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A SPATIAL ANALYSIS OF WESTERN PARANÁ: SCENARIOS FOR REGIONAL DEVELOPMENT

UMA ANÁLISE ESPACIAL DO OESTE DO PARANÁ: CENÁRIOS PARA O DESENVOLVIMENTO REGIONAL

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Abstract

The study analyzes whether there is a direct relationship between neighboring municipalities of western Paraná and their regional development. Thus, the spatial autocorrelation of livestock production (cattle, pork, poultry and milk production) from 2011 to 2017, of gross value of agricultural production and of additional fiscal value from 2013 to 2015 was analyzed. In addition, a bivariate spatial correlation analysis of the additional fiscal value per capita in relation to livestock production from 2013 to 2017 was carry out. The theoretical framework was based on the spatial performance assessment using the global, local and bivariate autocorrelation indexes of Moran. The results allow identifying regions with low and high livestock production, gross value of agricultural production and human development index per municipality. Pork and milk production have the highest positive autocorrelation, followed by the additional fiscal value per capita. The development human index had significant spatial autocorrelations, and the additional fiscal value per capita presented similar values among the studies regions. The bivariate spatial correlation between the additional fiscal value per capita and livestock production showed a positive spatial correlation for pork, poultry and milk production. For cattle, the result showed a significant negative spatial correlation.

Keywords: Autocorrelation, Bivariate correlation, Statistical geospatial, Moran index, Agro industry production.

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Resumo

Este estudo analisa se existe uma relação direta entre municípios limítrofes do oeste do estado Paraná, Brasil, e o seu desenvolvimento regional. Deste modo, analisou-se a autocorrelação espacial do efetivo da produção pecuária (quantidade de bovino, suíno, aves e produção leiteira) dos anos 2011 a 2017, do valor bruto da produção agropecuária (VBPA), do valor adicional fiscal per capita (VAF) dos anos 2013 a 2015 e a correlação espacial bivariada do valor adicional fiscal per capita em relação ao efetivo da produção pecuária dos anos 2013 a 2017. O referencial teórico se embasou na avaliação espacial de desempenho com base nas técnicas de índice de autocorrelação global de Moran, local de Moran e correlação bivariado de Moran. Os resultados permitem identificar regiões com baixo e elevado efetivo de produção pecuária, valor bruto da produção agropecuária e índice de desenvolvimento humano por município (IDHPM). Houve maior autocorrelação espacial positiva para a produção de suínos, produção de leite, seguida do valor fiscal adicional per capita. Para o indice de desenvolvimento humano municipal, foram encontradas autocorrelações espaciais significativas. O valor adicional fiscal per capita apresentou semelhança entre as regiões estudadas. Ao avaliar a correlação espacial bivariada entre o valor adicional fiscal per capita (VAF) em relação ao efetivo da produção pecuária, observou-se a presença de correlação espacial positiva para a produção de suínos, aves e leite. Já para a produção de bovinos, o resultado apresentou correlação espacial negativa significativa.

Palavras-chave: Autocorrelação, Correlação bivariada, Índice de Moran, Produção agroindustrial.

Introduction

Brazilian agribusiness is one of the main systems that promote the growth and development of the economy. Of the Brazilian states, Paraná has great representativeness in the agro-industrial systems of soy, poultry, pigs, cattle and more recently fish, with emphasis on the western region of Paraná (IBGE, 2017). The concept of agribusiness used in the study is that of management, and also includes family farming, regardless of its ideological character. Management should be the focal element for the conduction of enterprises (SCHENEIDER, 2016).

In this sense, there are a series of strategies and possibilities for family farming to develop as shown in the work of Swensoon (2019) and also to promote regional development (MARTINS et al., 2004; ROCHA Jr., BITTENCOURT and RIBEIRO, 2015; CZELUSNIAK, 2017; ZIDORA et al., 2018; RIBEIRO et al., 2020)

The growth and development of a region is a challenging and comprehensive process, whose political, socioeconomic and environmental articulations affect these spaces intensively and simultaneously, bringing opportunities, but also challenges. Due to this complexity, it is necessary to work with economic parameters as a proxy for development (FIGUEIREDO et al., 2018).

The development of a region must have indicators that show its real situation, so that mechanisms are created to assist the events, which positively promote the quality of life of the citizens. This way, the use of indices that allow a better understanding of the level of development achieved becomes relevant for municipal managers and entrepreneurs, who may have parameters for public policies and private investments (BECKER, 2017).

This study aims to analyze the direct relations between the bordering cities in the west of Paraná, Brazil, and their regional development. In this way, the spatial autocorrelation of livestock production (quantity of cattle, pig, poultry and dairy production) from the years 2011 to 2017 is studied, of the gross value of agricultural production (GVAP), of the additional tax value per capita (AVF) from the years 2013 to 2015 and the bivariate spatial correlation of the additional fiscal value per capita in relation to the livestock production in the years 2013 to 2017. With the analysis of these indicators it is possible to understand the dynamics of regional development that occurs in the western region of Paraná.

For the development of the study, the article was divided into five parts. The first is in this introduction itself. In the second section, a brief literature review on indexes was developed, in order

to present the methodological procedures. Following the fourth section, the results and discussions were elaborated, to conclude with the conclusions.

Spatial Analysis

To Silva et al. (2018) it is necessary to develop indices that allow a spatial assessment of the economic, political and social performance of a given region.

The indexes together with geostatistical techniques provide elements for spatial analysis between regions, which allow the identification of patterns and behaviors of association and spatial autocorrelation that serve as a reference for decision making.

The emphasis of spatial analysis is to measure properties and relationships, taking into account the spatial location of the phenomenon under study, explicitly (CAMARA et al., 2014).

Rahier et al. (2016) analysed the spatial variability of agricultural productivity in the micro regions of southerbn Brazil, from the years 1995 and 2006, used the spatial analysis that was estimated through the techniques of space econometrics. The results obtained confirmed the variability in agricultural productivity in the southern region of Brazil.

Cima et al. (2018) applied an analysis of univariate spatial autocorrelation and bivariate spatial correlation of grain production, quantity and static capacity of warehouses in the state of Paraná and identified the formation of groups of municipalities, through the similarity of the variables under analysis. When analyzing the spatial variability of soy productivity and agrometeorological variables in the state of Paraná-Brazil through the exploratory analysis of spatial data Grzegozewski et al. (2017) found great climatic variability, in different sowing periods, between the years 2003/2004 to 2009/2010 in the state of Paraná-Brazil.

Raiher, Higachi and Carmos (2018) analyze in Brazil the Competitive Paraná Program in perspective of evaluating the competitive dynamics of the cities between 2010 and 2014, whose technique adopted was spatial econometrics, the results show effectiveness in the generation of industrial jobs and contribute effectively to the generation of total jobs.

Corrêa, Silveira and Kist (2019) report that economic agents do not have the perspective of the region as a whole, so that regional interests should supplant the individual interests of the municipalities.

After this brief review of the literature, the next sections will present the methodologies that will transform the data into information, which will serve as parameters for the results and discussions on the topic addressed.

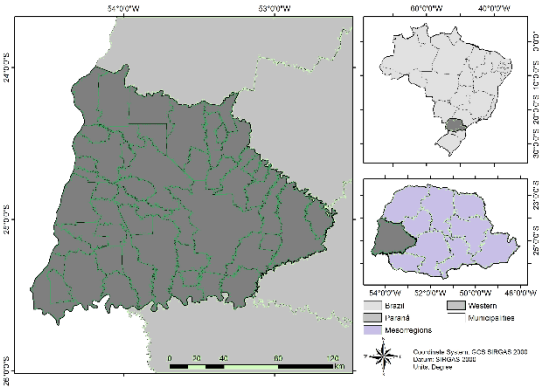
Methodology

The focus of the work was the analysis of the development and regional growth of 50 cities that make up the western region of the state of Paraná (Figure 1). Thus, a quantitative descriptive research was conducted, based on a survey and collection of secondary data made available by the database of the Paraná Institute of Economic and Social Development - IPARDES. Data were collected from January to April 2019.

In addition, several government sources were used to carry out the productive and socioeconomic analysis in the western region of Paraná. Primary data were collected on the basis of IPARDES in a statistical yearbook in the municipal notebooks file. The timeframe worked was from the years 2011 to 2017. The data were available by municipality, all with georeferenced characteristics, for the West Region of Paraná, which comprises 50 cities.

The information from IPARDES is from the years 2011 to 2017, SEAB-DERAL, 2015 and 2017 and IBGE, 2017, were relevant to outline the profile of the analyzed region, as well as its insertion regarding its economic participation in terms of human development, production indexes agriculture, raw value of agricultural production and Additional tax value per-capita in the survey.

Figure 1: Western Mesoregion of Paraná-Brazil



Source: Adapted from Seab-Deral (2015).

This way, information on the MHDI, agricultural production was collected: cattle (quantity per head), pig (quantity per head), poultry (quantity per head), milk (thousands of liters), GVAP (R$) and AVF (R$). As permitted statistics to indicate, between 2011 and 2017, in each city the socioeconomic indexes, the production volumes in quantity used per head, the gross value of agricultural production and the additional value per capita tax in reais of the indicated data. The collection of data allowed to verify the behavior of the variables in the fifty municipalities.

The choice of the western Paraná mesoregion was based on its strategic location, considering its local productive arrangements, as well as its privileged location regarding the flow of production to the major consumption centers, which makes it a great center for generating revenue, employment , taxes and in Brazilian grain exports, soy protein meal. The municipalities belonging to the western mesoregion of Paraná stand out for the agricultural production of pigs, milk, poultry, cattle and fish, which have high diversity, being considered one of the Brazilian states that most contribute to the development of national agribusiness, according to Mezzadri et al.(2018). The techniques of analysis of spatial area statistics (Exploratory Analysis of Spatial Data) were used, they're called: Moran univariate global spatial autocorrelation index, Moran bivariate global spatial correlation and Moran univariate local index (LISA). The geolocation of each of the fifty municipalities in Paraná was considered as: the Municipal Human Development Index (MHDI), the number of cattle, pigs, poultry and milk production, the gross value of agricultural production (GVAP) and the additional per capita tax value (AVF). This database has the following data: Geocoding of each municipality, Name of the municipalities, and the geographical coordinates (Latitude and Longitude) of the studied variables.

For the creation of the spatial database, it was necessary to carry out a general check of the entire database, which included the conference of each of the geographical coordinates of the cities. This procedure confirmed that the location data were perfectly aligned with the variables studied (MHDI, the number of agricultural producers, the GVAP and the AVF).

To facilitate the visualization of the data, thematic maps of the production of each livestock population were built, raw value of agricultural production, Additional tax value per capita and Municipal human development index (MHDI). In order for the assumption of normality to be met, the data was transformed using the Box and Cox methodology (BOX and COX, 1964; CIMA et al, 2018). The spatial exploratory analysis of the data was performed with the aid of the free software R Development Core Team, R (2018).

Applications of Exploratory Analysis of Data Using Spatial Area Statistics

Moran's Indices: Global and Local were applied for the analysis of the univariate spatial autocorrelation and the Moran Global Index for the analysis of the bivariate spatial correlation. These indices provide the identification of areas with High, medium and low spatial dependence. In addition, they enabled the identification of regions, in which there is no statistically significant spatial autocorrelation (ANSELIN, 2013; CAMARA, 2014; FONSECA and AGUIAR, 2019).

The Moran Global Index can be viewed in Equation 1. The application of this procedure was necessary to indicate the relation that exists between neighboring cities and presents the clusters (when they exist), in order to conduct more coherent decisions by public and private agencies. To apply these procedures, it was necessary to develop a spatial proximity matrix that shows the weights for each situation, neighbor = 1, and not neighbor = 0 (ANSELIN, 2013; CÂMERA et al., 2014; FONSECA and AGUIAR, 2019).

The Local Spatial Association Indicator (LISA) corresponds to a decomposition of the Moran Global index. It allows the construction of a value for each area studied and a map of local spatial dependence, thus presenting greater detail in relation to the global indicator of Moran (CÂMARA et al., 2014). Equation 2 expresses the Moran Local or LISA index.

Spatial autocorrelation (LISA and Moran I index)

Through the spatial exploratory analysis, the univariate global Moran (I) index was used for the analysis of the spatial autocorrelation, which shows the evaluation of the global autocorrelation, with a single value for the entire study area (Equation 1) and the index of local Moran autocorrelation (LISA) univariate, which measures the degree of spatial correlation in each specific municipality (Equation 2), (ANSELIN, 2013); (CIMA et al., 2018), In this work, the Queen contiguity criterion was used (ANSELIN, 2013).

$$I = \frac{n\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(x_i-\bar{x})(x_j-\bar{x})}{s_0\sum_{i=1}^{n}(x_i-\bar{x})^2},$$

(1)

therefore,

n : number of cities;

x_i e x_j : values of attribute X considered in cities i and j;

$\bar{x}$: average value of attribute X in the study region;

w_{ij} : element of the normalized neighborhood matrix, corresponding to the spatial weights of 0 and 1, 0 for cities i and j that do not border and 1 for municipalities i and j that border each other. In this work, the Queen contiguity criterion was used (ANSELIN, 2013);

s_0: sum of the elements wij of the symmetric matrix of spatial weights **W**, that is, $\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}$.

$$I_i = \frac{x_i-\mu}{\sigma_0^2}\sum_{j=1}^{n} w_{ij}(x_j-\mu),\ i = 1,\dots,n, \qquad (2)$$

therefore,

σ_0^2: population variance of variable X under study in n cities: $\sigma_0^2 = \frac{\sum_{i=1}^{n}(x_i-\mu)^2}{n}$;

x_i: observation of the variable of interest X in municipality i for i = 1, ..., n;

μ: average of n cities.

In the view of Fonseca and Aguiar (2019), the local Moran Index (LISA) aims to identify possible patterns of local spatial fragmentation, extreme spatial values and to capture patterns of local association (ANSELIN, 2013). Still in this analysis, the Spatial Association Index of Moran (LISA) is a statistical parameter that presents values relative to those of global statistics, in a way that allows demonstrating the degree of similarity or difference of each location in relation to the nearest locations. Therefore, the total sum of the LISA Index for all areas is proportional to the value obtained for the Moran Global index, (FONSECA and AGUIAR, 2019).

Spatial Correlation (Moran Bivariate Index)

In the study of two spatially geolocalized variables, the Moran bivariate index (I_{xy}) is an index of spatial correlation between two variables (X and Y) that are obtained in the n municipalities, as shown in Equation 3, as informed by Anselin and Arribas- Bel (2013).

$$I_{xy} = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} u_i z_j w_{ij}}{s_0\sqrt{s_u^2 s_z^2}}, \qquad (3)$$

therefore,

n: number of cities;

z_j and u_i : values centered on the means of the variables under study X and Y under study, respectively, $z_j = (x_j - \bar{x})$ and $u_i = (y_i - \bar{y})$;

w_{ij}: element of the normalized neighborhood matrix, corresponding to spatial weights 0 and 1, 0 for areas i and j that do not border between themselves and 1 for areas i and j that border between each other;

s_0: sum of the elements w_{ij} of the symmetric matrix of spatial weights **W**, that is, $\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}$;

S_z^2 *e* S_u^2: correspond respectively to the variances of X and Y, thus, $\frac{\sum_{i=1}^{n}(x_i-\bar{x})^2}{n}$ *e* $\frac{\sum_{i=1}^{n}(y_i-\bar{y})^2}{n}$

Results and discussion

The univariate global Moran (*I*) index for each year studied (Table 1) indicated positive spatial autocorrelation at the 5% level of significance. The positive spatial autocorrelation for all years analyzed with a mean Moran index of *I* = 0.3001, which indicates that in the West of Paraná there are municipalities with high and / or low human development index, effective in agricultural production, gross value of agricultural production and additional tax value per-capita, surrounded by municipalities that have similar characteristics.

Table 1: Global Moran index (*I*) and significance test of the Municipal Human Development Index, Livestock production (cattle, pigs, poultry, milk), Per capita additional tax value and Gross agricultural production value. The values presented in Table 1 correspond to the global Moran index (*I*) for each variable analyzed.

	Global Moran index						
Variables	2011	2012	2013	2014	2015	2016	2017
MHDI	0.235*	0.313*	0.186*	0.189*	-	-	-
Cattle	0.219*	0.247*	0.269*	0.259*	0.278*	0.262*	0.113NS
Pigs	0.293*	0.285*	0.326*	0.316*	0.410*	0.407*	0.447*
Poultry	0.145*	0.107NS	0.251*	0.056NS	0.140*	0.085NS	0.11 NS
Milk	0.126*	0.110NS	0.154*	-	0.128*	0.071NS	0.291*
GVAP	-	-	0.154*	0.158*	0.180*	0.124NS	0.177*
AVF	-	-	0.229*	0.265NS	0.328*	0.316*	0.286*

Source: Research results

Notes: Ns: Non-significant values; *: Statistically significant at the 5% probability level; -: Absence of information: Cattle production: (quantity per head); Number of swine production: (quantity per head); Number of poultry production: (quantity per head); Number of milk production (thousand liters); Gross value of agricultural production: (R $); Additional tax per capita amount: (R $).

When observing Table 1, with data from 2011 to 2017, the values of the global Moran index (*I*) showed differences, varying in an amplitude from 0.145 to 0.447, characterizing the existence of positive spatial self-correlation among the 50 municipalities analyzed.

This spatial behavior says that there are municipalities in the western region of Paraná with similar and different characteristics at the 5% level of statistical significance.

Cima et al. (2018) inform that these values are an indication of positive spatial autocorrelation. The highest Moran (I) index of significant spatial correlation were found in the years of 2014 to 2017, with emphasis for the year 2017 (0.447 *), indicating that there was a greater similarity between the municipalities for the production of pigs, that is, regions with high production, surrounded by neighbors presenting this same characteristic, also showed the same spatial pattern for milk production and additional per-capita fiscal value (I = 0.326) between the municipalities, when compared with other years studied (Table 1).

This result corroborates with Silva et al. (2016) who found similar values for the global Moran index for agricultural production. This result shows that the western region of Paraná is among the main producers in the state, with emphasis on the municipalities of Toledo and Marechal Cândido do Rondon, as shown in Figure 2, which shows the similar spatial grouping among the municipalities (red color), whose result showed high-high clusters, ie municipalities with high pig production, surrounded by municipalities with high pig production.

Moran's Local Autocorrelation Index (LISA)

Using Moran's local autocorrelation indexes (LISA), pig production was evaluated, the municipalities were classified according to the level of grouping (Figure 2). The cities that had a significant local Moran index (LISA) were separated into the colors transparent gray (Not significant), dark gray (High-High), medium gray (Low-Low), light gray (Low-High) and very gray clear (High-Low). Its observed that, in the production of pigs from the studied years of 2011 to 2017

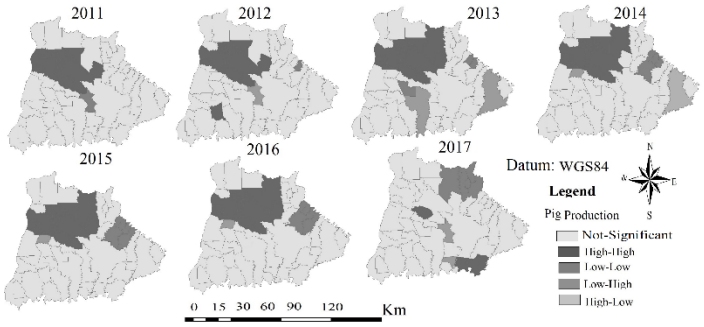
(Figure 2), spatial patterns of clusters occur, that is, the producing regions are similar to each other and are close to each other, allowing significant clusters to be identified (5%).

This proximity between regions is a fact that draws attention, since one region motivates the other regarding the production of this herd.

Such dynamics is very well captured by the local spatial analysis, the groupings make this trend clear and reinforce the importance of using statistical analysis technique in regional, national and international studies.

The western mesoregion presented clusters of municipalities with high and low pig production (dark gray and medium gray in Figure 2). The municipalities of Toledo, Assis Chateaubriand, Marechal Cândido do Rondon, Maripá and Tupãssi, presented clusters of municipalities with high pig production (dark gray in Figure 2). A fact that draws attention in these spatial groupings is the similar behavioral pattern among the municipalities over the years studied and that, as of 2017, the municipality of Santa Helena also showed high pig production. The municipality of Cascavel for the year 2017 showed high pig production, surrounded by neighbors with low pig herd production (very light gray in Figure 2).

Figure 2: Mapas *LISA Cluster Map*, related to Pig Production for the years of 2011 to 2017



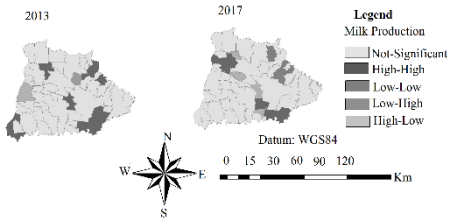
Source: Adapted by Author of Ipardes (2015).

It can be seen in Figure 2, that for the years 2015 and 2016 the pig production remained constant, this is due to the price fluctuations, associated with the production costs, experienced by the sector in the analyzed period. The costs of pig production increased considerably between the years 2015 and 2016, reaching expressive cost levels, which led the producer not to increase his production. (EMBRAPA, 2016).

Moran's local autocorrelation indexes (LISA) using the LISA Cluster Map for milk production in the years 2013 and 2017, in Figure 3. The population of the dairy basin in the western mesoregion of Paraná in the years 2013 and 2017 (Figure 3) presented significant groupings, that is, municipalities with high milk production are surrounded by neighbors with similar characteristics. Here, the municipality of Catanduvas is presented as a productive highlight, Três Barras do Paraná, Serranópolis do Iguaçu, Quatro Pontes, Entre Rios do Oeste, Marechal Cândido do Rondon and Boa Vista da Aparecida, as well as cities with low milk production surrounded by other cities with the same characteristics, Figure 3 in medium gray, corroborates Ipardes (2015), the municipalities of the western region of Paraná, present high demographic heterogeneity regarding milk production in Paraná. This result is justified, due to the fact that the largest milk basin in the state of Paraná is located in the Centro Oriental region, where large volumes are produced daily. Among the municipalities, Castro stands out for the presence of the Castrolanda cooperative (SEAB, 2015).

Moura and Santos (2017) inform that the microregion of Toledo is considered a major milk producer, with a significant share of the amount produced in Paraná. The result also showed some cities with low milk production surrounded by municipalities also with low milk production (Figure 3 cities in the shade with the medium gray color). In 2013 the municipalities with this characteristic were Nova Aurora, Iguatu, Anahy and Foz Iguaçu. In 2017 there was a new configuration and the municipalities that stand out with low neighborhood and low milk production are the following municipalities Iracema do Oeste, Jesuits, Anahy, Corbélia and municipality with high milk production surrounded with neighbors with low milk production here, municipality of Santa Helena (Figure 3 cities in tint with very light gray color).

Figure 3: LISA Milk Production Cluster map from the year of 2013 to 2017



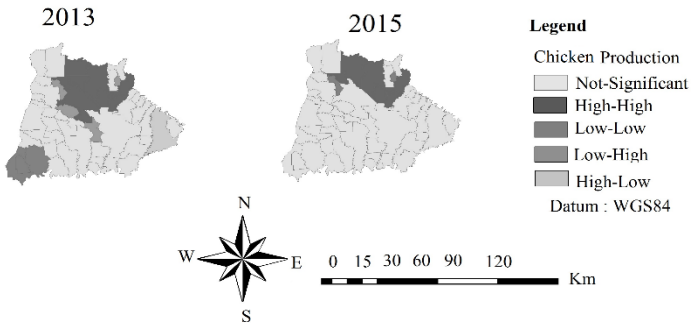
Source: Adapted by the Authors of Ipardes (2015).

The result made evident the expressive contribution of the western region of Paraná with milk production, values that contribute to the economic development of the state and Brazil.

Through the results found, the presence of agro-industrial organizations and dairy herds is inserted in the region under study (Figure 3).

Moran's local autocorrelation indexes (LISA) using the LISA Cluster Map for poultry production in the years 2013 and 2015, in Figure 4.

Figure 4: LISA Cluster Map maps, related to Poultry Production in the years of 2013 to 2015



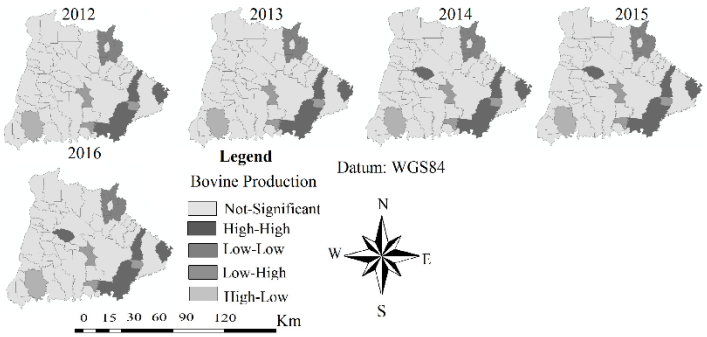
Source: Adapted by Authors of Ipardes (2015).

The cities of Nova Aurora and Toledo, in the year of 2013, presented high poultry production and are surrounded by cities that also have high poultry production, like the cities of: Maripá, Assis Chateaubriand, Palotina and Cafelândia (Figure 4). The municipality of Guaraniaçu showed high poultry production, but it is surrounded by cities with different characteristics (Figure 4), meanwhile the city of São Miguel do Iguaçu in the same year, presented low poultry production and borders municipalities that have similar characteristics. , here are the cities of Foz do Iguaçu and Santa Terezinha do Itaipu, this is justified, since the micro region of Foz do Iguaçu has more tourist characteristics and its market is geared to the tourism industry.

For the year 2015, these clusters had a spatial pattern similar to the year 2013, however, a significant cluster is observed in the city of São Miguel do Iguaçu, which presented high poultry production, but surrounded by cities with low production (Figure 4). This productive arrangement is economically interesting, since in this city, the incentive for the construction of aviaries was more present from this period, due to the great productive demand for animal protein (poultry slaughter) of a poultry cooperative, recently installed in microregion of Foz de Iguaçu (OCEPAR, 2015).

For the years 2011, 2012 and 2016, no significant spatial self-corrections were found at 5% significance between municipalities for poultry production. This behavior is justified, considering that among the largest poultry producers in the state of Paraná are the southwest and central south mesoregions, followed by the west mesoregion, which corroborates Ipardes (2015). Moran's local autocorrelation indexes (LISA) are presented through the LISA Cluster Map for Bovine Production from 2012 to 2016, in Figure 5. A spatial pattern of grouping is observed in the years studied that shows the participation of municipalities western mesoregion in beef production. The result showed regions with high and / or low cattle production, surrounded by neighbors with similar characteristics (Figure 5). It was observed in the years 2014 to 2016 that beef production remained constant, this fact is related to the decision of the producer to invest or not, according to the supply, demand and production costs present in the market.

Figure 5: LISA Maps, for the Bovine Cattle Production for the years 2012 to 2016

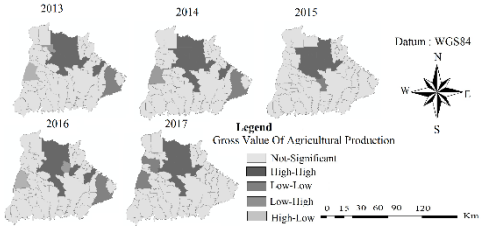


Source: Adapted by Authors of Ipardes (2015).

The cities that stood out in beef production in the years studied were: Catanduvas, Três Barras do Paraná, Campo Bonito and Boa Vista da Aparecida. The city of São Miguel do Iguaçu, in the six years studied, showed high production of cattle, but is surrounded by municipalities that have low production of cattle. These municipalities stand out for having vast pasture areas and a favorable climate for this type of animal.

Moran's local autocorrelation indexes (LISA) are presented using the LISA Cluster Map for the Gross Value of Agricultural Production from 2013 to 2017, in Figure 6. O VGAP presented similar clusters throughout the fifty municipalities of the western region of Paraná, being more evident in the micro-region of Toledo (Figure 6).

Figure 6: LISA Maps, relating to the raw Value of Agricultural Production in the years of 2013 to 2017



Source: Adapted by Authors of Ipardes (2015).

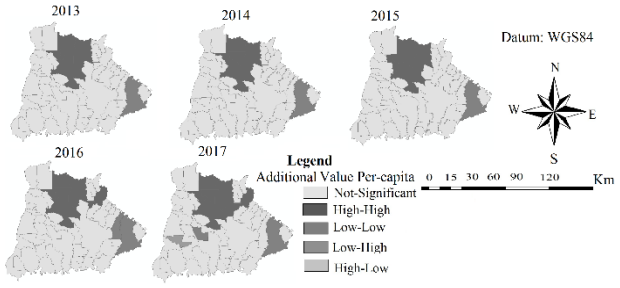
According to Figure 6, the Gross Value of Agricultural Production is an index calculated by the rural economy department of the Paraná State Department of Agriculture, this index represents the financial amount collected by agriculture, that is, the gross revenue of rural producers.

In the years studied, the presence of municipalities with high and/or low GVAP values is observed, surrounded by neighbor cities with similar characteristics. The city of Toledo had a high rate of GVAP, surrounded by municipalities also with a high index of gross value of agricultural production, namely: Maripá, Palotina, Assis Chateaubriand, Quatro Pontes, Braganey and Nova Santa Rosa (Figure 6). It is worth mentioning that in these municipalities there is an integration between the production processes, where the chicken and pork production chains interact with each other, thus creating a virtuous circle, generating competitive advantages for the agro-industrial segments.

The poultry and pork production chains together with the production of soy and corn accounted in 2017 for 76% of the Gross Value of Agricultural Production in the western region of Paraná (SEAB, 2017). There was the presence of a city with a high GVAP, surrounded by cities with a low GVAP, as is the case of the city of Santa Helena and the presence of a city with a low GVAP, surrounded by cities also with a low GVAP, here are the cities of Guaraniaçu in all over the years analyzed (Figure 6), such a decline in agricultural production can be caused by falls in prices paid to rural producers. These results are justified by the great agro-industrial development existing in these regions, which has been showing itself in recent years and which reinforces the presence and scope of agribusiness in these municipalities. Thus, the western mesoregion presented significant values of GVAP, which corroborates Seab (2017), which informs that in the state of Paraná, that the highest values of GVAP are also located in that region.

Moran's local autocorrelation indices (LISA) are presented using the LISA Cluster Map for the Per capita Additional Value for the years 2013 to 2017, in Figure 7.

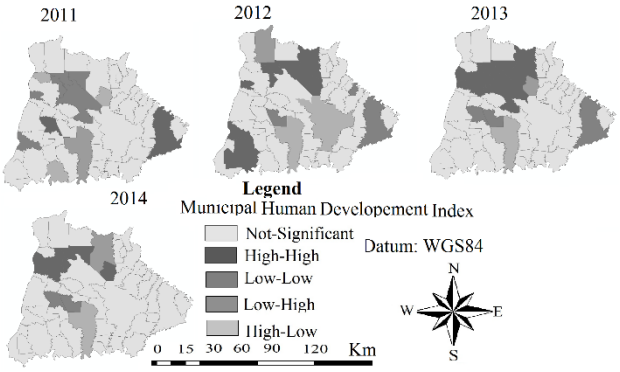
Figure 7: LISA Cluster Map, related to the Per capita Additional Tax Amount for the years 2013 to 2017



Source: Adapted by Author of Ipardes (2015).

Regarding the AVF, it can be seen that in Paraná, the weestern mesoregion, presented patterns of spatial grouping (clusters), represented by the dark gray color. This shows that in these regions there is a cluster with high VAF. Also, it was observed the presence of cities that presented clusters of municipalities with low AVF (medium gray color, Figure 6). For the other cities, no clustering was found, that is, there was no defined spatial pattern. Moran's local autocorrelation index (LISA) is presented using the LISA Cluster Map for the Human Development Index by cities (HDIC) for the years 2011 to 2014, in Figure 8.

Figure 8: LISA Cluster Maps, related to the Human Development Index by Municipalities (HDIC) for the years 2011 to 2014



Source: Adapted by Authors of Ipardes (2015).

Regarding the MHDI, it can be seen (Figure 8) that the western mesoregion of Paraná showed similar patterns of spatial grouping (clusters), represented by the color red in the municipalities of Cascavel, Toledo and Foz do Iguaçu in the four years studied, were also observed , municipalities with low MHDI, surrounded by neighbors with similar characteristics, represented by the strong blue color. This shows that in these regions there is a cluster with high and / or low MHDI (Figure 8). It was observed the presence of municipalities that presented clusters of municipalities with a high MHDI, surrounded by a municipality with a low MHDI, as is the case of the municipality of Cascavel and the municipality of Céu Azul (Figure 8).

Lima, Hersen and Klein (2016) found similar values, when analyzing the IDHPM, corresponding to the years 2000 to 2010 through indicators of the United Nations Development

Program (UNDP) and by the Institute for Applied Economic Research (IPEA) of western mesoregion of the state of Paraná.

Spatial Correlation

To analyze the spatial correlations of the additional per-capita value from 2013 to 2017 with the number of agricultural production in the same period, the Moran bivariate indexes (I_{xy}) were used (Table 2).

It was found that there was a significant positive and negative correlation (p-value ≤ 0.05) between all variants studied for the years 2013 to 2017 (Table 2), with the highest value being found for the additional per-capita tax value and the pig production (0.262), which is justified, since there are municipalities with high and / or low AVF surrounded by neighbors with high and / or low pig production, thus showing the relationship between these variables. In other words, the income of rural producers is directly related to pig production in different cities.

Table 2: Bivariate Moran Index (I_{xy}) between the additional per capita tax amount (R $) and the livestock production (Quantity per head)

Variables	Bivariate Moran Index I_{xy}	p-value
AVF and Cattle Production 2013	-0.198	*0.006
AVF and Pig production 2013	0.164	*0.01
AVF and Poultry production 2013	0.167	*0.01
AVF and Milk production 2013	0.021	*0.01
AVF and Cattle Production 2014	-0.209	*0.007
AVF and Pig production 2014	0.188	*0.01
AVF and Poultry production 2014	0.147	*0.021
AVF and Cattle Production 2015	-0.274	*0.001
AVF and Pig production 2015	0.230	*0.002
AVF and Poultry production 2015	0.168	*0.008
AVF and Cattle Production 2016	-0.286	*0.001
AVF and Pig production 2016	0.206	*0.006
AVF and Poultry production 2016	0.179	*0.008
AVF and Cattle Production 2017	-0.141	*0.021
AVF and Pig production 2017	0.262	*0.001
AVF and Poultry production 2017	0.170	*0.01

Source: Research result.

Notes: AVF: Additional per capita tax amount; I_{xy}: Moran's bivariate index; *: significant at the 5% probability level; Number of bovine animals: (quantity per head); Number of swine production: (quantity per head); Number of poultry production: (quantity per head); Per-capita additional tax amount: (R$).

The additional per-capita tax value (AVF) is a relevant socioeconomic index for evaluate the growth and economic development of the cities, the study made clear its relationship with the population of agricultural production, reinforcing the tendency and vocation of agribusiness in the western mesoregion of Paraná. It is pertinent to inform that the agricultural production that make up the state of Paraná, the West region presents an expressive participation and contributes to the growth and development of the state of Paraná, generating revenues for the different economic segments. The result Table (2) showed that there are differences in the AVF in relation to livestock production between the municipalities of the western mesoregion of Paraná, in the analyzed period, this profile was observed by means of spatial patterns (clusters) between the municipalities and is justified, since livestock production is related to the economy, agricultural incentive policies among others in each municipality, which corroborates Almeida and Silva-Junior, (2017).

Conclusion

With spatial autocorrelation, similarities between the number of agricultural production, gross value of agricultural production, AVF and MHDI in the years 2011 to 2017 were identified. With the univariate global Moran (I) index, in the global analysis, it was found that there was autocorrelation positive spatial between the municipalities, which was demonstrated by the groupings, thus showing the similarity between the municipalities analyzed.

Through the studied variables, equality was identified between the municipalities of the western region of Paraná. In the local analysis (local index of Moran LISA), municipalities with the

effective number of agricultural production, gross value of agricultural production, AVF and MHDI, also presented equivalences, throughout the fifty verified municipalities.

There was a bivariate spatial correlation between AVF in relation to livestock production, in the years 2013 to 2017, the result showed that there is a relationship between these variables analyzed.

This study showed that the number of agricultural production, raw value of agricultural production, AVF and MHDI varied between cities in the western region of the state of Paraná, which in fact comes in line with the different characteristics of each region, being them political, economic or even social.

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