Identification and Analysis of the Evolution of Local Productive Arrangements

Caroline Welter
Western Paraná State University

Luiz Cypriano
Western Paraná State University

Daniel Centurião
Western Paraná State University

Received: 03/30/2021
Accepted: 08/10/2021

Abstract

This study sought to identify and analyze the evolution of Local Productive Arrangements (LPAs) in the sectors of extractive and manufacturing industry in the state of Paraná, from 2006 to 2016. In the methodology, the normalized Concentration Index (nCI) and the Exploratory Spatial Data Analysis (ESDA), which consisted of the application of two statistical tests, the Global Moran's I and the Local Moran's I. With this methodological procedure it was possible to identify 57 industrial LPAs in the state of Paraná in 23 economic sectors, with its greatest incidence in the Metropolitan Region of Curitiba and North Central. We conclude that there is a consolidation process with positive evolution of LPAs in the analyzed period, where the regions of Londrina and Curitiba and its surroundings stand out, as well as the activities of food and beverage production; textiles and clothing; wood and furniture; and the production of machinery, equipment, rubber, and plastics.

1 Introduction

The Local Productive Arrangement (LPA) is a type of agglomeration of companies disseminated in Brazil and formalized by the Research Network on Local Productive and Innovative Systems (RedeSist), from the Economics Institute of the Federal University of Rio de Janeiro (IE/UFRJ). The concept of LPA can be considered the most appropriate for the Brazilian reality, as it involves not only the locational and sectorial proximity of companies, but also considers the interdependence between political, economic, and social actors, in order to strengthen the development of the place where the LPA is installed Cassiolato and Lastres (2003).

For Santos et al. (2004), LPA became relevant in terms of industrial and regional policy due to the competitive advantage it provides to companies. On the one hand, it is because location is a source of competitive advantages, regardless of tax incentives, transportation costs, and ease of access to raw materials or end consumers, and, on the other hand, these competitive advantages are related to the innovative capacity and diffusion knowledge, encouraging the entry of specialized services in the area, attracting investments and making good use of the regional image.

The federal government used the LPAs as a measure to stimulate regional economic development, in order to combine the reactivation of agglomeration economies to support the regions, as pointed out by Fuini (2013). Public policies were put in place to support LPAs and methodologies were created to identify them throughout the Brazilian territory, in addition to the constitution of state nuclei, with the purpose of organizing governance at the regional level, for the elaboration and implementation of state policies BNDES (2009).

In the state of Paraná, following on from the initiative of the state government, 18 industrial LPAs were identified IPARDES (2009), of which, in 2008, 68,670 thousand jobs were created, representing a positive variation of 33.5% in relation to the first identification of LPAs occurred in 2003 by IPARDES and SEPL (2005a).

Several identification initiatives have been carried out by researchers and institutional actors, such as Puga (2003), Suzigan et al. (2003a), IPARDES and SEPL (2005a,b,c), IPEA (2006), IPARDES (2009), and Brito et al. (2010), who applied LPAs identification methodologies, using indicators of productive specialization and employment variables and number of companies. However, these approaches, to some extent, did not address the evolution of these LPAs nor did they show their consolidation in specific activities or regions. In addition, the numerous studies of LAPs identification seen in the literature had a break in 2008, with much more modest approaches to identification. These facts motivated the choice of Paraná for the analysis proposed in the paper.

It was also verified the frequent use of political borders only from municipalities or microregions. Nevertheless, it is worth mentioning that political borders do not always reflect the location where the LPAs are present, as pointed out by Porter (1999), and they may geographically cover two microregions, three municipalities only, and so on.

The use of the Locational Quotient (LQ) specialization index also has limitations, since it can overestimate the weight of a sector when the productive structure of the region under analysis is little diversified, and can underestimate the weight of a sector when the productive structure is very diverse, mainly in developed regions Fingleton et al. (2004). The criteria and filters are used to eliminate this limitation, but they are not free of criticism, since they are arbitrated by the researcher.

All things considered, this work sought to verify the evolution of industrial LPAs in the state of Paraná. Therefore, the objective was to identify LPAs in the extractive and manufacturing industry in the period from 2006 to 2016, and whether they grew in terms of the number of participating companies and the expansion of their activities, covering neighboring companies and municipalities. For this purpose, a methodology for identifying and mapping LPAs was used, which aims to overcome the limitations mentioned regarding the spatialization of LPAs, beyond geographical boundaries, and to capture other economic dimensions, in addition to the LQ usually used.

The contributions of this research reside in updating the methodology of LPAs identification used in the literature, considering the effects that go beyond the geographical and political limits established between the spatial units and considering the diversity of activities that compose the industrial sector, besides minimizing the effect of using arbitrary filters in the identification of agglomerations. Additionally, the study also updates the works of LPAs identification that were developed in past periods, especially for Paraná, and this temporal update allows the analysis of the behavior of LPAs in a time of extensive economic crisis, where the Brazilian industry suffered greatly, especially from the year 2011, according to Oreiro (2017).

2 Theoretical Framework

About regional development, regionalization and clustering, the literature presents different approaches, Cavalcante (2008) highlights those who work with an evolutionary perspective, in an analysis of Regional Innovation Systems and Local Productive Arrangements (LPAs); Ehrnberg and Jacobsson (1997) and Cassiolato and Szapiro (2002) authors who emphasize the analysis of industrial districts in a context of flexible specialization; Lipietz and Leborgne (1988) and Markusen et al. (1995) , authors who emphasize "innovative environments", such as the European Research Group studies on innovative, Maillat (1995) those dealing with regionalization of theories of industrial organization; Storper (1994) author who emphasize business management and the formation of business clusters; and, finally, authors who consider increasing returns to scale and their effects on spatial phenomena, such as Krugman (1997) and Fujita et al. (1999).

In the Brazilian reality, LPAs emerged as a theoretical effort to understand the productive agglomerations of small companies, as pointed out by Fuini (2013). The term LPA is theoretically based on the industrial districts of Marshall (1890) and the clusters of Porter (1999). Europe also has experiences of analysis using these concepts, as in the case of France and Italy Becattini (1999).However, they still lack a consensus

on what characteristics define it. The term LPA was systematized in Brazil with the studies of RedeSist. Among the main researchers are José Eduardo Cassiolato and Helena Maria Martins Lastres, who started their studies focused on the innovative means and national and local innovation systems from the 1990s.

LPAs are constituted by the geographical concentration of companies, institutions, and organizations that have links with each other, even if incipient and that exercise their activities in specific economic sectors. Generally, there is an interaction between these actors, be it in the supply of inputs or services, training of human capital, promotion of research and development, and design of public policies Cassiolato and Lastres (2003).

Fuini (2013), after analyzing the specialized literature, with a wide range of researchers in the 1990s and 2000s, verified some fundamental factors to define LPAs, namely, the territorialization of production, external economies, locational competitive advantages, innovation, and cooperation. For Santos et al. (2004, p.162) "The literature seems to be converging more and more towards the definition of LPAs as a geographical concentration of companies and other institutions that are related in a particular sector."[1].Nonetheless, they show that the definition of LPAs must be carried out based on the existence of locational competitive advantages of sectorial scope. Therefore, it is necessary to understand that an agglomeration of companies becomes an LPA if location is an important source of sector-specific competitive advantages for participating companies.

With this emphasis on LPAs, which began in the 2000s, many authors sought to apply methods for identifying and mapping LPAs, such as the works by Puga (2003), Suzigan et al. (2003b), Suzigan et al. (2003a), IPARDES and SEPL (2005a,b,c), IPEA (2006), IPARDES (2009). Suzigan et al. (2003b) proposed a methodology to identify local production systems in the leather and footwear industry by using locational indicators, such as the Locational Gini coefficient (LG) and the Locational Quotient (LQ). RAIS/MTE data on the number of jobs and establishments for the 4 digits of the National Classification of Economic Activities (CNAE) were used for all municipalities in São Paulo, in 1998. The microregions of São Paulo that stood out in the leather and footwear industries were Franca, Birigui, and Jaú.

Puga (2003) proposed a methodology for identifying LPAs using LQ, considering only LQs greater than 5, and complemented the analysis with limits of at least 50 companies and more than 1,000 jobs. They applied LG equal to or greater than 0.5 and a minimum participation of 70% of micro and small companies. This application was made for Brazilian microregions in all economic sectors in 2001, but, in services, computer activities, and research and development were considered. 193 LPAs present in 152 Brazilian microregions in 2001 were mapped. In Paraná,12 arrangements were verified, with 2,572 establishments and 38,018 jobs.

Suzigan et al. (2003a) applied the same methodology to the manufacturing industry in the state of São Paulo. The calculation of the indicators was applied to the 267 classes of the CNAE and to the 63 microregions of São Paulo, in the year 2000. The following criteria were considered: LG greater than 0.5; LQ greater than 2; at least 1% share of employment; at least 20 establishments. 64 CNAE classes from the manufacturing industry were identified that had agglomerations in 2000.

In Paraná, a study was carried out to identify LPAs in the state by the Paraná Institute of Economic and Social Development (IPARDES) and the State Secretariat for Planning and General Coordination IPARDES and SEPL (2005a). The methodology was similar to that used by Suzigan et al. (2003a) and applied to 298 classes of the CNAE of the extractive, manufacturing, and software activities industry, and to the 39 micro regions of the state, in 2003. 165 classes of activities were selected in 33 microregions of the state. As some classes are similar, they were grouped, resulting in 114 productive agglomerations. The classification of these agglomerations followed the criteria described in Table 1, which includes the respective classes of activities in each classification.

This same study also defined six other criteria, namely: first, the largest number of classes of similar activities in the same microregion; second, tax density (sales/employment ratio); third, the destination of production (domestic or foreign market); fourth, was the volume of purchases of the same class in the state; fifth, presence of micro and small companies; and, the last, the importance of class sales in the microregion IPARDES and SEPL (2005a).

As a result, 25 potential LPAs were identified in the activities of the extractive, manufacturing, and

[1] "A literatura parece estar convergindo cada vez mais para a definição de APLs como uma concentração geográfica de empresas e outras instituições que se relacionam em um setor particular."

Table 1: Classification of productive agglomerations by IPARDES and SEPL (2005a).

		Importance for the sector	
		Low (<20% in class employment in the state)	High (≥ 20% in class employment in the state)
Local Importance	High (LQ ≥ 5)	Local Development Vector (LDV): 25 class clusters in 19 microregions	Nucleus of Sectorial-Regional Development (NSRD): 12 class clusters in 9 microregions
	Low (1 <LQ <5)	Local Productive Arrangement Embryo (E): 45 class clusters in 19 microregions	Advanced Vector (AV): 32 class clusters in 3 microregions

software activities industry in the state of Paraná, in 2003. The subsequent analysis was followed by the work of IPARDES and SEPL (2005b,c), which through on-site visits, they verified the formation of companies, the productive structure and the presence of institutions in 21 of the 25 potential LPAs, in order to select which LPAs would be subject to case studies and the application of public policies. They concluded that 22 LPAs would be the object of studies for the definition of support policies. In the work of IPARDES (2009), there is an update of the identification of LPAs carried out by IPARDES and SEPL (2005a), where the 22 identified LPAs remained and evolved, in terms of territorial coverage, number of jobs, and number of establishments.

An identification of LPAs in all Brazilian states was coordinated by Wilson Suzigan and it appears in the work of the Institute for Applied Research and Economics IPEA (2006). This work was carried out aiming to allow the later formulation of public policies and promotion actions in the identified and mapped LPAs. That is because the government created a support policy for LPAs, coordinated by GTP-APL(Permanent Working Group for LPAs) and its state nuclei, but which still lacked information on LPAs for the entire national territory. The control variables and filters were modified according to the specificities of each Brazilian state, resulting in 762 potential LPAs present in all states, except Roraima IPEA (2006). In Paraná, 61 agglomerations were identified, of which 30 (AV), 8 (E), 9 (NSRD), 8 (LDV), as shown in Table 1.

Unlike these studies that used LQ and LG, Crocco et al. (2003) proposed a methodology for identifying LPAs that uses other business concentration indicators, which could generate greater robustness in the calculation, and that takes into account that an LPA can be composed of companies from more than one municipality and/or be located between two microregions. This method is divided into two parts: the calculation of the normalized Concentration Index (nCI) and the application of Exploratory Spatial Data Analysis (ESDA).

This methodology was applied by the authors to the textile sector for all Brazilian municipalities, based on employment data from the 2000 Demographic Census. After calculating the nCI, two filters were applied, thus excluding LPAs that obtained an nCI below the average of the sector and those that did not reach the minimum number of 10 companies. 95 municipalities with LPAs were identified; however, with the application of ESDA, they identified 62 LPAs, of which 53 were composed of only one municipality and 9 were composed of more than one municipality, including those they were not part of the same state. In Paraná, 7 LPAs were identified, one located in two different municipalities.

Crocco et al. (2006) applied nCI to the industrial activities of leather and footwear; basic metallurgy; manufacture and assembly of motor vehicles; manufacture of machinery, equipment, and electrical material; manufacture of electronic materials, and communication equipment and apparatus, for all municipalities Brazilians, with employment data from the Demographic Census and number of RAIS establishments for the year 2000. The same filters as the work by Crocco et al. (2003) were applied. As a result, they showed the concentration of LPAs for these activities in the South and Southeast regions, with emphasis on Paraná where 3 potential LPAs were verified in the leather and footwear sector, 2 in basic metallurgy, 6 in the manufacture and assembly of motor vehicles, 6 in electrical material machines and apparatus, and 2 in electronic materials, and communication equipment and apparatus.

Several authors used the method proposed by Crocco et al. (2003) and Crocco et al. (2006) to identify LPAs, evidencing, in a way, its consistency and acceptance by the literature. Chain (2014) used the method by Crocco et al. (2003) and Crocco et al. (2006) to verify the industrial concentration of coffee in the municipalities of the state of Minas Gerais, between the years 2002 and 2010, analyzing its evolution, where an increase in the industrial concentration of coffee was verified over the years analyzed.

Rodrigues et al. (2012) identified the productive agglomerations of the clothing sector in the southern region of the country, for the years 1995, 1999, 2003, and 2007, in order to verify their evolution. They verified the growth of clothing LPAs in Paraná, mainly in the North Central and Northwest regions. In Santa Catarina, the LPA present in the municipalities of the Vale do Itagui mesoregion stands out, which showed a stable spatial trend over time, indicating its consolidation in the region. In Rio Grande do Sul, no clothing LPAs were found.

Pinheiro et al. (2008) identified LPAs in the civil construction sector in 2002 in the state of Pará, with a total of 4 LPAs identified. Filgueiras et al. (2008) identified the LPAs in forestry and wood and furniture activities between 1998 and 2004, in the municipalities of Pará. They calculated only the nCI of the method by Crocco et al. (2003), not considering the EASD. As a result, they identified 47 LPAs in 1998 and 52 LPAs in 2004, indicating the growth of productive agglomerations over the years analyzed, with a positive variation of 10.64%.

The productive agglomerations in the food and beverage industry in Paraná were present in 5 municipalities in 1999, and grew to 22 municipalities in 2015, with the majority of the municipalities belonging to the Northwest and North Central regions. In the South region, there was a geographical restructuring of the concentration of industries in this sector, as the number of clusters decreased considerably in Rio Grande do Sul and Santa Catarina Paschoalino et al. (2019).

Paraná constitutes the largest volume of productive agglomerations in the country's clothing sector, according to Rodrigues et al. (2012, p. 318), who also highlights the positive spatial relationship between these agglomerations and their positioning in the Western Central, Southern Central, Northwestern, North Central, North Pioneer, Western, and Southeastern mesoregions, covering 99 municipalities.

Using locational indicators, Vidigal et al. (2014) present a scenario of the evolution of the manufacturing LPAs in Paraná for the 2000s, in which they reveal that the LPAs of Maringá, of the Southwestern and Cianorte region, suffered a reduction in their relative participation. The LAPs of Apucarana and Terra Roxa presented the best growth prospects and, in general lines, advances in these LPAs are pointed out for smaller municipalities due to the search for labor. The authors pointed out gains for the development of the region in terms of improving the efficiency of the installed productive activities and generating new businesses.

The results presented by Sobrinho and Azzoni (2014) testify in favor of the regional effects of development caused by the economies of agglomerations generated from industrial concentration. In addition to this effect, there is a positive highlight on the importance of industrial agglomerations in the region of Londrina/Maringá and Curitiba in Paraná, with 0.48% and 2.64% of participation in the gross added value of Brazilian industrial production. The occurrence of the Londrina region as significant illustrates the fact of the occurrence of an intra-regional dispersion causing a "concentrated deconcentration" Azzoni (1986).

There is strong evidence that the productivity of the regions is influenced by other factors, in addition to the spillover effects that present gains to the regions at the expense of the agglomeration economy. The work of Raiher and Candido (2018) demonstrates that the diversification and agglomeration of the industry can generate positive effects on the productivity of the municipalities, depending on their size. The authors made the reservation that in the largest municipalities in terms of population and number of industries, the economy of agglomeration without the necessary infrastructure can lead to negative effects on productivity. There is also an important highlight for the growth of the productive spatial concentration in the southern region of the country between 2001 and 2015.

These considerations are aligned in the field of regional economic development, in which Hirschman (1958) argues that economic growth does not occur throughout the territory at the same time, but when it does, it causes powerful forces that encourage the concentration of activities in local spaces. In addition, the author highlights the importance of imbalances, where an economy seeking to achieve higher levels of income should create points of growth. Points that influenced issues of labor availability and qualification, productivity, salaries, and quality of life.

3 Methodology

In order to allow the analysis of the evolution of industrial LPAs in Paraná, as well as their spatial behavior over time, the method based on Crocco et al. (2003) and Crocco et al. (2006) was applied for each year in the period from 2006 to 2016, for the 399 municipalities of Paraná, using the CNAE divisions of the extractive and manufacturing industry, as shown in Table 2, which totaled 29 sectors. The selection of municipal data is justified by the more common availability of employment data in Brazil, besides allowing comparability with other work carried out in other periods. The limitation of identifying LPAs beyond the municipal geographic boundaries is overcome by the methodological apparatus of this work as is better detailed in item 3.2.

Table 2: CNAE 2.0 divisions for the extractive and manufacturing industry.

CNAE	Description
5	Extraction of mineral coal
6	Extraction of oil and natural gas
7	Extraction of metallic minerals
8	Extraction of non-metallic minerals
9	Support activities for mineral extraction
10	Manufacture of food products
11	Manufacture of beverages
12	Manufacture of tobacco products
13	Manufacture of textile products
14	Manufacture of wearing apparel and accessories
15	Preparation of leather and manufacture of leather goods, travel goods, and footwear
16	Manufacture of wood products
17	Manufacture of cellulose, paper, and paper products
18	Printing and reproduction of recorded media
19	Manufacture of coke, petroleum products, and bio fuels
20	Manufacture of chemicals
21	Manufacture of pharmaceutical chemicals and pharmaceuticals
22	Manufacture of rubber products and plastic material
23	Product manufacture of non-metallic minerals
24	Metallurgy
25	Manufacture of metal products, except machinery and equipment
26	Manufacture of computer equipment, electronic, and optical products
27	Manufacture of machinery, equipment, and electrical material
28	Manufacture of machinery and equipment
29	Manufacture of motor vehicles, trailers, and bodies
30	Manufacture of other transportation equipment, except motor vehicles
31	Manufacture of furniture
32	Manufacture of various products
33	Maintenance, repair, and installation of machinery and equipment

Source: IBGE (2019).*Note: The CNAE 2.0 is a usual activity classification in Brazil, however it has a very similar structure to the ISIC 4.0 - International Standard Industrial Classification, the compatibility of these classifications can be obtained in National Classification Commission of IBGE.CONCLA (2007)

The motivation for the selection of this period occurred as a result of allowing a continuation of the existing studies of mapping the LPAs in the state of Paraná and because the Brazilian industry presented, especially in this period, very poor results throughout the country, with a negative highlight for the transformation industry. Oreiro (2017) attributes this poor performance of the sector to a set of factors, such as the collapse of investment and reduction of profit rates in the sector, the loss of fiscal subsidies and realignment of important operating costs, along with macroeconomic elements, as the increased penetration of imported products and high interest and exchange rates.

This method is divided into two parts: the calculation of the normalized Concentration Index (nCI) and the application of Exploratory Spatial Data Analysis (ESDA). The first one overcomes the limitation of using

only the LQ, when calculating two more indexes together with the LQ, and the second allows verifying if the spatial concentration of the activities of a region is also verified in the neighboring regions, thus it is not limited to municipalities or the microregions. The variables used to calculate the indicators were extracted from RAIS/MTE RAIS (2019), with the number of formal jobs and the number of formal establishments.

3.1 Normalized Concentration Index

To develop a possible indicator to identify LPAs, Crocco et al. (2003, p. 18) considered that this indicator should meet the following criteria: "(...) (1) the specificity of a sector within a region; (2) its weight in relation to the region's industrial structure; (3) the importance of the sector nationally; and (4) the absolute scale of the local industrial structure.".

To meet these criteria, the Locational Quotient (LQ) was applied, which made it possible to measure the first analysis criterion: the specificity of sector i in municipality j, as can be seen in equation (1). Due to the limitation of this indicator verified in section 4.1, Crocco et al. (2006)developed a second indicator, the modified Hirschman-Herfindahl index (mHH), which made it possible to compare the weight of sector i of municipality j in sector i of Paraná (PR) with the weight of the productive structure of municipality j in the productive structure of Paraná, according to equation (2). Thus, mHH captured the real value of the sector's weight in the local productive structure, meeting the second criterion. The last index, which met the third criterion, was the Relative Participation (RP) of the industrial sector in the total employment of this sector in the state, because it captures the importance of the sector in the municipality at the state level, according to equation (3).

$$LQ = \frac{\frac{E_i^j}{E_j}}{\frac{E_{PR}^i}{E_{PR}}} \tag{1}$$

$$\text{mHH} = \left(\frac{E_j^i}{E_{PR}^i}\right) - \left(\frac{E_j}{E_{PR}}\right) \tag{2}$$

$$\text{RP} = \frac{E_j^i}{E_{PR}^i} \tag{3}$$

Where:

E_j^i = Employment of sector i in municipality j;

E_j = Total employment of the municipality j;

E_{PR}^i = Employment of the sector i in Paraná;

E_{PR} = Total Industrial Employment in Paraná.

In order to meet the fourth criterion, the linear combination of these indicators mentioned above composed the normalized Concentration Index (nCI), as indicated in equation (4). The weight of each indicator for each productive sector was represented by θ. As each indicator has, according to Crocco et al. (2003, p.13),"(...) different capacity to represent agglomerative forces, especially when taking into account the various industrial sectors of the economy (...)", it was necessary to calculate specific weights for each indicator.

$$\text{nCI}_{\text{i,j}} = \theta_1 \text{nLQ}_{\text{i,j}} + \theta_2 \text{nRP}_{\text{i,j}} + \theta_3 \text{nmHH}_{\text{i,j}} \tag{4}$$

For this, the multivariate method called Principal Component Analysis (PCA) was applied, which aims to identify, through the correlation matrix of the variables, which percentage of the variance of the total data dispersion is explained by each of the three indicators. This percentage indicated the specific weight for each indicator. After calculating the weights, it was possible to make a linear combination of the indicators and, therefore, calculate the nCI and thus hierarchize all the sector-municipal pairs according to their agglomerative potential Crocco et al. (2006).

PCA is a multivariate statistical technique that explains the structure of variance and covariance of a random vector, transforming, through linear combinations, a set of original variables into another set of variables of equal dimension, not correlated, called main components Hongyu et al. (2016). The PCA analysis seeks to build components Z1, Z2, ..., Zp from the analysis of p variables X1, X2, ..., Xp combined linearly, subject to a constraint. In this case, the use of three indicators (variables) resulted in three main components.

3.2 Exploratory Spatial Data Analysis

The Exploratory Spatial Data Analysis (ESDA), is a set of techniques that allows describing and visualizing spatial distributions, identifying spatial outliers (atypical locations), finding patterns of spatial association, among other forms of spatial instabilities, as pointed out by Anselin (1999).

Two tests were used in this research. The first was Global Moran's I statistic, elaborated by Moran (1948), and it is a spatial autocorrelation coefficient, measured by the auto covariance in the form of a cross product by the data variance. This statistic verifies whether the data were randomly distributed in space and, therefore, the null hypothesis was spatial randomness and the alternative hypothesis was spatial autocorrelation. Thus, if the null hypothesis is rejected, the nCI of the municipalities was related to the nCI of their neighbors. The method of calculating Moran's I is presented in equation 5, and it has an expected value of - [1 / (n - 1)].

$$\mathrm{I} = \frac{n \sum \sum w_{ij}(y_i - \acute{y})(y_j - \acute{y})}{\sum \sum w_{ij} \sum (y_i - \acute{y})^2} \tag{5}$$

In the above equation, n represents the number of municipalities, $y_{i,}$ and $y_{,j}$ are the nCI of municipality i e j respectively, y′ is the nCI average for all municipalities in the state of Paraná, and w_{ij} is the matrix of spatial weights indicating the neighborhood of i and j.

The matrix of spatial weights, also called the spatial weighting matrix W, is a square matrix of dimension n by n, which reflects the arrangement of spatial interactions between regions. The w_{ij} weights are the degrees of connection between the regions according to some proximity criterion, which show the influence of region j on region i, as highlighted by Almeida (2012). In this research, the W matrix was determined by the first-order geographic contiguity, following the one proposed by Crocco et al. (2003), with the queen matrix being determined as the most adequate the proposal of this research, after the tests with the other types of W matrices were performed. This indicates that the regions were considered neighbors if they had a common physical border, assigning a value of 1 when i e j they are contiguous and 0 when they are not.

The interpretation of Global Moran's I can be done as follows: considering a significance level of 5%, if the value of I is statistically greater than its expected value, there is positive spatial autocorrelation; the value of I being statistically smaller, there is a negative spatial autocorrelation between the municipalities Moran (1948).

According to Almeida (2012), positive spatial autocorrelation indicates that high nCI values (y) tend to be surrounded by high nCI values in neighboring municipalities; or low nCI values tend to be surrounded by low nCI values in neighboring municipalities. In these cases, it is possible to consider that the concentration of industrial activities given by the nCI can be verified throughout the neighboring municipalities. However, for negative spatial autocorrelation it is possible to verify that the concentration of industrial activities given by nCI will be dispersed among the municipalities of the state. In other words, a high nCI value in a municipality tends to be surrounded by low nCI values in neighboring municipalities – the opposite being also true.

In addition to the global measure of spatial linear association, other information can be verified in the quadrants of the diagram, which are the four types of spatial linear association defined by Anselin (1996): High-High (HH), Low-Low (LL), High-Low (HL) and Low-High (LH). In this research, the HH ratio represents the municipalities with high nCI values surrounded by municipalities with high nCI values. In the LL relationship, the opposite of HH is verified. For the HL relationship, municipalities with high nCI values are surrounded by municipalities with low nCI values, and in the LH relationship the opposite of HL is found.

According to Chain (2014), generally, when working with large territorial units it is very likely that there are different patterns of spatial association, in this sense, the Global Moran's I is unable to capture the existence of local clusters or to capture local patterns of spatial autocorrelation. To solve this problem, Anselin (1995) proposed the Local Indicators for Spatial Association (LISA), which has the capacity to indicate statistically significant spatial agglomerations.The LISA indicator used, Local Moran's I, derived by Anselin (1995), according to equation 6, where z_i and z_j are the deviations around the mean of the observations y, w_{ij} the matrix of spatial weights and the sum in j includes only the neighbors of observation i.

$$I_i = Z_i \sum_j W_{ij} Z_j \tag{6}$$

With the application of these two spatial autocorrelation tests, it was possible to observe whether the LPA identified in one municipality expanded its activities in number of companies to neighboring municipalities.

3.3 Research Filters

In order to relate the results verified in the nCI and the Local Moran's I, and, in this way, to identify the LPAs in the municipalities and sectors delimited in this research, it was necessary to use some filters, namely:

Filter 1. nCI higher than the state average, that is, above 0.00.

Filter 2. Number of formal establishments equal to or greater than 10.

Filter 3. Local Moran's I that presented only the spatial linear association relationship of the High-High type.

In filters 1 and 2, the orientation of Crocco et al. (2003) was followed, in which the municipalities that presented a concentration index below that verified in the average of the state of Paraná were disregarded. As for the number of companies, to be characterized as an LPA, the minimum necessary concentration of these companies in the same geographic space is expected. Therefore, it was considered that there were at least 10 formal establishments in the same sector in each municipality.

In filter 3, the application by Rodrigues et al. (2012, p. 318) was taken into account, in which he emphasizes "(...) since governmental strategies are focused on regions, and not only on individual places, it is reasonable to consider the spatial effect involved." Thus, the municipalities that presented a linear spatial association of the High-High type were considered, which considered the municipalities that presented high nCI values and were surrounded by neighboring municipalities also with high nCI.

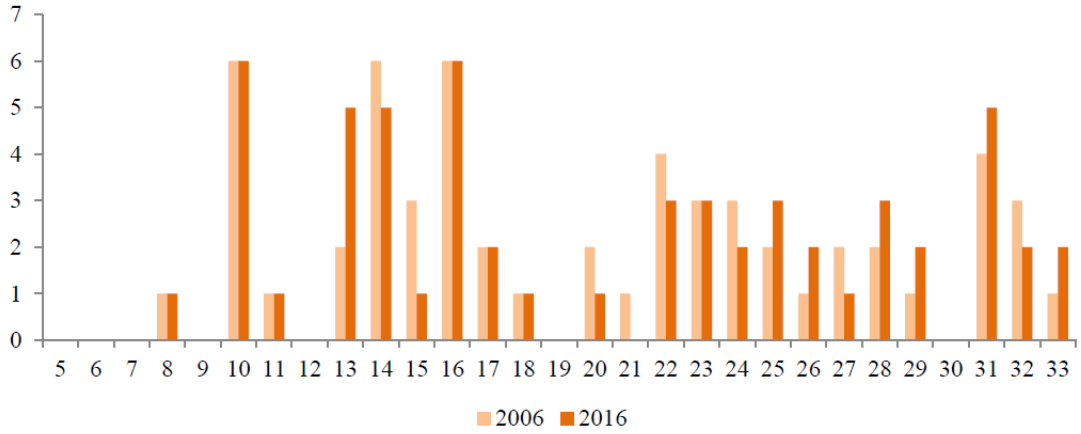
It was a methodological choice to disregard the relationship of spatial association of the High-Low type, in order to highlight those regions that presented expansion of the activities of an industrial sector to neighboring municipalities, incurring locational competitive advantages in these LPAs, thus considering their evolution in terms of growth and development, the central theme of this work.

4 Results and Discussions

Based on the nCI calculation, Global and Local Moran's I, following the proposed filters, it was possible to identify the industrial LPAs in Paraná, in the period from 2006 to 2016, in each of the 29 sectors analyzed. As shown in Figure 1, which shows the evolution of the number of LPAs in the analyzed period, the CNAEs that had an evolution in the number of LPAs were: (13) manufacture of textile products; (25) manufacture of metal products, except machinery and equipment; (26) manufacture of computer equipment, electronic, and optical products; (28) manufacture of machinery and equipment; (29) manufacture of motor vehicles, trailers, and bodies; (31) manufacture of furniture; and (33) maintenance, repair, and installation of machinery and equipment.

In contrast, the CNAEs that decreased in the number of LPAs were: (14) manufacture of wearing apparel and accessories; (15) preparation of leather and manufacture of leather goods, travel goods, and footwear;

Figure 1: Number of LPAs identified in each industrial sector in 2006 and 2016.



Source: Research results.

(20) manufacture of chemical products; (21) manufacture of pharmochemical, chemicals and pharmaceuticals; (22) manufacture of rubber products and plastic material; (24) metallurgy; (27) manufacture of machinery, equipment, and electrical material; (32) manufacture of various products. The other CNAEs kept the quantities of LPAs unchanged.

The choice of the period from 2006 to 2016 was sufficient to understand how the evolution of the identified LPAs occurred, being possible to verify three situations:

1. LPAs that were identified in 2006 showed growth both in the number of companies and in territorial coverage, incorporating companies from neighboring municipalities until 2016;

2. LPAs that had the participation of many companies and neighboring municipalities, but over time showed a drop in the number of companies, or in the participation of companies from neighboring municipalities, or even ceased to exist;

3. LPAs that have been identified in a certain region, but over time have ceased to exist. However, another region that previously did not have LPAs from the same industrial activity identified the presence of APLs. In other words, industrial concentration has emerged in another region in recent years that had not yet shown signs of the formation of LPAs.

A relevant point to be highlighted is the convergence of the identification aspects verified between this work and the works of Rodrigues et al. (2012), IPARDES (2009), IPARDES and SEPL (2005b,c), once the LPAs identified in these works were also identified in this research. Nonetheless, with the difference of verifying a higher number of LAPs, especially when compared with the studies of IPARDES and SEPL, which have a similar scope, a total of 25 identified by this last study mentioned against 57 identified in this research. This difference is justified on two grounds: the evolution and appearance of new productive activities, as well as the reduction of other activities; and the methodological aspect of considering the LPA beyond the political frontier of the municipality, which ends up enabling a new set of activities.

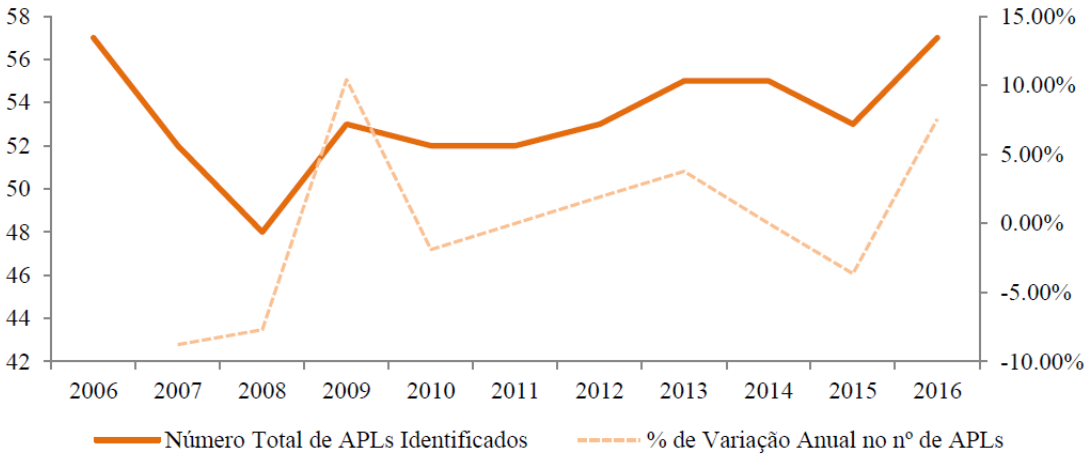
The industrial activities that had the highest incidence of LPAs in the state, were: manufacture of food products; manufacture of textile products; manufacture of wearing apparel and accessories; manufacture of wood products; manufacture of rubber products and plastic materials; manufacture of metal products, except machinery and equipment; manufacture of machinery and equipment; and finally, manufacture of furniture. Each of these activities presented at least three LPAs in 2016.

The industrial activities in which LPAs have not been identified, being the CNAEs 5, 6, 7, 9, 12, and 19, refer to sectors naturally constituted by a small number of companies, ranging from medium to large, which maintain production highly concentrated in the smallest number of companies possible, and for this reason

they did not pass through the filters proposed in the methodology. CNAE 30 passed the filter only in the years 2013, 2014, and 2015, and did not present the constitution of an LPA in the other years.

Regarding the evolution of the number of LPAs identified in the period, as shown in Figure 2, it is possible to highlight the sharp drop in this number between the years 2008 and 2009, which among other factors may be a consequence related to the global economic crisis, experienced in this period, arising from the financial crisis in the United States. After this period, there was an increase in the number of LPAs until the year 2013, in which a slight fall is taking place, a movement that is quite characterized by the conjuncture of the national industry, which since mid-2011 has suffered a recent slowdown in terms investment.

Figure 2: Evolution of the total number of LPAs identified between 2006 and 2016.



Source: Research results.

This reflected in the form of contraction of industrial production, which led to the closing of a significant contingent, of approximately 13.8 thousand establishments according to IBGE (2017), throughout the country. The growth seen between 2009 and 2016 was, therefore, a recovery in terms of the increase in the number of LPAs, since in 2016 the exact number of LPAs identified in 2006 is equaled.

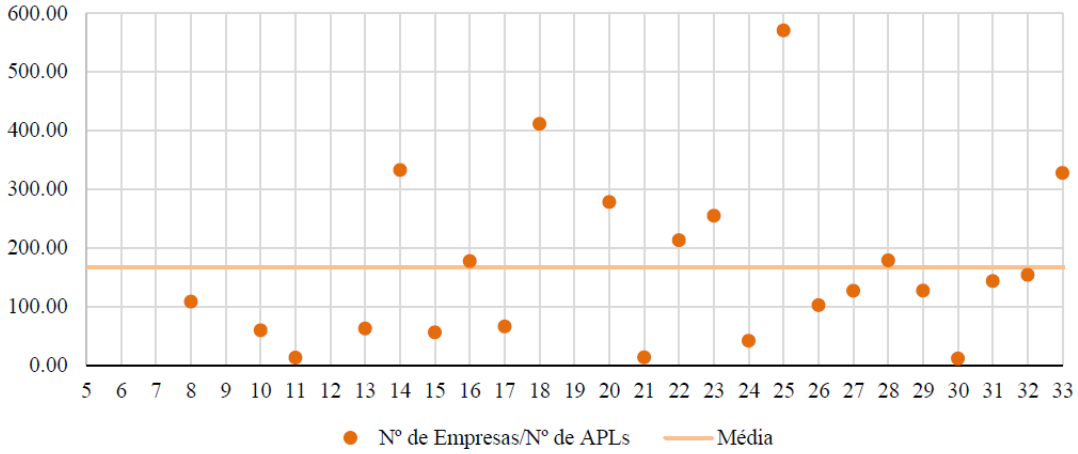
Regarding the number of companies that make up the LPAs, as shown in Figure 3, it was found that only a total of nine LPAs had an average positioning (total number of companies in all years in the sector divided by the total number of LPAs identified in all years in the sector) higher than the global average of companies per LPA of the verified industrial sectors. This fact indicates that these LPAs, listed: 14, 16, 18, 20, 22, 23, 25, 28, and 33, were the ones that increased in number of companies over the analyzed period.

Regarding the spatial distribution of the identified LPAs (Figure 4), the presence of LPAs from different sectors in the same municipality was verified, some of which presented complementary activities such as the manufacture of textile products and manufacture of wearing apparel and accessories; the manufacture of machinery and equipment, and maintenance, repair and installation of machinery and equipment; and manufacture of furniture and wood products.

The metropolitan region of Curitiba and the North Central region are the regions where the highest volume of LPAs were identified, mainly in the municipalities surrounding Curitiba and Londrina. This is due to the fact that these regions have a very diversified productive structure, presenting agglomerations of companies in various sectors analyzed, such as in the printing and reproduction of recorded media; manufacture of rubber products, plastic material, chemicals, metal products, vehicles motor vehicles; and manufacture and maintenance of machinery and equipment.

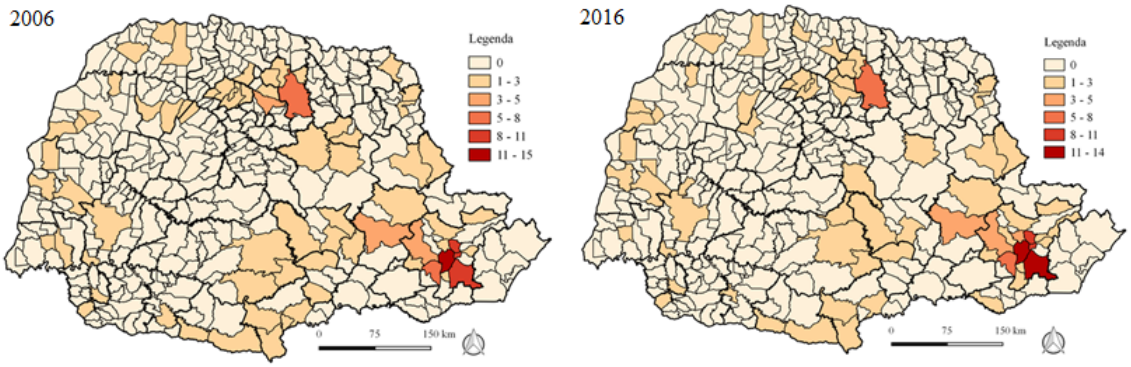
In turn, the western region is strong in the manufacture of food products and agricultural machinery and equipment; and in the southern region of the state, the predominant activity is the manufacture of furniture and wood. In the textile and clothing activities, several municipalities stood out, belonging to the Northwestern, North Central and Southwestern regions of the state. There is a gap in industrial activity

Figure 3: Average rate of volume of companies per LPA in CNAEs 5 to 33, between 2006 and 2016.



Source: Research results.

Figure 4: Municipalities with the presence of LPAs in the years 2006 and 2016.



Source: Research results.

and, consequently, in the formation of LPAs in the Central and North Pioneer regions, which predominated throughout the analyzed period.

The verified results converge with the other studies that analyzed LPAs for the southern region of the country and for Paraná itself, where the regions of Londrina and Curitiba are highlighted in the occurrence and deepening of productive agglomerations. Regarding the main productive agglomerations identified by the literature, in the works of Sobrinho and Azzoni (2014), Paschoalino et al. (2019), Vidigal et al. (2014), Raiher and Candido (2018) there is a persistence of the occurrence of agglomerations in the textile and wearing apparel, food and beverage, wood and furniture, metal mechanics, and plastics and rubber, including CNAEs, 10, 11, 13 , 14, 16, 22, 23, 25, 28, and 31, which are close to those highlighted as above the state average in Figure 3.

Due to the evidence of these activities, an overview of the number of municipalities and companies in these identified LPAs was presented below. In textile manufacturing, in 2006, 2 LPAs were identified: 116 companies in Londrina and Apucarana and another with 10 companies in Astorga. In 2016, 6 LPAs were consolidated, with 51 companies from Cianorte, 28 from Pérola, 14 from São José dos Pinhais, and 12 from Ponta Grossa.

In the manufacture of wearing apparel and accessories, 6 LPAs were identified in 2006, with 41 companies

from the municipalities of Santo Antônio do Sudoeste and Ampére; 139 from Terra Roxa, Altônia, Pérola, and Xambrê; 491 from Cianorte, Jussara, and Terra Boa; 611 from Paiçandu, Maringá, Sarandi, and Astorga; 701 from Apucarana and Londrina; and 30 from Carlópolis and Siqueira Campos.

In 2016, 5 LPAs were identified, 72 companies from Antônio do Sudoeste and Ampére, an increase of 75% in number of companies; 213 from Terra Roxa, Altônia, Pérola, and São Jorge do Patrocínio, with an increase of 53%; 384 from Paiçandu and Maringá, representing a 42% drop in the number of companies that formed this APL; 774 from Apucarana and Londrina and 44 from Carlópolis and Siqueira Campos.

There was a spillover effect in the Northwestern and Western region, felt in the Terra Roxa Baby Fashion LPA IPARDES (2009), which became an important agglomeration to stimulate local development, especially in the generation of employment, being its influence perceived in neighboring municipalities and the growth in the number of companies. There was a dispersion of sewing activities in the surroundings of Cianorte, which specialized in textile activities.

In food manufacturing, 6 LPAs were identified in 2006, comprising 162 companies belonging to Cascavel, Toledo, and Marechal Cândido Rondon; 24 from the municipalities of Medianeira and Matelândia; 59 belonging to Terra Rica and Paranavaí, 13 from Tapejara, 37 from Rolândia and 18 from Jacarezinho. In 2016, 6 LPAs were formed, 76 companies from Cascavel, Cafelândia, Toledo, Maripá, and Marechal Cândido Rondon; 23 from Medianeira; 15 from Itapejara d'Oeste; 62 from Paranavaí; 12 from Colorado; and 45 from the municipalities of Jaguapitã and Rolândia. In the LPA of Toledo and region the spillover effect is observed for the municipalities surrounding the concentration verified in 2006.

For the manufacture of beverages, in the period, only Curitiba companies formed an LPA, comprising 18 companies in 2006, with a drop to 13 companies in 2016. For the manufacture of wood products, 6 LPAs were identified in 2006, mainly in the South region of the state. The 27 companies from Tunas do Paraná formed LPAs; 89 from Sengés and Jaguariaíva; 63 from Curiúva and Telêmaco Borba; 204 from Ponta Grossa, Teixeira Soares, Ipiranga, Imbituva, and Irati; 138 from Guarapuava, Pinhão, and Inácio Martins; 306 from Clevelândia, Palmas, General Carneiro, Bituruna, Porto Vitória, União da Vitória, and Mallet.

For 2016, the formation of 6 LPAs was maintained, located in the same regions, with a slight change in their composition: 17 companies from Tunas do Paraná, representing a 37% drop in the number of companies; 66 companies from Sengés and Jaguariaíva; 46 from Telêmaco Borba; 61 from Ponta Grossa; 246 from Guarapuava, Inácio Martins, and Turvo that overflowed to the municipalities of Imbituva, Prudentópolis, and Irati; and, 229 companies from Clevelândia, Palmas, General Carneiro, Bituruna, and União da Vitória. The LPAs for metal furniture in Ponta Grossa and the wood and window frames of União da Vitória, classified as nuclei of sector-regional development by IPARDES and SEPL (2005a), had a drop in the formation of new companies, together with the LPAs of Tunas do Paraná, Jaguariaíva, and Telêmaco Borba. The Ponta Grossa LPA also reduced its territorial coverage, while the Guarapuava LPA presented the spillover effect with the participation of companies from the municipalities in the region.

In the manufacture of furniture, 4 LPAs were identified in 2006, namely: 12 companies from Douradina; 19 from Capitão Leônidas Marques; 50 from Sarandi; and 301 from Arapongas, Rolândia, Londrina, and Cambé. In 2016, 5 LPAs were identified, in which the 11 companies in Araruna appear as APLs; Captain Leônidas Marques maintained its formation for the entire period, presenting 18 companies; Douradina with 21 companies. The LPA present in Sarandi in 2006 expanded, being formed in 2016 by 268 companies from Sarandi and Maringá. Finally, the LPA present in the microregions of Londrina and Apucarana also expanded its activities, being composed in 2016 by 426 companies from Sabáudia, Arapongas, Rolândia, Londrina, and Cambé. The 23 companies in Sabáudia started to compose the LPA in 2007.

For the manufacture of rubber products and plastic material, 4 LPAs were identified, namely: an LPA in the microregion of Londrina, comprising 18 companies from Cambé, 11 from Ibiporã, and 86 from Londrina; LPA formed by 67 companies from Maringá; LPA composed of 14 companies from Mandaguari; and, finally, LPA formed by 19 companies from Campo Largo, 23 from Araucária, 210 from Curitiba, 60 from São José dos Pinhais, 74 from Pinhais, 29 from Colombo, and 11 from Quatro Barras, totaling 426 companies from 7 municipalities in the microregion of Curitiba, each of which owned more than 80% of micro and small companies.

In 2016, 3 LPAs were identified, namely: LPA composed of 64 companies from Maringá and 15 from Marialva, municipalities belonging to the microregion of Maringá; LPA formed by 67 companies from Lond-

rina, 22 from Cambé and 41 from Arapongas, municipalities in the microregion of Londrina and Apucarana; LPA formed by 12 companies from Mandirituba, 29 from Araucária, 164 from Curitiba, 74 from São José dos Pinhais, 80 from Pinhais, 39 from Colombo, 11 from Almirante Tamandaré, and 15 from Campina Grande do Sul, totaling 424 companies from 8 municipalities in the microregion of Curitiba. All continued with the base of composition of micro and small companies.

In the manufacture of metal products, except machinery and equipment, 2 LPAs were identified in 2006, formed by 173 companies from Londrina and 1,048 companies from Curitiba, Pinhais, Araucária, Colombo, São José dos Pinhais, Campo Largo, Almirante Tamandaré, and Fazenda Rio Grande. 3 LPAs were identified in 2016, comprising 201 micro and small companies in Londrina, an increase of 12% in the number of companies. The LPA in the microregion of Curitiba was maintained, being formed by 1,289 companies from Curitiba, Araucária, Pinhais, Colombo, São José dos Pinhais, Almirante Tamandaré, and Fazenda Rio Grande. And as from 2007, an LPA was identified in Loanda, ending 2016 with 44 companies and with an increase in companies verified with each passing year – also identified by IPARDES and SEPL (2005a).

For the manufacture of non-metallic mineral products (CNAE 23), in 2006, 3 LPAs were identified, namely: 27 companies from Ortigueira and Sapopema; 51 from Prudentópolis, and 563 from Campo Largo, Rio Branco do Sul, Colombo, Almirante Tamandaré, São José dos Pinhais, Curitiba, Balsa Nova, Araucária, and Fazenda Rio Grande.

In 2016, 3 LPAs were maintained, but with a different composition: 96 companies from Cândido de Abreu and Prudentópolis; 12 from Rio Negro; and 655 from Colombo, São José dos Pinhais, Rio Branco do Sul, Almirante Tamandaré, Curitiba, Campo Largo, Balsa Nova, Araucária, Castro, Pinhais, and Campo Magro. The LPA present in Ortigueira and Sapopema ceased to exist as of 2015. The Prudentópolis LPA overflowed its activities to companies in the municipality of Cândido de Abreu since 2010 and the APL in the microregion of Curitiba showed a spillover effect for the municipality of Castro.

In the manufacture of machinery and equipment in 2006, 2 LPAs were identified, comprising 21 companies from Loanda and 340 companies from Araucária, Curitiba, Pinhais, Colombo, and São José dos Pinhais. In 2016, 3 LPAs were identified, being 70 companies from Toledo and 45 from Loanda, an increase in the number of companies compared to 2006; and 483 companies from Curitiba, Araucária, Pinhais, Colombo, Campo Largo, and São José dos Pinhais; the latter having an overflow effect for the municipality of Campo Largo.

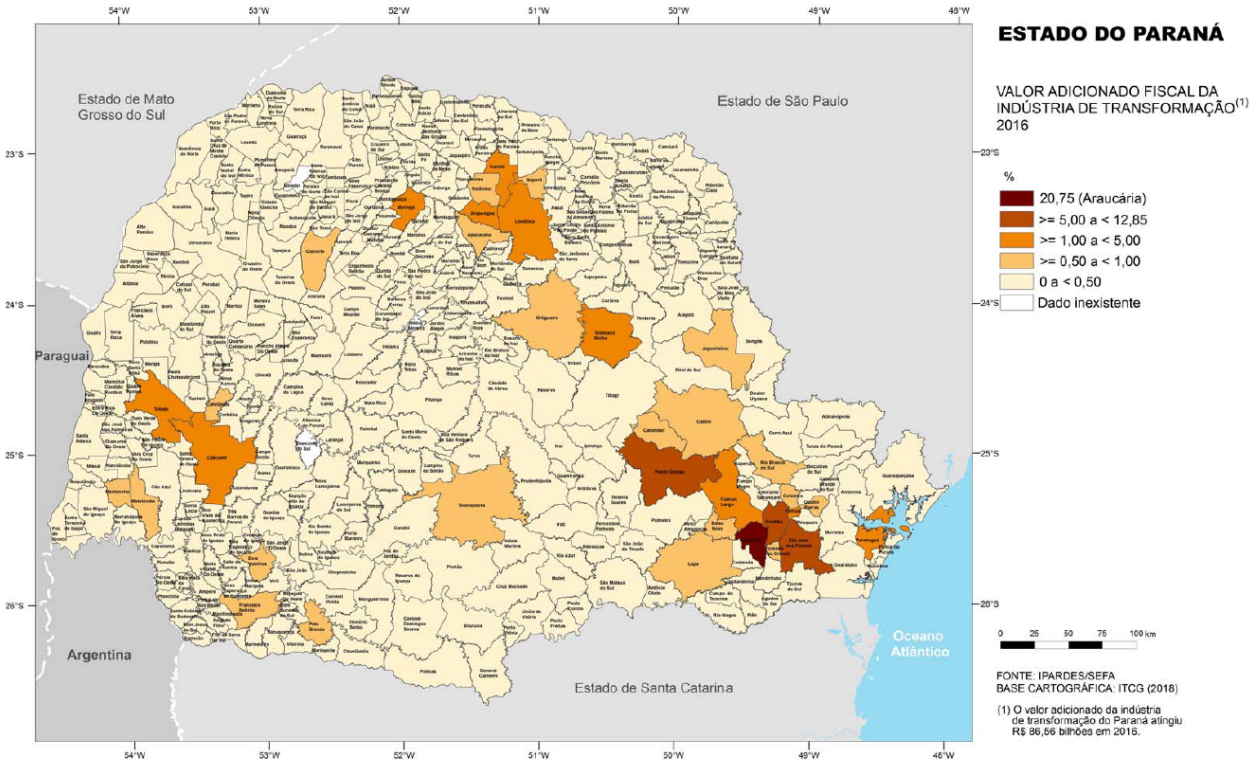
The EASD application was fundamental to incorporate the existing spatial effect in the productive relations, making the analysis of the concentration index of industrial activities more consistent and in accordance with the theoretical precepts of identification of LPAs. In this way, it was possible to verify the existence of LPAs that covered areas of more than one municipality and also in municipalities of different microregions. This result was expected precisely due to the proposal to apply this methodology, overcoming the gaps of other methods that needed to delimit a specific territorial unit for the identification of LPAs.

In addition to the proposed analysis, the Value-Added Tax (VAT) of the manufacturing industry was verified in 2016, already mapped by IPARDES (2019) (Figure 5). The VAT is an economic-accounting indicator that shows the participation of the municipality in the contribution to the state of the following taxes: The Brazilian tax on the circulation of goods, interstate and intercity transportation and communication services (ICMS) and The Brazilian Tax on Industrial Products (IPI), which means that the greater the economic flow and the greater volume of industries in the municipality, the greater its VAT will tend to be.

It is possible to see, clearly, that the denser productive agglomerations, which have evolved, and the significant ones shown by the LISA indicator are positioned in the same regions and in most of the main municipalities mentioned, which makes the analysis very close to the analyzed reality. In addition, the VAT data reinforce the overflow movement of productive activities to municipalities in the vicinity of densely populated municipalities, identified with LPAs.

Due to the high number of industrial sectors analyzed, the specificities of each of the LPAs to clearly verify the level of cooperation and interaction between economic agents and the level of productivity and innovation of the industries need to be analyzed in loco and complemented based on published studies on some specific LPAs, in order to seek more information to build a more robust analysis of the reality experienced in the LPAs identified by this study. In addition, it is worth mentioning that the analysis of secondary data is not

Figure 5: Value-Added Tax (VAT) of municipalities in Paraná in 2016.



Source: IPARDES (2019).

sufficient to verify these particularities, even though they are fully valid and relevant.

Even with the analysis of several sectors and the determination of a scientifically proven methodology, this work is configured as initial, since there was the investigation of a first step when analyzing the LPAs, which was their identification. It is possible in future work to relate the presence of LPAs with the level of growth and development of the regions.

In the light of theory, these activities can be considered relevant, especially to the development and growth of the regions, as explained by Hirschman (1958), the planning for directing public and private investments in them can lead to a more homogeneous development, because, as seen, the evolution of the concentration of activities between 2006 and 2016 demonstrates heterogeneity between the regions, both in terms of activities and in variations in the volume of companies and displacement of business concentration between them.

5 Conclusion

The aim of this work was to analyze the evolution of industrial LPAs in the state of Paraná over the period from 2006 to 2016. The methodology used was the construction of the nIC, from the PCA, combined with ESDA and LISA indicators, as well as the filters applied to identify the productive agglomerations of the 27 economic sectors of the extractive and manufacturing industry. This method proved to be effective and robust, showing important results in the evolution of LPAs.

Over the period of analysis, 57 LPAs were identified. In some sectors, these LPAs are very similar to the one verified by the current literature; however, it was possible to identify new LPAs, not yet studied and that can be elements of development policies, aiming at their development. At least one LPA formation was found in all the industrial sectors analyzed – a very positive sign when one believes in this productive

structure as a dynamizer of the local and regional development process.

The evolution of the LPAs identified since 2006 became evident, with the apparent consolidation of several of them over time, explained by the growth in the number of companies and municipalities. The most dynamic regions in terms of diversified productive structure –Metropolitan Region of Curitiba and North Central – were those that presented the largest number of LPAs in several economic sectors. Regarding the growth in the number of companies, 9 sectors performed above the average between 2006 and 2016.

LPAs were identified in more than one municipality and that belong to different microregions, making the consideration of spatial autocorrelation between regions relevant. It is suggested to apply this method in other economic sectors or in smaller locational and sectoral cuts, to identify LPAs in some strategic or interest area. The final contribution of this study is to promote an extension of the studies carried out until 2008, to guide the movement of consolidation of these productive arrangements and strategic sectors and to signal the gaps liable to act in terms of planning.

There is a movement of concentrated deconcentration in which the local industries have overflowed their activities to the surroundings where the concentration of the productive activity arose, the most explicit cases for Paraná are Curitiba and Londrina. Two points that stand out in terms of public policies are: the productive void that is imposed in the areas of non-concentrated production, and in some way the dependency relationship that is established by this inequality; and how to enable the effects of overflowing to reach a greater number of municipalities? We believe that the answers are in line with regional economic planning and in the promotion of policies that allow the advancement of productive activities and their strengthening and consolidation throughout their territory.

This reflection was proposed to show that the LPAs were emerging and consolidating over the analyzed period, but that in some cases they did not enjoy the institutional support of previous periods, from mid-2004 to 2008, when they were thought of as a tool to promote development. In this sense, some limitations of the research and possibilities for future studies are the insertion of the analysis of new variables, such as the physical production of the industry, export volume, export destination countries, fiscal aggregate value, aggregate value of industrial production, among others, and thus determine the intrinsic characteristics of the LPAs, compiling this information in the dimensions of Porter's "diamond" Porter (1999).

References

Almeida, E. (2012). Econometria espacial. *Campinas–SP. Alínea*.

Anselin, L. (1995). Local indicators of spatial association—LISA. *Geographical analysis*, 27(2):93–115.

Anselin, L. (1996). *The Moran scatterplot as an ESDA tool to assess local instability in spatial association*. Routledge.

Anselin, L. (1999). Interactive techniques and exploratory spatial data analysis. In Longley, P. A., e. a., editor, *Geographic information system: principles, techniques, management and applications*, chapter sn, pages 251–264. John Wiley, New York.

Azzoni, C. R. (1986). *Indústria e reversão da polarização no Brasil*. Instituto de Pesquisas Econômicas.

Becattini, G. (1999). Os distritos industriais na itália. *Empresários e empregos nos novos territórios produtivos: o caso da terceira Itália. Rio de Janeiro: DP&A*, pages 45–58.

BNDES (2009). Os arranjos produtivos locais no paraná: mapeamento, metodologia de identificação e critérios de seleção para políticas de apoio. Technical report, BNDES - BANCO NACIONAL DE DESENVOLVIMENTO ECONÔMICO E SOCIAL.

Brito, E. P. Z., Brito, L. A. L., Porto, E. C., and Szilagyi, M. E. (2010). A relação entre aglomeração produtiva e crescimento: a aplicação de um modelo multinível ao setor industrial paulista. *Revista de Administração Contemporânea*, 14:615–632.

Cassiolato, J. E. and Lastres, H. M. (2003). O foco em arranjos produtivos e inovativos locais de micro e pequenas empresas. *Pequena empresa: cooperação e desenvolvimento local. Rio de Janeiro: Relume Dumará*, pages 21–34.

Cassiolato, J. E. and Szapiro, M. (2002). Arranjos e sistemas produtivos e inovativos locais no brasil. *Notas técnicas da fase II do Projeto "Proposição de políticas para a promoção de sistemas produtivos e inovativos locais de micro, pequenas e médias empresas brasileiras*.

Cavalcante, L. R. M. T. (2008). Produção teórica em economia regional: uma proposta de sistematização. *Revista brasileira de estudos regionais e urbanos*, 2(1).

Chain, C. P. (2014). Concentração espacial e aglomerações produtivas na indústria do café em minas gerais. *Dissertação - Programa de Pós-Graduação em Administração*.

CONCLA (2007). Documentação cnae 2.0: correspondência cnae 2.0 x isic 4.0. `https://cnae.ibge.gov.br/documentacao/documentacao-cnae-2-0.html`. Online; accessed 08-August-2021.

Crocco, M. A., Galinari, R., Santos, F., Lemos, M. B., and Simões, R. (2006). Metodologia de identificação de aglomerações produtivas locais. *Nova economia*, 16:211–241.

Crocco, M. A., Galinari, R., Santos, F., Lemos, M. B., Simões, R., et al. (2003). Metodologia de identificação de arranjos produtivos locais potenciais. Technical report, Cedeplar, Universidade Federal de Minas Gerais.

Ehrnberg, E. and Jacobsson, S. (1997). Technological discontinuities and incumbents' performance: an analytical framework. *Edquist, C., Systems of innovation, Pinter, London and Washington*, pages 318–341.

Filgueiras, G. C., de Santana, A. C., Homma, A. K. O., Herreros, M. M. A. G., de Barros, P. L. C., and Mendes, F. A. T. (2008). Arranjos produtivos locais no estado do pará: localização espacial das atividades florestal e de madeira e mobiliário. *Embrapa Amazônia Oriental-Artigo em periódico indexado (ALICE)*.

Fingleton, B., Camargo Igliori, D., and Moore, B. (2004). Employment growth of small high-technology firms and the role of horizontal clustering: evidence from computing services and r&d in great britain, 1991-2000. *Urban Studies*, 41(4):773–799.

Fuini, L. L. (2013). Os arranjos produtivos locais (apls): uma breve explanação sobre o tema. *GeoTextos*, 9(2).

Fujita, M., Krugman, P. R., and Venables, A. (1999). *The spatial economy: Cities, regions, and international trade*. MIT press.

Hirschman, A. (1958). Estratégia do desenvolvimento econômico. rio de janeiro: Fundo de cultura, 1961. *Publicação original: The Strategy of Economic Development, New Haven: Yale University Press*.

Hongyu, K., Sandanielo, V. L. M., and de Oliveira Junior, G. J. (2016). Análise de componentes principais: resumo teórico, aplicação e interpretação. *E&S Engineering and science*, 5(1):83–90.

IBGE (2017). Pesquisa industrial anual empresa 2017. `https://www.ibge.gov.br/estatisticas/economicas/industria/9042-pesquisa-industrial-anual.html?=&t=o-que-e`. Online; accessed 05-December-2017.

IBGE (2019). Classificação nacional de atividades econômicas - cnae. `https://concla.ibge.gov.br/busca-online-cnae.html?view=estrutura`. Online; accessed 05-December-2019.

IPARDES (2009). Identificação e mapeamento das aglomerações produtivas do paraná: atualização 2008. Technical report, IPARDES - INSTITUTO PARANAENSE DE DESENVOLVIMENTO ECONÔMICO E SOCIAL.

IPARDES (2019). Valor adicionado fiscal dos municípios paranaenses: atualização 2016. `http://www.ipardes.gov.br/index.php?pg_conteudo=1&cod_conteudo=28`. Online; accessed 20-December-2019.

IPARDES and SEPL (2005a). Identificação, caracterização, construção de tipologia e apoio na formulação de políticas para os arranjos produtivos locais (apls) do estado do paraná: etapa 1 - identificação, mapeamento e construção da tipologia das aglomerações. Technical report.

IPARDES and SEPL (2005b). Identificação, caracterização, construção de tipologia e apoio na formulação de políticas para os arranjos produtivos locais (apls) do estado do paraná: etapa 2 - pré-seleção das aglomerações produtivas e mapeamento dos ativos institucionais. Technical report, IPARDES, Instituto Paranaense de Desenvolvimento Econômico e Social e SEPL, Secretaria de Estado do Planejamento e Coordenação Geral.

IPARDES and SEPL (2005c). Identificação, caracterização, construção de tipologia e apoio na formulação de políticas para os arranjos produtivos locais (apls) do estado do paraná: etapa 3 - caracterização estrutural preliminar dos lpas pré-selecionados e notas metodológicas. Technical report, INSTITUTO PARANAENSE DE DESENVOLVIMENTO ECONÔMICO E SOCIAL e SECRETARIA DE ESTADO DO PLANEJAMENTO E COORDENAÇÃO GERAL.

IPEA (2006). Identificação, mapeamento e caracterização estrutural de arranjos produtivos locais no brasil. Technical report, IPEA - INSTITUTO DE PESQUISA E ECONOMIA APLICADA.

Krugman, P. R. (1997). *Development, geography, and economic theory*, volume 6. MIT press.

Lipietz, A. and Leborgne, D. (1988). O pós-fordismo e seu espaço. *Espaço e debates*, 25:12–29.

Maillat, D. (1995). Ambientes inovadores e dinâmica territorial. *economia industrial e 'e economia espacial*, pages 213–231.

Markusen, A. et al. (1995). Áreas de atração de investimentos em um espaço econômico cambiante: uma tipologia de distritos industriais. *Nova economia*, 5(2):9–44.

Marshall, A. (1890). *Principles of Economics*. Nova Cultural Ltda.

Moran, P. A. (1948). The interpretation of statistical maps. *Journal of the Royal Statistical Society. Series B (Methodological)*, 10(2):243–251.

Oreiro, J. L. (2017). A grande recessão brasileira: diagnóstico e uma agenda de política econômica. *Estudos Avançados*, 31:75–88.

Paschoalino, P. A. T., Parré, J. L., and Rodrigues, M. A. (2019). Evolução das aglomerações produtivas da indústria de alimentos e bebidas na região sul. *Revista Brasileira de Estudos Regionais e Urbanos*, 13(1):119–140.

Pinheiro, A. M., Sobreira, L. M. G., and Rapini, M. S. (2008). Aglomerações produtivas no estado do pará: uma proposta de análise para a construção civil. *Revista Brasileira de Gestão e Desenvolvimento Regional*, 4(1).

Porter, M. E. (1999). *Competição: estratégias competitivas essenciais*. Gulf Professional Publishing.

Puga, F. P. (2003). Alternativas de apoio a mpmes localizadas em arranjos produtivos locais. *Texto para Discussão 99*.

Raiher, A. P. and Candido, M. J. (2018). Aglomerações produtivas da região sul do brasil e sua relação com a produtividade industrial. *Revista Brasileira de Estudos Regionais e Urbanos*, 12(1):17–34.

RAIS (2019). Rais estabelecimento e vínculos. *RELAÇÃO ANUAL DE INFORMAÇÕES SOCIAIS- MTE-MINISTÉRIO DO TRABALHO*.

Rodrigues, M. A., Monteiro, W. d. F., Campos, A. C. d., and Parré, J. L. (2012). Identificação e análise espacial das aglomerações produtivas do setor de confecções na região sul. *Economia aplicada*, 16:311–338.

Santos, G. A. G. d., Diniz, E. J., and Barbosa, E. K. (2004). *Aglomerações, Arranjos Produtivos Locais e Vantagens Competitivas Locacionais*. Banco Nacional de Desenvolvimento Econômico e Social, Rio de Janeiro.

Sobrinho, E. M. G. and Azzoni, C. R. (2014). Aglomerações industriais relevantes do brasil. *TD NEREUS: Núcleo de Economia Regional e Urbana da Universidade de São Paulo–USP, São Paulo*.

Storper, M. (1994). Desenvolvimento territorial na economia global do aprendizado: o desafio dos países em desenvolvimento. *Globalização, fragmentação e reforma urbana: o futuro das cidades brasileiras na crise. Rio de Janeiro: Civilização Brasileira*, 1.

Suzigan, W., Furtado, J., Garcia, R., Sampaio, S., et al. (2003a). Sistemas locais de produção: mapeamento, tipologia e sugestões de políticas. *Encontro nacional de Economia*, 31:39–60.

Suzigan, W., Furtado, J., Garcia, R., and Sampaio, S. E. (2003b). Coeficientes de gini locacionais–gl: aplicação à indústria de calçados do estado de são paulo. *Nova Economia*, 13(2).

Vidigal, V. G., Vignandi, R. S., and de Campos, A. C. (2014). Evolução dos arranjos produtivos locais (apl) de confecção do estado do paraná nos anos 2000. *Revista Brasileira de Estudos Regionais e Urbanos*, 8(1):54–76.