of the relationship between the financial system and economic growth with participation of credit cooperatives in this context.

Methodology

This section deals with research methods and procedures. Initially, exploratory spatial data analysis was conducted; this was followed by a method of spatial econometrics; both stages were conducted using GeoDa software.

In order to conduct this study, the selected data was both total GDP and GDP per person of the municipalities of Rio Grande do Sul, acquired via the FEE, a georeferenced archive of the state made available by the Brazilian Institute of Geography and Statistics (IBGE), and information acquired with the Brazilian Central Bank pertaining to credit cooperatives in the state.

Spatial Analysis

In order to effectively conduct the spatial econometrics analysis, it became clear that the exploratory spatial data analysis was a requirement. ESDA is a set of techniques dedicated to the study of spatial distribution, it allows for the identification of outliers[5] and spatial association patterns, as well as other instances of spatial inconsistencies (ANSELIN, 1999). For this type of analysis, spatial density variables[6] are used in order to generate results that are not distorted by spatial factors (ANSELIN, 2005).

As a methodological procedure, to evaluate the measure of spatial autocorrelation, the ESDA technique selected for this study was Moran's local *I* statistic, presenting Cluster Maps, Significance Maps, and Moran's Dispersion Diagrams.

[5] Atypical locations, outside spatial standards of a particular region.
[6] Variables that are divided by intensity indicators.

Moran (1948) introduced the first coefficient of spatial autocorrelation, where he used measures of autocovariance in the form of a cross-product; this metric came to be known as Moran's *I* Statistical value. It can be represented in two ways:

Algebraically:

$$I = \frac{n}{S_0} = \frac{\sum_{i=1} . \sum_{j=1} . w_{ij} z_i z_j}{\sum_{i=1} z_i{}^2}$$

Or as a Matrix

$I = \frac{n}{S_0} = \frac{z\prime Wz}{z\prime z}$

Where:

I is the autocorrelation index;

n is the number of regions;

Z is the standardized value of the variable of interest;

Wz represents the standardized average value of the variable of interest in neighbors

Wij is the element of the matrix referent to region *i* and region *j*;

S0 is the result of $\sum\sum wij$ meaning that all elements in the spatial weights *W* must be added.

For situations where there is no spatial pattern in the data, the expected value of Moran's *I* index is –[1/(n-1)], within the bounds of statistical significance, being independent of values in neighboring regions. *I* values superior to the expression above indicate a positive spatial autocorrelation, while values less than that indicate negative spatial autocorrelation (ALMEIDA, 2012). When the autocorrelation value is positive, the value of researched attributes and their spatial location are similar, which suggests grouping in some areas outlined within the region relevant to the study. In contrast, a negative autocorrelation indicates dissimilarity across these values (FOTHERINGHAM et al. 2002). Therefore, Moran's *I* value, when significant, indicates that the data is spatially concentrated, while its negative value indicates the dispersion of data.

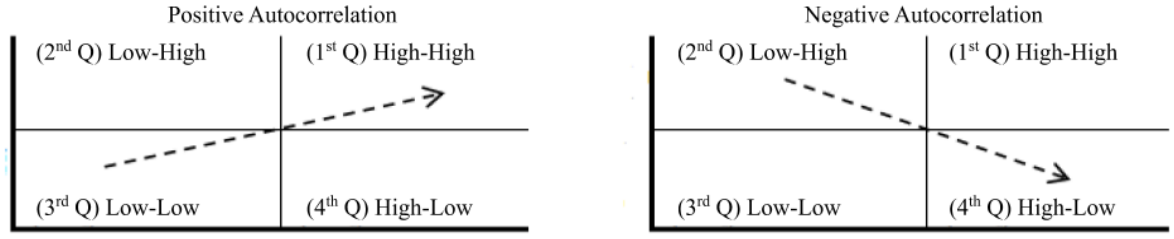
In order to analyze spatial dependency, it was necessary to establish neighboring criteria, for such, a matrix with spatial weights was elaborated. Such a matrix is defined in accordance with the surroundings and geographical or socio-economic distances. These were also based on contiguity, attributing a value of one to the matrix when regions are neighbors and zero otherwise. For such:

Wij = {1 if *i* and *j* are contiguous; 0 if *i* and *j* are not contiguous}

Another approach employed to visualize the spatial autocorrelation was Moran's dispersion diagram, which demonstrates the spatial discrepancy of the variable of interest in the vertical axis plotted as a function of the value such variable takes in the horizontal axis. Moran's dispersion diagram is distributed into four quadrants, High-High - HH, Low-Low - LL, High-Low - HL, and Low-High - LH (ALMEIDA, 2012).

The HH quadrant considers that regions with high values also surround the region with a high value in the variable of interest. The LH quadrant indicates that neighbors with high value surround the group with a low variable value. The LL quadrant refers to the spatial association group where neighbors with a low value surround the group with low value. HL quadrant points to a region with high value for the variables of interest that is surrounded by neighboring regions with low values. **Figure 1** represents the quadrants of Moran's Dispersion Diagram.

Figure 1: Moran's Dispersion Diagra,



Source: Developed by the Author, Based on Almeida (2012).

In the specific case of this research paper, analyses of spatial autocorrelation were conducted in a univariate and bivariate manner, generating a LISA[7] Significance Map, LISA Clustering Map, and Moran's Dispersion Diagram. In this methodology, the weight matrix had its identification field generated by the GeoDa software, established using a first-order Queen contiguity matrix.

Univariate Local Spatial Autocorrelation

The analysis which involves territorial aspects is generally more interested in identifying local behavior, associated with the observation of characteristics of each analyzed region. As such, the most appropriate indicator to verify spatial autocorrelation are Local Indicators of Spatial Association, LISA (SABATER et al. 2011).

Moran's *I* value incorporates local patterns of spatial autocorrelation, which are statistically significant, in addition to decomposing the global indicator. In evaluating the linear association, using GeoDa software, located at the LISA Significance map, one can observe regions with Moran's *I* value being locally significant for the variable of interest. This is also obtained through the LISA Cluster, which combines information from Moran's dispersion diagram and the LISA Significance map (ALMEIDA, 2012). Moran's Local *I* coefficient can be expressed in accordance with the following equation:

$$I = Zi \sum_{j=1}^{j} W_{ij} Z_j$$

The calculation for this *I* value only encompasses the neighbors of observation i, in accordance with the matrix of spatial weights, In order for *I* to be a LISA indicator, the sum of local indicators must be equated to the related global indicator, following the proportionality constant (ANSELIN, 2005).

In the analysis application of the local univariate autocorrelation, two situations were evaluated. In the first case, the variable of interest was the number of credit cooperative offices per city (PAHAB[8]), and the second was rural credit distributed per person (CREDRURAL[9]).

Bivariate Local Spatial Autocorrelation

According to Almeida (2012), a local measure of autocorrelation can be obtained when 2 variables of interest Z1 and Z2 are used. The following equation represents moran's Local Bivariate *I* value:

$$I = Z_{1i} W Z_{2i}$$

Where:

Z_{1i} is a variable of interest;

WZ_{2i} is the spatial discrepancy of the other variable of interest Z2 in the neighboring region.

In order to apply the bivariate local autocorrelation, the following relations of variables of interest were considered:

- The GDP per person[10] in each city was classified as a variable of interest, and the rural credit per person was considered the neighboring variable.
- The GDP per person in each city was classified as a variable of interest, and the number of credit cooperative offices per person was considered the neighboring variable.
- The behavior of the number of credit cooperative offices as a variable of interest and the credit concession per person as a neighboring variable.

Therefore, the methodology proposed presented and discussed the spatial behavior of GDP in the 497 cities of Rio Grande do Sul, starting with spatial analysis, credit cooperatives, and rural credit.

Spatial Econometrics Method

In a complementary fashion to the spatial analysis proposed in this paper, a classic regression model was applied, including a weight matrix for the neighbors, this allowed for an association to be made between the spatial dependency of local reach in the proposed model. It also

[7]*Local Indicator of Spatial Association* – LISA: Any statistic that satisfies the capacity to indicate statistically significant spatial clusters, and whose sum of local indicators, for all regions, is proportional to the corresponding global spatial autocorrelation index (ALMEIDA, 2012).
[8]PAHAB – Nomenclature presented in the figures.
[9]CREDRURAL – Nomenclature presented in the figures.
[10]PIBPERCAP – Nomenclature presented in the figures.

allows for the selection, by means of feasibility tests, the most appropriate econometrics model for this type of analysis. According to Almeida (2012), the class of econometric models considers that the impact of spatial dependency be observed for some regions of the area being studied, in particular those directly neighboring it, first-order neighbors, and indirectly neighboring it, second-order neighbors.

The spatial econometrics models are an appendix to classical econometrics, where one considers territorial location to be an explicative factor in the correlative analysis. The most common econometrics models are the Spatial Auto-Regressive[11] (SAR), Spatial Error Model[12] (SEM), and Spatial Lag Model(SLX) (ALMEIDA, 2012).

Initially, the classical model was applied, which allowed for a subsequent choice on the most appropriate econometric model to be made considering the following.

$$y = \beta_1 + \beta_2 X + \beta_3 X + \varepsilon$$

In this research paper, the Spatial Auto-Regressive model was used in accordance with what is described in the following section:

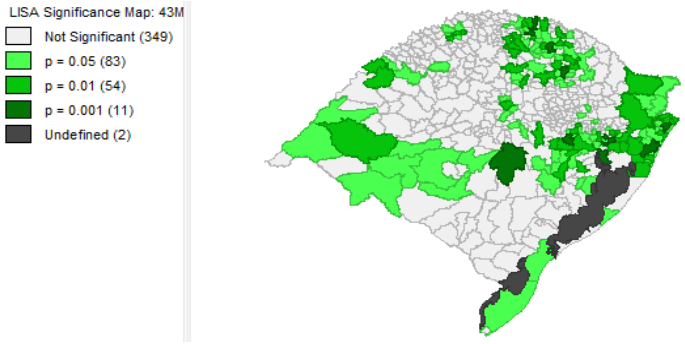
Results

In consideration of the methodological approach proposed before, this section is outlined in a similar manner, commencing the presentation and discussion of results with the univariate local spatial autocorrelation, followed by the bivariate local spatial autocorrelation and lastly the Spatial Auto-Regressive model.

Univariate Local Spatial Autocorrelation

In the LISA Significance, number of credit cooperative offices per person, it is possible to locate the municipalities that formed statistically significant groups to at least 5%. In accordance to **figure 2**, of the 497 cities analyzed with respect to this variable, 349 did not have significant readings in this variable of interest even when considering the relationship with neighboring cities. For this analysis, of the total number of cities, 148 presented spatial dependency for the number of credit cooperative offices. In the state map, the two regions identified as undefined represent lakes, and therefore do not interfere in the analysis.

Figure 2: LISA Significance (Relationship of COs per person)

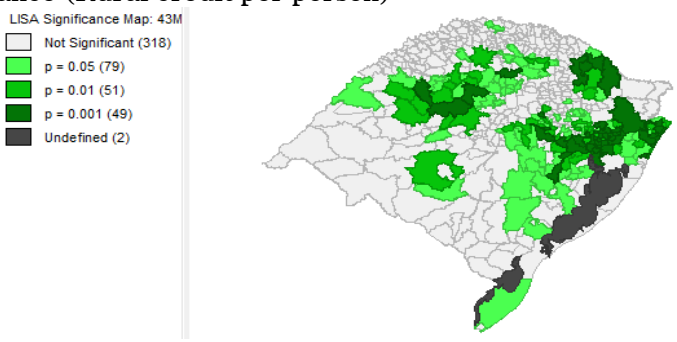


Source: Elaborated by the author.

With respect to rural credit concessions in the State of Rio Grande do Sul, it is observed, as shown in **figure 3**, that in 318 cities, this variable was not significant. Of a total of 497 municipalities, 179 showed a significant value of spatial dependency with respect to the concession of rural credit.

[11] *Spatial Auto Regressive* - SAR
[12] *Spatial Error Model* - SEM

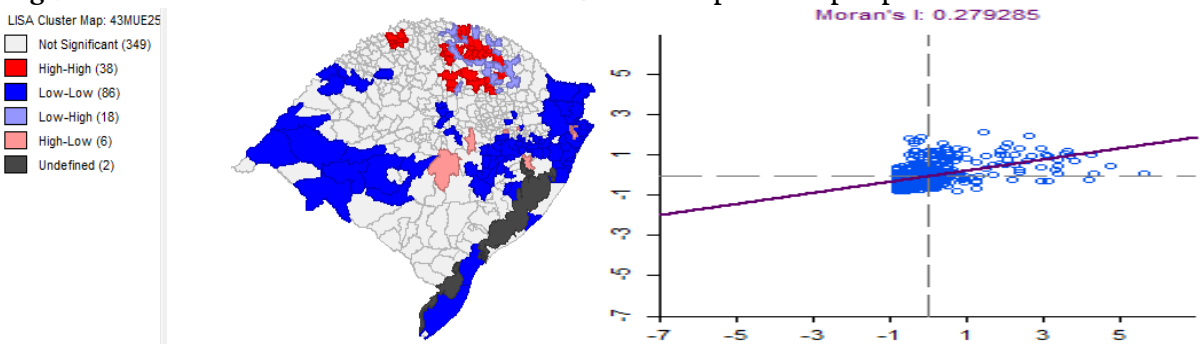
Figure 3. LISA Significance (Rural credit per person)



Source: Elaborated by the author.

As is shown in **figure 4**, 38 municipalities of the state are located in the HH quadrant of the Moran dispersion diagram, which indicates a high concentration of credit cooperative offices and agencies per inhabitant also in neighboring cities. This is illustrated through the dark red grouping in the northern region of the state in the LISA cluster map, and this indicates that municipalities with a strong presence of credit cooperatives contribute positively to a similar manifestation in neighboring cities. For 86 cities, the variable of interest demonstrated LL grouping, shown in dark blue, these cities and their neighbors had lower concentrations of credit cooperative offices per person. This grouping demonstrates a spillover effect amongst cities of this region, meaning cities with a low concentration of credit cooperatives per person are surrounded by cities where this value is also low. It is also notable that 18 cities had low numbers of offices per person, yet were surrounded by cities with a high count of offices per person, shown in light blue. Furthermore, 6 cities recorded a high presence of credit cooperative offices per person, yet are surrounded by cities where that was not the case, shown in light red.

Figure 4. LISA Clusters e Moran's *I* index - Relationship of COs per person.



Source: Elaborated by the author.

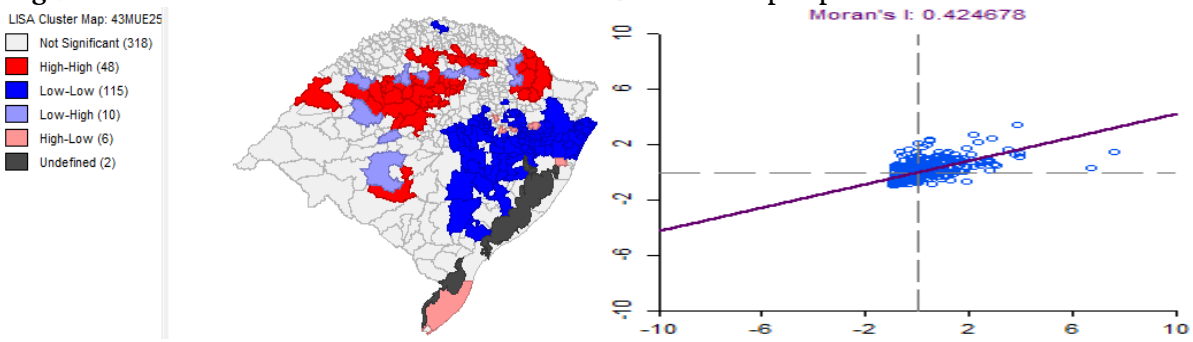
Moran's *I* index, when applied to evaluate the spatial dependency of credit cooperative offices established in Rio Grande do Sul, demonstrates positive spatial autocorrelation with a positive value of 0.2792, as depicted by the Moran dispersion diagram, **figure 4**, which indicates a similarity in the spatial distribution of municipalities which constitute clusters for the variable in question.

In lieu of what has been exposed in **figure 4**, it is considered that few regions in Rio Grande do Sul demonstrate the spillover effect with respect to the credit cooperative offices, despite Moran's *I* value being positive and indicating a spatial relationship.

As shown in **figure 5**, considering the concession of rural credit as the variable of interest, 318 cities presented spatial correlation values which were not statistically significant, 48 cities belong to the HH quadrant in Moran's dispersion diagram, presented in red are the regions where cities and their neighbors demonstrated elevated rated of rural credit concession per person. The regions outlined in the dark blue are where both the cities and their neighbors had low values of rural credit per person. The regions in light blue had low measures of credit concession for rural practices and are surrounded by cities where this value is high. Light red signifies HL regions in the Moran diagram. With this in mind, it is possible to consider that the offering of resources, by means of rural credit concessions, strengthens the economy in the red regions, in consideration of what has

previously been discussed on the effect of credit in economic growth and in the context of the state's economy.

Figure 5: LISA Clusters and Moran's *I* index - Rural credit per person



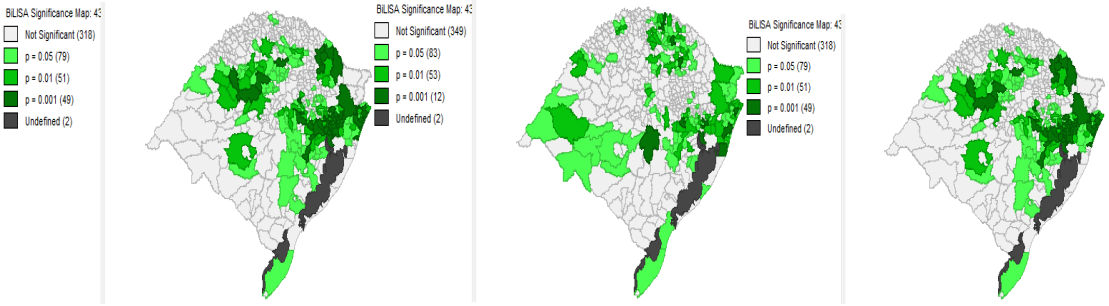
Source: Elaborated by the author.

Moran's *I* Index, 0.4246, indicates a robust spatial dependency with respect to the variable credit concession per person. As seen in **figure 5**, the spatial autocorrelation for this variable of interest is confirmed.

Bivariate Spatial Autocorrelation

For the variables of interest analyzed in this section, the following data was presented in the BILISA significance maps. For 179 municipalities, there were statistically significant groupings, to at least 5%, pertaining to the relationship between GDP per person and the concession of rural credit, as demonstrated in **figure 6** (a). In contrast, the relationship between the variables of interest GDP per person and number of credit cooperative offices had 148 cities with statistically significant spatial groupings, according to **Figure 6**(b). **Figure 6**(c) demonstrated how 179 cities presented spatial groupings of statistical significance for the relationship between credit cooperative offices and the concession of rural credit.

Figure 6. BILISA Significance - GDP per person/rural credit (a); GDP per person/credit cooperative offices (b); credit cooperative offices/rural credit per person(c).



(a) (b) (c)

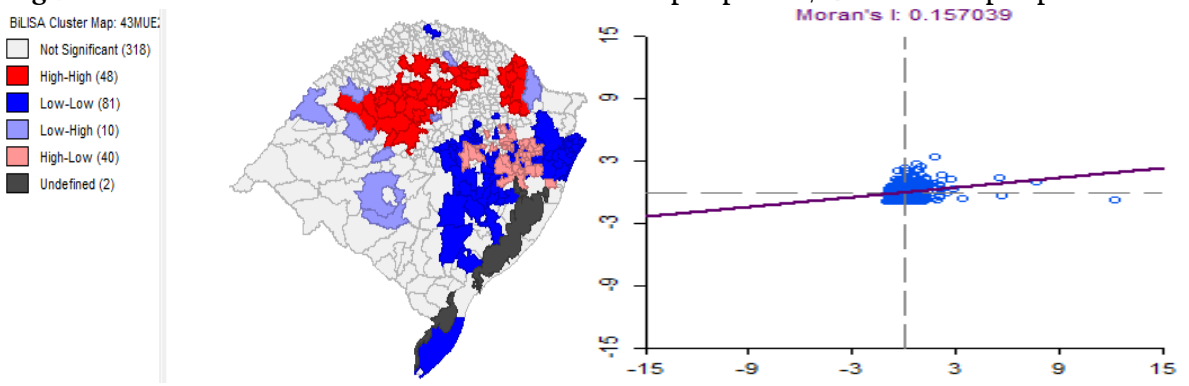
Source: Elaborated by the author.

The bivariate cluster maps, depicted in figures 7, 8, and 9 show in which regions spatial clusters were formed for the relationship between GDP per person and credit concession per person, GDP per person and credit cooperative offices, and between credit cooperative offices and concession of rural credit respectively.

In the analysis of the relationship between the variables GDP per person and concession of rural credit per person, **Figure 7**, the red area grouped 48 municipalities with an elevated GDP per person and elevated values for the concession of rural credit in neighboring cities, and this means they are a part of the HH quadrant in Moran's dispersion diagram. The areas shown in dark blue represent 81 cities situated in the LL quadrant, and the areas in light blue are the LH quadrant. Meanwhile, the 40 cities in light red are the HL quadrant in Moran's diagram. It is worth noting that the region in dark red concentrates municipalities with high GDP per person, as well as high concession of rural credit destined towards rural activity. The regions in light red, on the other hand,

constitute high GDP per person but are surrounded by cities with lower values of rural credit per person, which may indicate the economic activities of this region consist of practices and sectors that are not as dependent on rural credit or use other forms of financing.

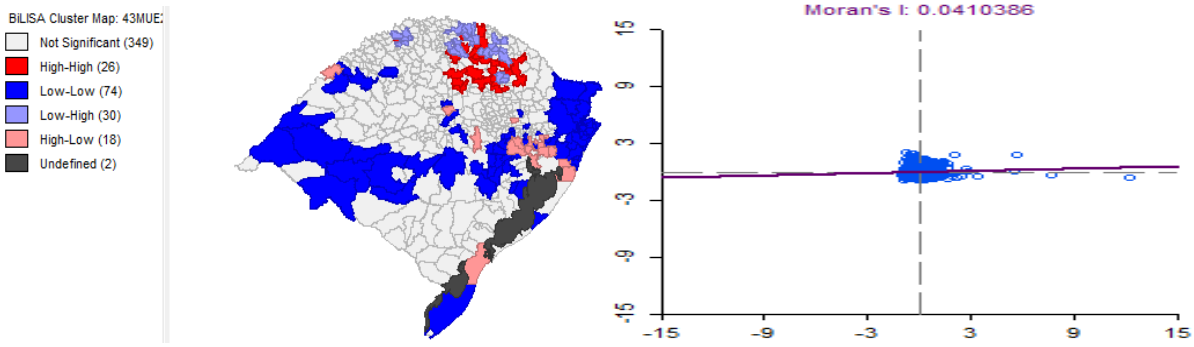
Figure 7: BILISA Clusters e Moran's *I* index - GDP per person/Rural credit per person



Source: Elaborated by the author.

The BILISA cluster map, **Figure 8**, demonstrates that 26 cities in Rio Grande do Sul are spatially grouped by cities with an elevated GDP per person and whose neighbors have elevated presence of credit cooperative offices, outlined in red in the map. The cities in dark blue fall into Moran's LL quadrant. A group of 30 cities, located in the northern region of the state, presents low GDP per person but is surrounded by neighbors with a high number of credit cooperative offices. Still in **Figure 8**, one can observe that 18 cities presented high GDP per person with neighbors where the number of credit cooperatives was low, falling into the HL quadrant of Moran's dispersion diagram, represented in light red. The regions in light blue presented an elevated ratio of credit cooperative offices to GDP per person. It is also worth emphasizing that the analysis above took into consideration the number of credit cooperative offices, not factoring into account the infrastructure and capabilities of each.

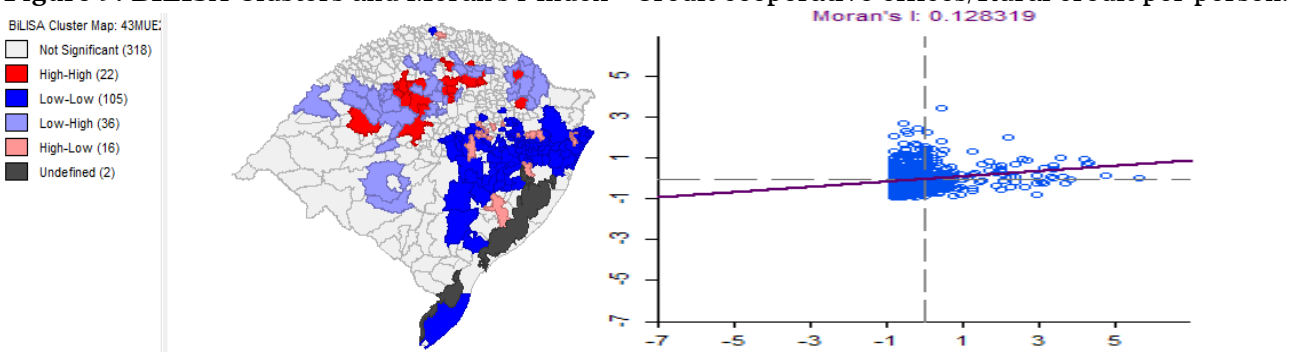
Figure 8: BILISA Clusters and Moran's *I* index - GDP per person/Credit cooperative offices



Source: Elaborated by the author.

As illustrated in the map, **Figure 9**, 22 cities demonstrated an elevated number of credit cooperative offices, and their neighbors obtained a high level of credit concession, falling into Moran' HH Quadrant. 106 grouped municipalities are highlighted in dark blue, and they display low number of credit cooperative offices as well as a low value of rural credit concession, Moran's LL quadrant. The light blue region of this same map is the LH quadrant of the diagram, while the light red region of the map is the HL quadrant. One can observe that the dark blue region, where there is a low number of credit cooperatives per person, is the same geographical location as the cities with a reduced value of rural credit concession.

Figure 9: BILISA Clusters and Moran's *I* index - Credit cooperative offices/Rural credit per person.



Source: Elaborated by the author.

Figures 7, 8, and 9 present Moran's bivariate *I* Index values GDP per person/Rural credit per person, GDP per person/Credit cooperative offices, and credit cooperative offices/concession of rural credit per person, with values 0.1570, 0.0410 and 0.1283 respectively. These values confirm a positive spatial autocorrelation.

It is worth noting that the relationship between the variables of interest GDP per person and credit cooperative offices had a value of 0.0410, indicating a weak positive spatial dependency.

Econometric model

Considering how the variable of interest rural credit per person displayed, among the studied variables, the highest spatial dependency, with Moran' s *I* index of 0.4246, it was chosen to be the dependent variable for the developed econometrics model, the independent variables being the number of credit cooperative offices per person and GDP per person. The model to be estimated can be represented in accordance with the following equation:

$$CREDRURAL = \beta_1 + \beta_2 PAHAB + \beta_3 GDP + \varepsilon$$

It is worth noting that in rotating the proposed model, the neighbor matrix (43MUE250GC_SIR[13]) was considered, and in considering the value of utilized data, the SAR model, table 1, is the most appropriate to verify the relation between the explicative variables and the value of rural credit concessions in the state of Rio Grande do Sul.

Table 1: Spatial Autoregressive Model – SAR (CREDRURAL per person)

SUMMARY OF OUTPUT: SPATIAL LAG - MAXIMUM LIKELIHOOD ESTIMATION				
Data set:43MUE250GC_SIR				
Spatial Weight: 43MUE250GC_SIR				
Dependent Variable: CREDRURAL Number of Observations: 497				
Mean dependent var: 4859.13 Number of Variables: 4				
S.D. dependent var: 5153.68 Degrees of Freedom: 493				
Lag coeff. (Rho): 0.604081				
R-squared: 0.435047 Log likelihood: -4831.78				
Sq. Correlation: - Akaike info criterion: 9671.56				
Sigma-square: 1.50054e+007 Schwarz criterion: 9688.4 S.E of regression: 3873.68				
Variable	Coefficient	Std.Error	z-value	Probability
W_CREDRURAL	0.604081	0.0432663	13.9619	0.00000
CONSTANT	-723.462	385.48	-1.87678	0.06055
PAHAB	991.752	378.623	2.61937	0.00881
PIBPERCAP	0.0753847	0.00907357	8.30817	0.00000
REGRESSION DIAGNOSTICS				
DIAGNOSTICS FOR HETEROSKEDASTICITY				
RANDOM COEFFICIENTS				
TEST	DF	VALUE	PROB	
Breusch-Pagan test	2	857.5249	0.00000	
DIAGNOSTICS FOR SPATIAL DEPENDENCE				
SPATIAL LAG DEPENDENCE FOR WEIGHT MATRIX : 43MUE250GC_SIR				
TEST	DF	VALUE	PROB	
Likelihood Ratio Test1	149.1602	0.00000		

Source: Elaborated by the author (GeoDa Software).

[13] Matrix generated with GeoDa software.

In including the spatial aspects, the spatial auto-regressive model, it is possible to observe that 43.5% of the variation in the dependent variable can be explained by the variables of interest, credit cooperative offices per person and GDP per person. Such observation confirms that the spatial aspect, location of the cities, associated with the independent variables being studied, can provoke alterations in the concession of rural credit.

Conclusion

The LISA and BILISA Significance maps allowed for a visualization that several of the municipalities demonstrate spatial autocorrelation at a statistical significance superior to 5%.

As one observes the LISA Cluster maps, the variable of interest number of credit cooperative offices, which fall into the HH quadrant of Moran's distribution, are grouped in the following regions[14]: North, Northeast, and Northwest regions of the state. In contrast, the South, Center-south, Center-east, East, West border, Southeast border, and a small part of the Northwest fall into the LL quadrant of Moran's dispersion diagram. For this variable of interest, the *I* value was 0.279285, which indicates a positive spatial autocorrelation. For the concession of rural credit, Moran's *I* value 0.424678, indicates a strong positive spatial autocorrelation, it is worth noting that in the Northwest, Northeast, Center-north, Center-northeast, part of the North and Southeast border fall into the HH quadrant of Moran's diagram. Meanwhile, the East, Center-east, Center-Northeast, Center-south, and a small section of the North are classified as LL.

The BILISA Cluster maps demonstrate that the relationship between the GDP per person and concession or rural credit fall into the HH quadrant with groupings in the Northwest, Center-north, Center-west, and Northeast. On the other hand, the cities which fall into the LL quadrant are located in the East, Center-East, Center-south, and South of the state. For the relationship between GDP per person and Rural Credit concession, Moran's *I* value of 0.157039, indicates a positive spatial dependency. The relationship between GDP and number of credit cooperative offices showed a slightly positive value 0.041386 for Moran's *I* Index, with a spatial concentration in Moran's HH quadrant in the North, Northeast, Center-north, and Center-Northeast of the state. For the relationship between the number of credit cooperative offices and the concession of rural credit, Moran's *I* value of 0.128319, confirms the spatial dependency.

The results presented and discussed above show that a spatial dependency exists for the variables of interest number of credit cooperative offices per person and concession of rural credit per person. For these variables, it was observed that, predominantly, the northern half of Rio Grande do Sul presented groupings with elevated values in such measures, while Southern and Eastern regions have groupings with low values for the variables being analyzed.

In accordance with the obtained results and considerations surrounding the spatial location, it is possible to note that the geographical aspect plays a vital role concerning the potential for economic growth. The conducted study indicates that in the regions with a spatial dependency that fall into the HH quadrant, credit cooperatives had active participation in the concession of rural credit, these institutions and the concession of rural credit show relationship with local economic development through the spillover effect. With this, one can consider that regions with a higher concentration of credit cooperative offices also tend to have the highest concentration of rural credit conceded and, consequently, larger GDP per person. Such a thesis is not confirmed for the metropolitan region, where locations with low rural credit concession per person and a low number of credit cooperative offices present high GDP per person.

In accordance with the results of this research paper, the existence of clusters for the variables of interest studied is clear, as is the existence of the spillover effect in the outlined regions of the map. This demonstrates evident interference of geographical factors in the concession of rural credit and the activity of credit cooperatives.

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