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THE INCREASE OF AGRIBUSINESS IN THE CERRADOS OF THE BRAZILIAN NORTHERN CENTER: A SPATIAL ANALYSIS

A EXPANSÃO DO AGRONEGÓCIO NOS CERRADOS DO CENTRO NORTE BRASILEIRO: UMA ANÁLISE ESPACIAL

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Abstract

This paper analyzes which regions in the Cerrados of the Brazilian Northern Center have achieved a significant growth as Agribusiness Productive Region. For this purpose, I of *Moran* Global and Local is used in order to detect the existence of spatial autocorrelation. The study period between 2005 and 2015, and the main source of data comes from the Brazilian Institute of Geography and Statistics (IBGE). The results demonstrated that this part of Brazil has different types of spatial dynamics. The Immediate Region of Balsas-MA and the Intermediate Region of Barreiras-BA consolidated as the main areas of regional agribusiness. Therefore, the Immediate Region of Uruçuí-PI and Bom Jesus-PI and the center of Tocantins became areas of expansion of these productive activities. It was observed that in some parts of the Northern Center Cerrado´s the I of *Moran* local occurred the formation of municipal groupings disassociated to this productive context. Consequently, due to its transport infrastructure and favorable physical conditions, the central region of Tocantins, formed by the triad Palmas, Paraíso and Porto Nacional, was the main responsible for boosting agribusiness in the Cerrados of the Brazilian Northern Center.

Keywords: Regional economics. Spatial analysis. Cerrado Northern Center.

Resumo

O principal objetivo da pesquisa consiste em identificar quais regiões dos cerrados do Centro Norte brasileiro obtiveram um crescimento significativo como Região Produtiva do Agronegócio. Para tanto, utiliza-se do *I* de *Moran* Global e Local a fim de detectar a existência de autocorrelação espacial entre os seus municípios. O período de estudo compreende os anos de 2005 e 2015, e a principal fonte de dados provém do Instituto Brasileiro de Geografia e Estatística. Os resultados demonstram que essa parte do Brasil possui diferentes tipos de dinâmicas espaciais. A Região Imediata de Balsas e a Região Intermediária de Barreiras consolidaram-se como as principais áreas

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do agronegócio regional. Por sua vez, a Região Imediata de Uruçuí e Bom Jesus e o centro do Tocantins tornaram-se áreas de expansão dessas atividades produtivas. Entretanto, observou-se que em algumas partes dos cerrados do Centro Norte o I de *Moran* local ocorreu a formação de agrupamentos municipais desvinculados a esse contexto produtivo. Nesse sentido, diante da sua infraestrutura de transporte e condições físicas favoráveis, a faixa central do Tocantins, formado pela tríade Palmas, Paraíso e Porto Nacional, foi a principal responsável por impulsionar o agronegócio nos cerrados do Centro Norte.

Palavras-chave: Economia regional. Análise espacial. Cerrados Centro Norte.
Classificação JEL: R11 e R12

Introduction

The portion of land that comprises the eastern Tocantins (TO), southern Maranhão (MA), southern Piauí (PI) and western Bahia (BA) has witnessed, in recent decades, the systematic advancement of agricultural activities into their domains, thus becoming an Agribusiness Productive Region (RPA)[4]. On the other hand, the intensity of this phenomenon varies depending on the municipality, which resulted in a space formed by different modes of appropriation. In this sense, it is a geographic delimitation in a formation that needs a deep scientific investigation (HAESBART, 2015).

In view of this, in 2015, the Brazilian Enterprise for Agricultural Research (EMBRAPA) created the phrase MATOPIBA, anachronistic of Maranhão, Tocantins, Piauí and Bahia with the objective of applying development policies in this part of the country. In the same year, the section "Cerrados of Northern Center" was disseminated in the academic environment, a group of municipalities that are specifically inserted in this biome. Regardless of the reference, the focus is on analyzing the dynamics originated by the recent advance of agribusiness in the agricultural space of Tocantins and in the Northeastern inner (ELIAS, 2015).

However, in this research, we opted for the closed delimitation of the Cerrados in the Brazilian Northern Center because we understand that it has advantages regarding the spatial homogeneity in relation to MATOPIBA. This eliminates a recurring problem in the Regional Economy, which consists in work with internally different municipal clusters. In this way, it is possible to carry out statistically reliable studies that determine the level of internal cohesion present in geographic cutouts. Thenceforth, essential information is acquired that enables the formulation of efficient public policies, as well as providing the implementation of projects promoting integrated development (OCDE, 2002).

Thus, the research identifies which regions of the Cerrados in the Brazilian Northern Center have achieved significant growth as an Agribusiness Productive Region. Therefore, it uses the I of Moran Global and Local to detect the existence of autocorrelation space between locations. The study period covers the years 2005 and 2015, and the main source of data comes from the Brazilian Institute of Geography and Statistics (IBGE). Finally, it is justified to carry out this research as a way of increasing the understanding of the interactions exercised by RPA in this part of the country.

Literature review

The first regionalization in Brazil, following the German and French geographic schools, adopted natural criteria as a selection matrix. Subsequently, the consolidation of theoretical frameworks such as Walter Christaller's Central Place Theory[5] changed the process of spatial delimitation. In this sense, new agents, such as urbanization, are considered a major factor for the creation of territorial cutouts (FRANÇA, 2014).

Recently, the Brazilian Institute of Geography and Statistics (IBGE) incorporated the concept of urban centralities when proposing a new regionalization in the country. Thus, the

[4] They are areas where the agents involved in agricultural activities are responsible for boosting regional production, configuring themselves in functional regions of globalized agribusiness (ELIAS, 2011; 2015 and 2017).
[5] The conception that urban centers dynamize the regional economy refers to the Theory of the Central Place by W. Christaller (1893-1969). In summary, this conception demonstrates that the greater the capacity of cities to gather people and services, the greater their power to influence other regions.

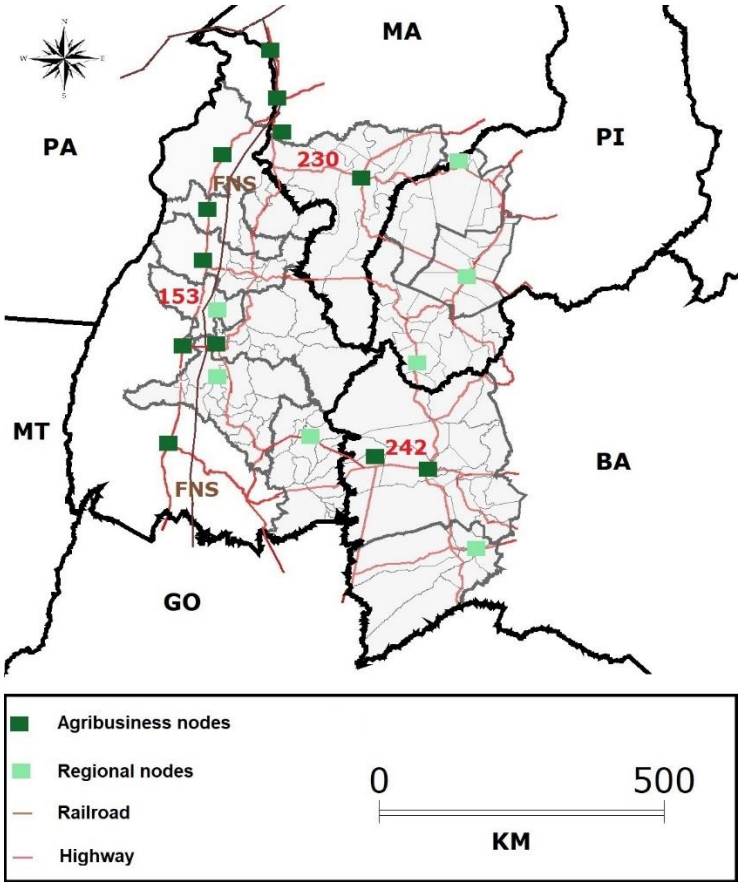
Immediate and Intermediate Regions emerged, which are areas where residents meet their needs for consumption and services, in addition to exercising employment activities in certain centers. Therefore, this new configuration demonstrates that all Brazilian municipalities in some way trade with each other (IBGE, 2017).

On the other hand, the recent transformations have been unable to create fully urban spaces in the Brazilian inner. On the contrary, agrarian conflicts and the rise of agro-industrial networks have accentuated the countryside-city relationship. In view of this, by specializing in the export of commodities, their cities have become vulnerable places, with their growth strictly dependent on global agribusiness (CASTILLO et al, 2016).

In the case of the Cerrados located in the Northern Center of Brazil[6], its urban centers acquired importance only in the mid-1980s. Previously, they were isolated and deprived of any production that could integrate them to the national economic dynamics. Therefore, there is a deepening of the population dispersion in its territory and the migration to large capitals (OLIVEIRA; PIFFER, 2016).

Besides since the mid- 1990s, the process of land ownership has intensified. In this sense, emerged nodes directly linked to agribusiness. Its function is to concentrate agricultural production and flow through highways and railways to coastal ports. In addition, there are the interregional nodes, which are responsible for supporting the flow of capital in the sections with less movement (HUERTAS, 2015). Figure 1 illustrates these considerations:

Figure 1: The municipalities of the Cerrados of the Northern Center of Brazil, their nodes, and their main traffic routes



Source: Huertas (2015). Prepared by the authors

It is noted that the main nodes in Maranhão and Tocantins are located close to the Nortg South Railway (FNS), BR-153, BR - 230 and BR – 242 (federal highways). In this context, the

[6] The North Center of Brazil is a geographical delimitation originating in Brazil (2008) and further developed by Oliveira; Piffer (2017), composed of 419 municipalities in the states of Tocantins, western Bahia, southern Piauí, southern and central Maranhão, southeast Paraense mesoregion and northern Araguaia / MT microregion, which fully integrated into the national productive context 2000, whose economic base is concentrated in agribusiness, mineral extraction and trade.

municipalities of Imperatriz-MA, Porto Franco-MA, Colinas-TO and Palmas-TO stand out. This capital benefits from the Terminal Integrador Luzimangues, which although located in Porto Nacional-TO, offers all the necessary infrastructure for the expansion of agricultural activities in the region of Jalapão, eastern Tocantins (OLIVEIRA, 2017).

In the Cerrado Piaui, its municipalities integrated into the context of agribusiness in the mid-1990s. The nodes Bom Jesus and Uruçuí, despite increasing their influence in the inner of the Northeast, play a secondary role on the agribusiness strength Barriers-BA, Luís Eduardo Magalhães-BA and Balsas-MA[7], places where they developed the first soybean cultivars adapted to the soil and climate of the Brazilian Northern Center. Furthermore, the significant distance to the ends of the North-South Railway makes its flow only through highways, mainly the BR-135 and the BR-235 (HUERTAS, 2015).

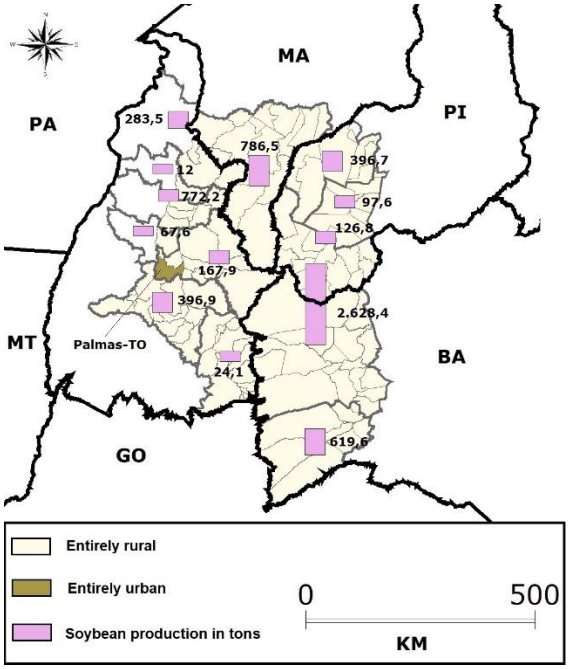
Although it has a limited role in the agro-industrial network of Cerrados in the Northern Center, southern Piauí has made a significant leap in terms of spatial integration. At first, the transformation process faced difficulties in the absence of an adequate infrastructure, long periods of drought and sandy soil, a factor that contributed to desertification. However, scientific research and favorable planting conditions adjacent to the Parnaíba River have inserted the region into global agribusiness (SILVA; BARROS, 2016).

In the same scenario, the southeast Tocantins had followed an economic marginalization period, mainly after the construction of BR-153. The highway moved the flow of capital, goods, and people to the center of Tocantins. However, the approach to Luis Eduardo Magalhães-BA and Barreiras-BA influenced agricultural production in the neighboring state (OLIVEIRA; ARAÚJO, 2012). In addition, the Manuel Alves River irrigation project, although presenting management and implementation issues, from 2015 demonstrated the first positive results for the Dianópolis region (OLIVEIRA; RODRIGUES, 2017).

At first, the exposed context demonstrates that the spread of large-scale planting has transformed the Cerrados of the Northern Center into an Agribusiness Productive Region. On the other hand, the process of land ownership led to social exclusion and environmental problems. As a result, the geographical delimitation is prone to fragmentation because of the discontinuity of the mechanisms that define them as a region (HAESBART, 2010). So much so that, while maintaining soybean cultivation at considerable levels, only one location is in the essentially urban category, note:

[7] The diffusion of soy planting in the Balsas region is due to technicians from the Brazilian Agricultural Research Corporation - EMBRAPA, who together with Dutch farmers, created a soybean species adapted to the Cerrado's sandy soil in the 1970s (DUTRA; AREND, 2015).

Figure 2: Identification of rural or urban municipalities in the Cerrados Northern Center based on Veiga (2001) and the quantity of soy produced (t) by Immediate Region in 2016



Source: IBGE. Prepared by the authors.

It is noted that the Intermediate Region of Barreiras-BA and the Immediate Region of Balsas-MA obtained the largest amount of soy produced in the Northern Center of Brazil. However, all its municipalities are essentially rural. This demonstrates the high level of dependence that the south of Maranhão and the west of Bahia have in relation to soybean. The only essentially urban one, Palmas-TO, acquired this characteristic by housing the state public apparatus, a condition that attracted activities from the tertiary sector and transformed them into a regional pole (OLIVEIRA; PIFFER, 2015). Even so, the capital is integrated into the context of the Agribusiness Productive Region in view of the production of grains in the district of Buritirana and the proximity to the Integrator Terminal Luzimangues (OLIVEIRA, 2017).

Research design

Based on the concept of the Agribusiness Productive Region, the expansion of agricultural activities in the Cerrados of the Brazilian Northern Center is analyzed based on the Gross Added Value of Agriculture (AGR), the Gross Added Value of Industry (IND), and the Gross Added Value of Service (SERV). Such variables are provided by the Brazilian Institute of Geography and Statistics (IBGE). Intertemporal research will contribute to observing spatial changes over time. The study is simplified by adding the IND parameter to the SERV, thus creating the URB, a measure that aggregates all existing urban activities in the municipality.

The Gross Added Values are transported to a Microsoft Excel spreadsheet, where the rows are the municipalities. In this file, the growth rate of AGR and URB is calculated between the years 2005 and 2015. Then, the values are entered in the GeoDA freeware, where spatial statistics is applied. At first, a proximity matrix is built following the binary criterion of the common border (ANSELIN, 1995), note:

$$w_{ij} = \begin{cases} 0, \text{if there is no boundary between i and j;} \\ 1, \text{if there is a boundary between i and j.} \end{cases} \quad (1)$$

The matrix w_{ij} represents each one of the *n* municipalities {*A1*,..,*An*} of the Cerrados of the Northern Center according to their geographical approach. Moreover, for its creation are used the *queen* function and the criterion of neighborhood of the first order. Finally, two univariate analyzes

are performed - growth rate AGR and URB- and one bivariate -x: rate AGR; y: URB rate for this is used the I of Moran Global[8], note:

$$I = \frac{n}{\sum_{i=1}^{i=n}\sum_{j=1}^{j=n} w_{ij}} \frac{\sum_{i=1}^{i=n}\sum_{j=1}^{j=n} w_{ij}\left(y_i - \bar{y}\right)\left(y_j - \bar{y}\right)}{\sum_{i=1}^{i=n}\left(y_i - \bar{y}\right)^2} \qquad (2)$$

Being that,

Y_i = value of variable y in municipality i;
Y_j = value of the variable y in the municipality j;
$\bar{y}$ = average of y;
W_{ij} = element ij of the spatial proximity matrix;
n = number of observations.

Assuming that *I* of *Moran* Global is equivalent to a linear regression coefficient, a graph is created to illustrate the relationship between the attribute value of each standardized element - zi - with the average of the values of the attributes of its neighbors - Wzi, following this classification:

- the first quadrant (I) presents the growth rates above the average with neighbors also performing in this direction (high-high);
- quadrant three (III) contains pairs, unit and neighbors, with below-average growth rates (high-low);
- quadrant two (II) holds the regions and respective neighbors with performances below and above average (low-high);
- quadrant four (IV) contains the regions and neighbors, respectively, with above and below average growth rates (low-low).

The identification of fragmentation or integration in the Cerrados of the Northern Center is reinforced through the *I* of *Moran* Local *(LISA)*. This indicator produces a specific value for each set of geographical areas, thus allowing the identification of spatial groupings through only one index . Its formula is:

$$I_i = z_i \sum_{j=1}^{n} w_{ij} z_j \Big/ \sum_{i=1}^{n} z_i^2 / n \qquad (3)$$

where,

Ii = local Moran index;
zi = difference between the value of the attribute in place i and the average of all attributes;
zj = difference between the value of the attribute in place j and the average of all attributes;
wij = weights or degrees of connectivity assigned according to the topological relationship between i and j.

After calculation of *I* to *Moran* location *(LISA)*, if the Ii values are different from zero, it indicates that the unit i is spatially associated with their neighbors. As the distribution of Ii is

[8] It is a spatial association indicator that points to whether in a given region, where it presents high or low values for any variable, its surroundings also present high or low values, which would characterize a kind of cluster in the analyzed space (ANSELIN, 1995).

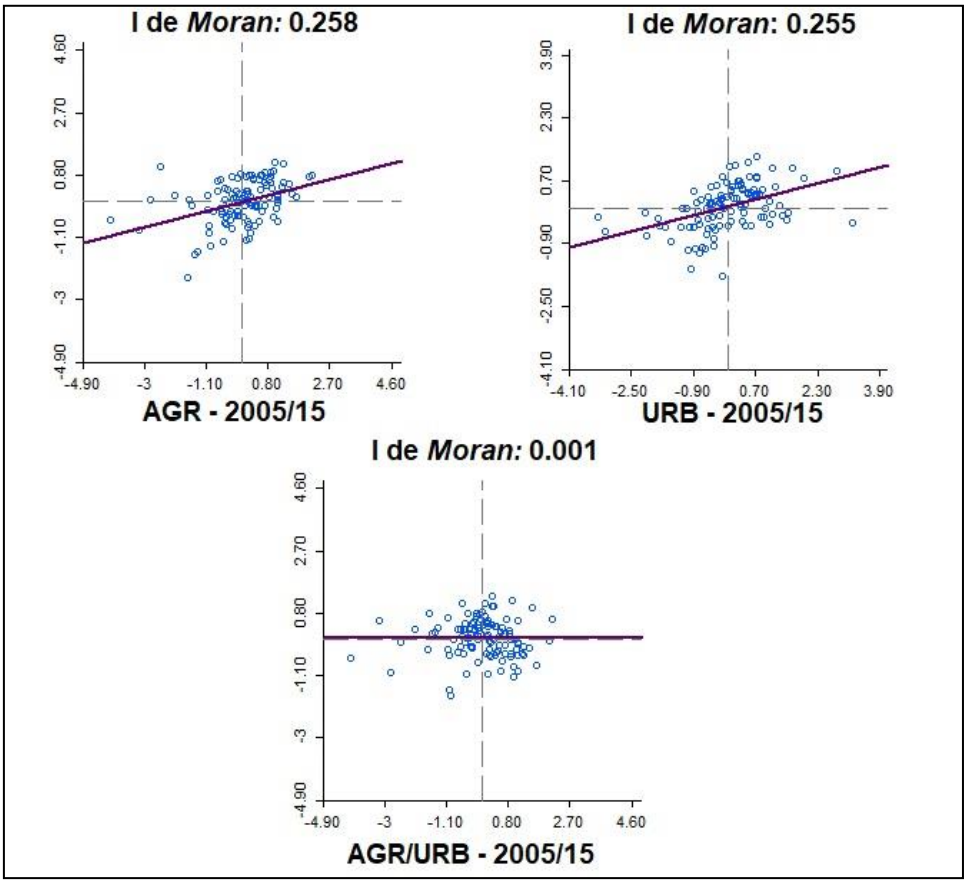
unknown, the way to get it is through random permutations of the neighbors of each unit with other areas, until reaching a pseudo-distribution for which the significance parameters can be computed. The comparison of these with the observed allows to infer if the spatial correlation is significant if it is greater than 95% (ANSELIN, 1995).

Then, choropleth maps called Moran Map are constructed, which allow the spatial joints to be identified. Based on that we can observe the existence of spatial associations between the municipalities that make up the Cerrados of the Brazilian Northern Center. However, it is emphasized that the I of *Moran* Global and Local are the beginning, not the end of an analysis process (LEITE; MAGALHÃES, 2010). Thus, the considerations are realized on the results presented.

Results and discussions

The I of Moran global for the growth rate of the Gross Production Value of Agriculture in the Cerrados of the Northern Center showed a positive value, as well as the Gross Production Value of Urban Activities. At that, there is a significant probability of these parameters being grouped in space. On the other hand, in the bivariate analysis, there is no evidence that points to a positive association between the municipalities, see figure 3:

Figure 3: Results of the linear regression of the I of Moran Global for the growth rate of Gross Production Value of Agriculture (AGR), Gross Production Value of Urban Activities (URB) and of the bivariate analysis between AGR and URB - 2005/2015



Search results. Organized by the authors

It is noted that the I of Moran Global of the AGR and URB have similar values, however the AGR / URB demonstrates that the perspective of a cluster of municipalities to achieve simultaneous growth in these two parameters is close to zero. Under this conception, choropleth maps are elaborated to identifying the spatial patterns based on Moran Local 's I. Figures 4, 5 and 6 illustrate the results presented, note:

Figure 4: I of Moran location on the growth rate of agriculture (AGR) in the Cerrados of Northern Center - 2005/2015

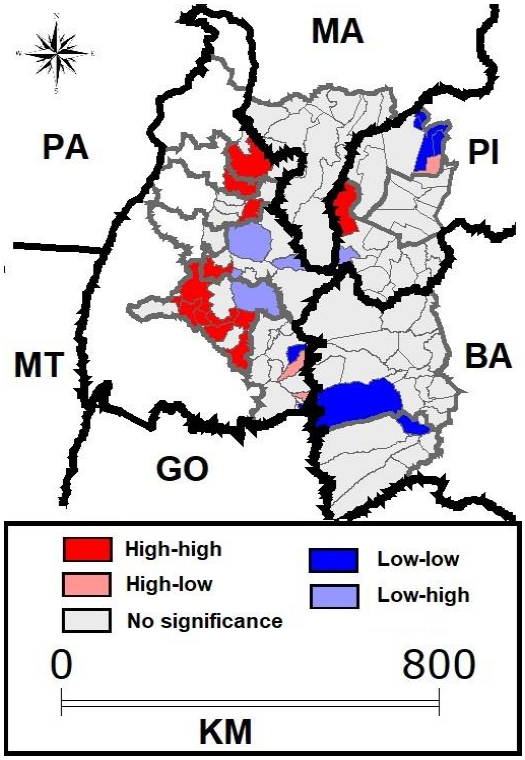


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Figure 5: I of Moran on the growth rate of urban activities (URB) in the Cerrados of Northern Center - 2005/2015.

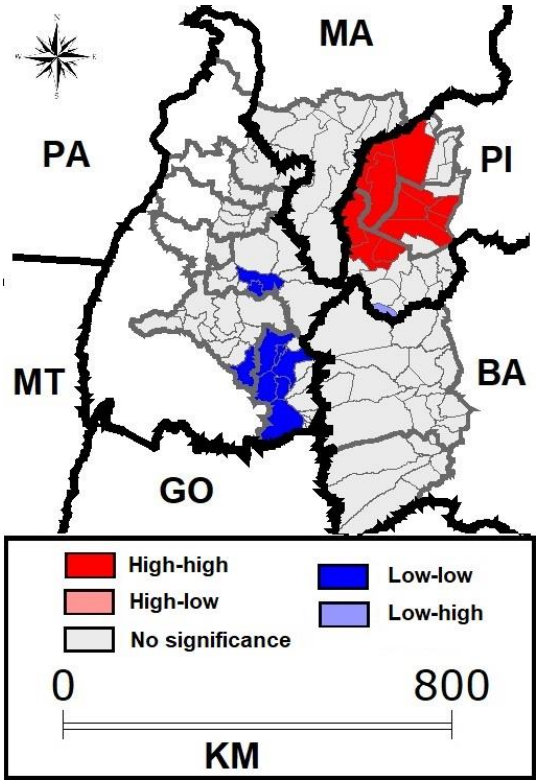

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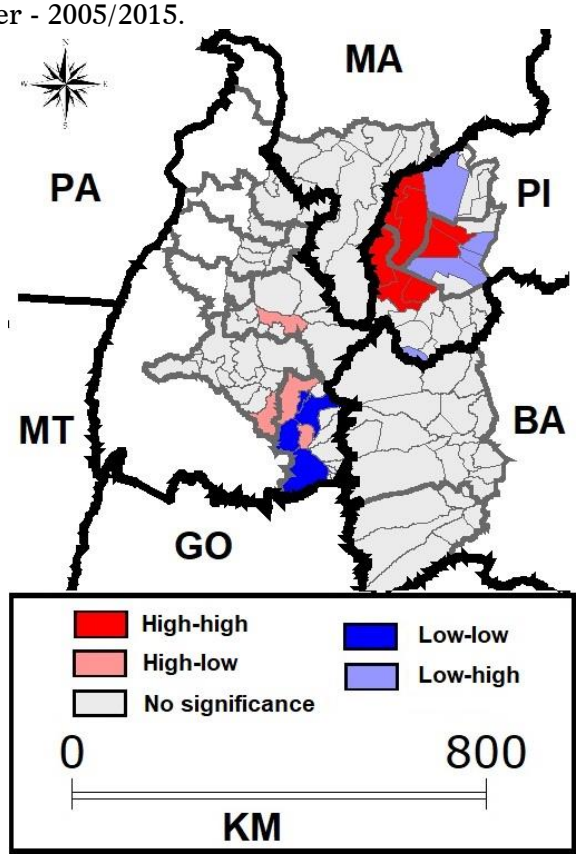
Figure 6: I of Moran on the growth rate of agriculture (AGR) and urban activities (URB) in the Cerrados of Northern Center - 2005/2015.



Search result. Prepared by the authors.

In figure 4 can be seen that the high-high municipalities are located in the state of Tocantins, most of them in the Immediate Region of Porto Nacional. In addition, Palmas, Itacajá, Goiatins and Centenário showed a positive autocorrelation. In the Immediate Region of Dianópolis, Ponte Alta do Bom Jesus and Aurora do TO experienced high growth in their agricultural production in the middle of the existence of locations that showed low output. In relation to the other areas of the Cerrados of the Brazilian Northern Center, only Santa Filomena and Alvorada do Gurgueia in Piauí have positive values.

On figure 5 can be seen that municipalities of Piauí stand out in relation to the others. Altogether, 11 locations, Uruçuí, Ribeiro Gonçalves, Baixa Grande do Ribeiro, Gilbués, Santa Filomena, Monte Alegre do PI, Currais, Santa Luz, Bom Jesus do PI, Cristino Castro and Palmeiras do PI fit into the pattern of high-high. In the state of Tocantins incurs the formation of clusters with significant growth in urban activities. On the contrary, there is a low-low cluster in the Immediate Region of Dianópolis and in the vicinity with Palmas. In this parameter, the Cerrados of Bahia and Maranhão showed statistically irrelevant values.

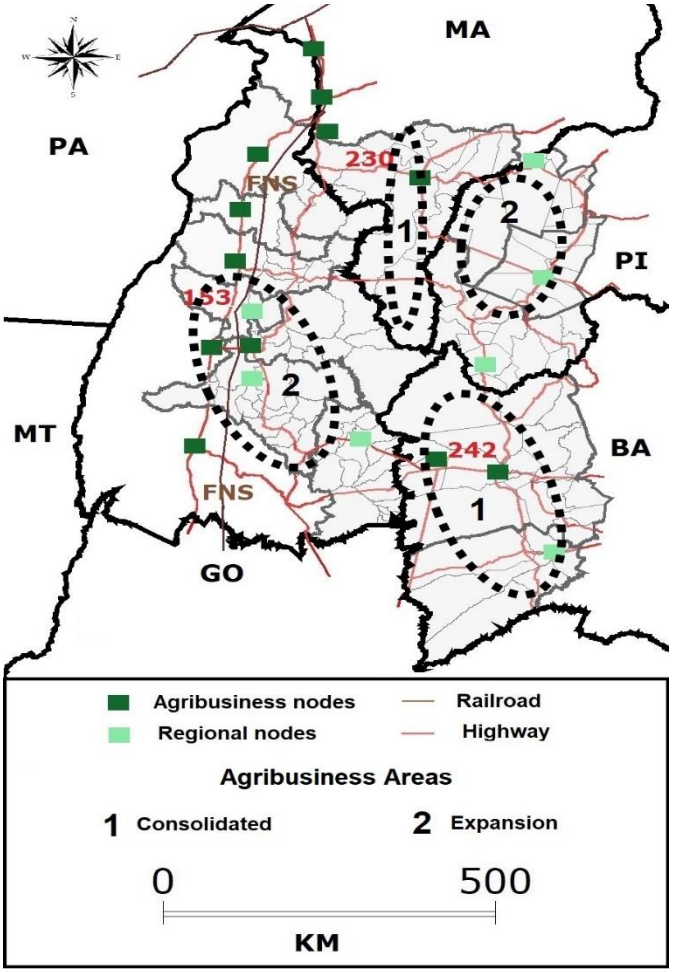
Finally, figure 6 shows that only seven locations have achieved joint growth between agricultural and urban production. In this context, Currais, Baixa Grande do Ribeira, Palmeiras do PI, Ribeiro Gonçalves, Santa Filomena, Gilbués, Monte Alegre do PI, New Agreement, Lagoa do TO, Natividade, Almas and Taipas do TO stand out. In the case of the municipalities in Piauí, the expansion of the tertiary and agro-industrial sector between 2005 and 2015 contributed to these municipalities being placed in the alto-alto category.

In relation to what happened in Tocantins, the introduction of large-scale planting of soybeans and corn in the Immediate Region of de Dianópolis made possible by the experience of neighboring farmers coming from western Bahia, boosted rural activities in this area. Nevertheless, the municipalities of Dianópolis-TO and Porto Alegre-TO, benefited by the Manuel Alves river project, are at the low-low level, confirming that irrigated fruit production had a limited impact on the creation of agro-industries or any unit that supplies inputs at the regional level.

In view of the information collected, there is a lack of spatial patterns with a high level of statistical significance in the municipalities belong of the Immediate Region of Balsas-MA, Barreiras-BA and Santa Maria da Vitória-BA. These are geographical areas where agribusiness has

been consolidated and which, in view of physical and social barriers, has expanded beyond its geographical limits, infiltrating the Cerrados of Piauí and Tocantins, as shown in figure 7:

Figure 7: Area of expansion of agribusiness in the Cerrados of the Brazilian Northern Center - 2005/2015.



Search result. Prepared by the authors.

It is observed that the expansion area in Tocantins soil includes the nodes of the agribusiness Palmas and Paraíso, and the regional nodes, Porto Nacional and Miracema. Furthermore, its transport network is based on high capital movement routes, the BR - 153 and the North-South Railway. Unlike the situation in Piauí, where there are no railroads that connect you quickly with coastal ports and cities above 50,000 inhabitants, in addition to climate and soil restrictions. Under such circumstances, the Cerrado of Piauí has barriers with regard to actions of agricultural agents within their geographical limits.

Conclusion

The research identified the areas of the Cerrados of the Brazilian Northern Center where the agribusiness networks expanded between 2005 and 2015. The spatial association indicators, I of *Moran* local and global, based on the Gross Production values by municipality, provided by IBGE, detected the groupings that fit into the concept of RPA. The elaboration of choropleth maps made possible to discuss the phenomena over the presented results.

The Cerrados that are inserted in the Brazilian Northern Center have different types of spatial dynamism. Because of the large amount of soy produced within their domains, a process that began in the 1970s and 1980s, and the emergence of nodes aimed at agriculture, the Immediate Region of Balsas-MA and Immediate Region of Barreiras-BA consolidated agribusiness in this part of Brazil. As they are sectors that need new lands, rural producers entered to the Cerrado of Piauí, having a great output in the Immediate Region of Uruçuí and Bom Jesus, and in Tocantins state. In

this area, there is a robust urban and transport infrastructure, making it one of the main agro-industrial expansion networks.

However, it was observed that in parts of the Cerrados of the Northern Center, the *I* of *Moran* local incurred the formation of municipal clusters with a high level of significance. The rugged terrain, as in the case of the extreme southeast of Tocantins and east of Balsas, the existence of legally protected areas, a situation that happens precisely in Jalapão, and rainfall deficiencies, a frequent scenario in the Cerrados of Piauí and Bahia, limit the performance of agribusiness regional.

On the other hand, the predominant factor that fragments the Cerrados of the Northern Center are the cities. Some cities act as nodes of agribusiness, such as Palmas-TO, Barreiras-BA and Balsas-MA, being the main representatives, polarizing internal trade. These differentiations break the classic concept of region, and for this reason the recently elaborated definitions, Agribusiness Region Production, and Intermediary Region and Immediate Region are consistent with the Brazilian reality.

In view of such inferences, it is assumed that in the next decade the central strip of Tocantins, formed by the triad Palmas, Paraíso and Porto Nacional, will become the irradiating center of agribusiness in the Cerrados of the Northern Center, removing this primacy from the west Bahia and southern Maranhão. In fact, the absence of important structures, such as the West-East Integration Railway and the New Transnordestina Railway, which would boost the economic base of the Northeastern inner, enables the consolidation of this assumption. In addition, it is recommended that authorities develop public policies that consider the present spatial diversification in this area of agricultural expansion, for the purpose of promote the integrated development of its municipalities.

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