Revista Portuguesa de Estudos Regionais, nº 71 2025, 19 - 28

Artigo submetido a 15 de novembro 2024; versão final aceite a 10 de janeiro de 2025
Paper submitted on November 15, 2024; final version accepted on January 10, 2025
DOI: https://doi.org/10.59072/rper.vi71.736

Opportunities and Agglomeration Forces in the Automotive and Auto Parts Industry in Mexico in the Presence of Chinese Companies

Oportunidades y Fuerzas de Aglomeración en la Industria Automotriz y de Autopartes en México Ante la Presencia de Empresas Chinas

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Abstract

Mexico has emerged as one of the world's leading producers and exporters of vehicles. With the entry into force of the USMCA, an increase in North American regional content in the automotive industry is expected, presenting an opportunity to boost technology transfer and the development of local capabilities. The automotive and auto parts industry (AAI) in Mexico exhibits spatial concen-tration patterns, generating agglomeration economies linked to knowledge spillovers, specialized labor, local inputs, and urbanization economies. However, few studies have analyzed these forces with a high level of territorial disaggregation, particularly regarding the presence of Chinese com-panies in the sector. This study examines the existence of agglomeration economies in the AAI across nine micro-regions in Mexico, home to 13 Chinese companies. Using kernel density maps and global and local autocorrelation indices, the analysis explores their local and regional impact. The findings provide evidence of agglomeration economies in five regions, with a trend toward further growth.

Keywords: Economic density, Localization economies, Urbanization economies, Sectorial analysis, Spatial analysis.

JEL codes: C81, R12, L60, O18.

Resumen

México se ha posicionado como uno de los principales productores y exportadores de vehículos a nivel mundial. Con la entrada en vigor del T-MEC, se espera un aumento en el contenido regional norteamericano en la industria automotriz, lo que representa una oportunidad para impulsar la transferencia de tecnología y el desarrollo de capacidades locales. La industria automotriz y de autopartes (IAA) en México muestra patrones de concentración espacial, generando economías de aglomeración vinculadas a externalidades de conocimiento, trabajadores especializados, insumos locales y economías de urbanización. Sin embargo, existen pocos estudios que analicen estas fuerzas con alto nivel de detalle territorial, especialmente en relación con empresas chinas en el sector. Este trabajo examina la presencia de economías de aglomeración en la IAA en nueve micro-regiones mexicanas, donde operan 13 empresas chinas. A través de mapas de densidad kernel e índices de autocorrelación global y local, se verifica su impacto local y regional. Los resultados evidencian economías de aglomeración en cinco regiones, con una tendencia creciente.

Palabras clave: Densidad económica, Economías de localización, Economías de urbanización, Análisis sectorial, Análisis espacial.

Códigos JEL: C81, R12, L60, O18

1. INTRODUCTION

The auto parts and automotive industry (AAI) has undergone major restructuring processes following the 2009 crisis, which is shown by an increase in the participation of Asian companies in world production (Alvarez-Medina et al., 2014; Basurto-Alvarez et al., 2013). Industry based on the North American common market (Mexico, United States and Canada) was strengthened by the North American Free Trade Agreement (NAFTA). In 2018, intra-manufacturing trade linked to the NAFTA participating countries of the AAI was equivalent to 39% of the sectorial trade in the region (Ortiz-Velásquez, 2019).

Mexico has become one of the world's leading vehicle producers and exporters (Álvarez-Medina et al., 2014), where the manufacture of transportation equipment corresponds to a fifth of this country´s gross domestic product in the first quarter of 2020 (INEGI, 2019). Although the presence of Chinese investment in Mexico is still marginal in this sector, it showed a faster growth in 2017 and 2018.

After signing the Mexico-United States-Canada Agreement (T-MEC), which updates NAFTA, the value of regional content is expected to increase in the most important segments of the AAI, where China is considered a threat to the United States. Without making it explicit, T-MEC seeks to contain China's advance in North America. China´s increased presence in the AAI sector provides an opportunity for this industry in Mexico to contribute to technology transfer and local capacity building, a scenario in which an active industrial policy plays a key role (Ortiz-Velásquez, 2019).

One of the features that distinguishes economic activity, and particularly manufacturing, is its spatial concentration (Asuad, 2007; Isaac-Egurrola, 2012; Isaac-Egurrola & Quintana, 2012). In fact, this feature is particularly intense in the case of the automotive industry, which in Mexico only 5 of its 32 states concentrated more than half of the sector´s value added in 2018 (INEGI, 2019).

The causes of the spatial concentration of manufacturing and the location decisions of companies are closely related and are part of the studies of disciplines such as economic geography and urban and regional economics (Capello, 2007; Fischer & Nijkamp, 2014). The reasons explaining industrial agglomeration include local knowledge spillovers, concentration of specialized workers, and the presence of inputs (Hart, 2021), as well as the advantages derived from economies of scale and urbanization economies (McCann & Van Oort, 2009).

Localization economies are the company´s external economies resulting from the high use of local factors, which positively affect the group of local companies within the sector. In turn, urbanization economies are also external economies that have positive effects on the company and derive "from the savings of large-scale exploitation of agglomeration or the city as a whole and are therefore independent of the industrial structure" (McCann & Van Oort, 2009, p. 8).

There are several studies on the location patterns of manufacturing economic activities in Mexico; nevertheless, few have dealt with the location and agglomeration patterns of specific industries (Baylis et al., 2012; Gómez-Zaldívar, 2017; McCann & Van Oort, 2009). There are studies dealing with the location patterns of the aerospace industry (Flores et al., 2017) or the effects of agglomeration on the growth of the auto parts sector (Cota, 2021) However, despite the relevance and growth of the presence of Chinese companies in Mexico in this sector, we could not identify works with a high territorial disaggregation, which study the economic agglomeration forces around the presence of Chinese companies in Mexico in the AAI sector and in the T-MEC context.

The objective of this research is to analyze the presence of agglomeration economies in the auto parts and automotive industry in nine micro-regions of Mexico, where 13 Chinese companies in the sector are located. For this purpose, kernel density maps, as well as global and local spatial autocorrelation indices are used. The results indicate that there is evidence of agglomeration economies in the local environment of Chinese companies and that these have tended to increase. Together with political factors such as the renegotiation of trade agreements in North America and the strategy of Chinese companies to deal with it, this fact contributes to explaining the performance of the sector and, under certain conditions, could create opportunities to take advantage of technology transfer and regional development.

The rest of the article describes the sources of information and briefly discusses the methods used for identifying and evaluating agglomeration economies. The results obtained are then presented and analyzed, and in the last section, the conclusions and possible extensions of this research are discussed.

2. MATERIALS AND METHODS

2.1 Databases

The information to calculate the previously described instruments comes from the National Statistical Directory of Economic Units (DENUE in Spanish) (INEGI, 2019) published by the National Institute of Statistics and Geography (INEGI in Spanish). It contains information on the location of economic units and a they are classified by their line of business based on the North American Industry Classification System (NAICS). We used economic units of three activities at a four-digit level: 3361 Motor Vehicle Manufacturing, 3362 Motor Vehicle Body and Trailer Manufacturing, 3363 Motor Vehicle Parts Manufacturing.

The information on the economic units of those activities is georeferenced through points, so the kernel density maps are built according to such locations; meanwhile, the global and local autocorrelation statistics are calculated based on the count of economic units per spatial unit of the mentioned industries.

2.2 Spatial unit of analysis

The spatial units of analysis were delimited based on the location of 11 well-known companies in the auto parts and automotive sector: Minth, Sanhua Automotive, Beijing West Industries (BWI), JAC Motors, Hangzhou XZB México, Saargummi, Cheerson, AMI PPM, Key Safety Systems and Sonavox Electronics.

Based on the location of these companies, nine micro-regions were identified based on the methodological approach of the Center for Regional and Sustainable Urban Development Studies (CEDRUS) of the National Autonomous University of Mexico (UNAM), which groups the Mexican territory into homogeneous areas of local administrative units (Asuad, 2020). The set of nine micro-regions is made up of 100 local areas that cover an extension equivalent to 6.5% of the country´s territory.

The analysis of the spatial distribution of the industry in the nine micro-regions[1] of interest was carried out based on three spatial analysis techniques: heat maps with kernel density, Moran's spatial

[1] Aguascalientes, Saltillo, Chihuahua, Pachuca De Soto, Monterrey, Santiago De Querétaro, San Luis Potosí San Fernando y Huamantla.

correlation index and local indicators of spatial autocorrelation (LISA). Each of them is described below.

2.3 Location density with kernels and heat maps

Heat maps are graphical tools for identifying clusters based on kernel density estimation. Kernel density consists of the calculation of the "density of points in a neighborhood around each output raster cell, which represents the characteristics of the point distributions" (Lu & Cao, 2019). In other words, kernel density shows how dense the concentration of elements in a point-based area is. This instrument is a visual approach to detect industrial clusters associated with the emergence of agglomeration forces in the sector of interest.

The calculation of the kernel density for points is based on the classic work of Silverman (Silverman, 2018), in which the density is calculated as:

$$density = \frac{1}{(radius)^2}\sum_{i=1}^{n}\left[\frac{3}{\pi}\cdot pond_i\left(1-\left(\frac{dist_i}{radius}\right)^2\right)^2\right]$$

Where $i = 1, \ldots, n$ are the points considered for the density calculation, which should only be included in the sum if they fall within the neighborhood search radius (45 thousand meters in our case, $radius$, to identify concentrations at a national territorial scale. The variable $pond_i$ is a weighting of the importance of the points (it could usually be a value such as population), when $pond_i = 1$, each point is assigned the same relative importance, as was done here. Meanwhile $dist_i$ is the distance between reference point i and the reference location. The heat maps were produced with the support of the QGIS program (QGIS.org, 20122).

2.4 Global spatial autocorrelation with Moran's I

Spatial autocorrelation is "the functional relationship between the values adopted by an indicator in one area of space and in neighboring areas" (Chasco, 2004, p. 57). According to Anselin (Anselin, nd), Moran's I is one of the most common measures to detect global autocorrelation, that is, spatial correlation over the entire dataset. It is the variable expressed in deviations from the mean multiplied by the weighted mean value of the neighboring variable. Following Anselin's notation (2020), and if $z_i = x_i - \bar{x}$, the Moran statistic is:

$$I = \frac{\sum_i \sum_j w_{ij} z_i . z_j / S_0}{\sum_i z_n^2 / n}$$

Where w_{ij} is each of the elements of the weight matrix reflecting the neighborhood structure, in our case, we use a queen-type neighborhood structure of first order; meanwhile, $S_0 = \sum_i \sum_j w_{ij}$ is the sum of all the weights and n is the number of observations. Moran's I measures the degree of linear association between the variable of interest and the mean value of the neighboring variable. Moran's I is between positive and negative one. The global autocorrelation indices, Moran's I, were obtained using the GeoDa program (Anselin, 2009).

2.5 Local spatial autocorrelation

Moran´s global index evaluates a complete spatial pattern and does not provide information on the location of the clusters, in other words, it is a measure of global spatial autocorrelation. Anselin (1995) proposed the local version of Moran's I: *local indicator of spatial association* (LISA) to remedy this situation. This indicator provides a statistic for each location with a level of significance and establishes a proportional relationship between the local and the global statistic. This analytical approach allows to create cluster maps that characterize four types of local clusters: i) regions with signs of agglomeration, that is, clusters of spatial units with high values of the variable of interest surrounded by neighboring spatial units also with high values (High-High clusters); ii) depressed regions, that is, clusters of municipalities with a low value of the variable of interest surrounded by neighbors with the same characteristic (Low-Low clusters); iii) "empty" regions, that is, clusters of spatial units with low values surrounded by neighbors with high values (Low-High clusters); and

iv) isolated regions, that is, clusters of spatial units with a high value of the variable of interest surrounded by spatial units with a low value (High-Low clusters).

3. RESULTS AND DISCUSSION

3.1 Heat maps

In 2010, the highest density of AAI economic units was found in the municipality of Monterrey, in northeastern Mexico, and its surroundings, in the state or province of Nuevo León, the third largest urbanization in the country (Fig. 1). This is the most important cluster identified by using this instrument. The core overlaps with another cluster of lower density located in Saltillo and Ramos Arizpe, in the state of Coahuila, so we argue that it is a single cluster located in the northeast of Mexico.

Fig. 1. 2010 kernel density of AAI economic units. Source: based on INEGI (2019)- National Statistical Directory of Economic Units of 2010.

Three minor clusters were identified in central Mexico in 2010: one in Aguascalientes, another one in San Luis Potosí and the last one in Querétaro, which is the most intensive and extensive. Concentrations of much lower density are found near Matamoros, in Tamaulipas, specifically in the municipality called Valle Hermoso, as well as in Pachuca, Tlaxcala, Chihuahua and Puebla.

In contrast, in 2020 the density increased considerably (Fig. 2) as the upper range limits rose to more than 150, that is, about 40% above the maximum values of 2010. The main cluster identified is still located in northeastern Mexico, with few changes in its intensity and extension. However, the neighboring core of lower intensity identified in Saltillo and Ramos Arizpe increases its importance, and seems to integrate definitively with the main one in Nuevo León.

A factor that can be attributed to this change is that, in March 2019, the company Hangzhou XBZ was inaugurated as the first Chinese auto parts plant located within the Hofusan Industrial Park in the municipality of Salinas Victoria, Nuevo León (México Industry, 2019).

Regarding the change in the core identified in Saltillo and Ramos Arizpe, Sanhua Automotive, which started operations with two industrial buildings in 2015 at the Amistad Aeropuerto Industrial

Park in Ramos Arizpe, Coahuila, announced its decision to expand and create a third building, which was inaugurated in 2017 (Ponce, 2017).

Fig. 2. 2020 kernel density of AAI economic units. Source: based on INEGI (2020)- National Statistical Directory of Economic Units of 2020.

The cluster identified in 2010 in the capital of Querétaro shows signs of higher density and became the second most important. The other two minor clusters, in the cities of Aguascalientes and San Luis Potosí, increased in size, particularly the first one. The shape of the two small concentrations identified in Chihuahua and Tamaulipas changed by spreading towards the northern border, particularly with the emergence of a concentration on the border of the city of Ojinaga, in Chihuahua.

What happened in Querétaro with Saargummi, located in the Bernardo Quintana industrial park, and with Minth Group in Aguascalientes, may be due to the fact that in 2017 both companies announced their decision to expand by building new plants (Estrella, 2017; Líder Empresarial, 2017). For its part, AMMI PPM began its operations at the Millenium Industrial Park located in San Luis Potosí in 2015, although it faced challenges such as the insufficiency of local supplies (Hernández, 2017).

3.2 Global correlation coefficient

The number of economic units in the AAI sector registered in the DENUE increased by almost 65% between 2010 and 2020, going from 480 economic units to 796 in 10 years, as can be seen in Table 1, which also shows the global correlation coefficient, Moran's I, calculated by the number of economic units per local administrative unit.

A positive and significant spatial autocorrelation was identified with a confidence level of 95% in the investigated period, 2010-2020. This is a sign of a non-random distribution of the AAI economic units in the micro-regions considered, in other words, spatial distribution is a sign of spatial concentration patterns associated with agglomeration forces.

Table 1. Economic units of the AAI sector and Moran's spatial correlation coefficient

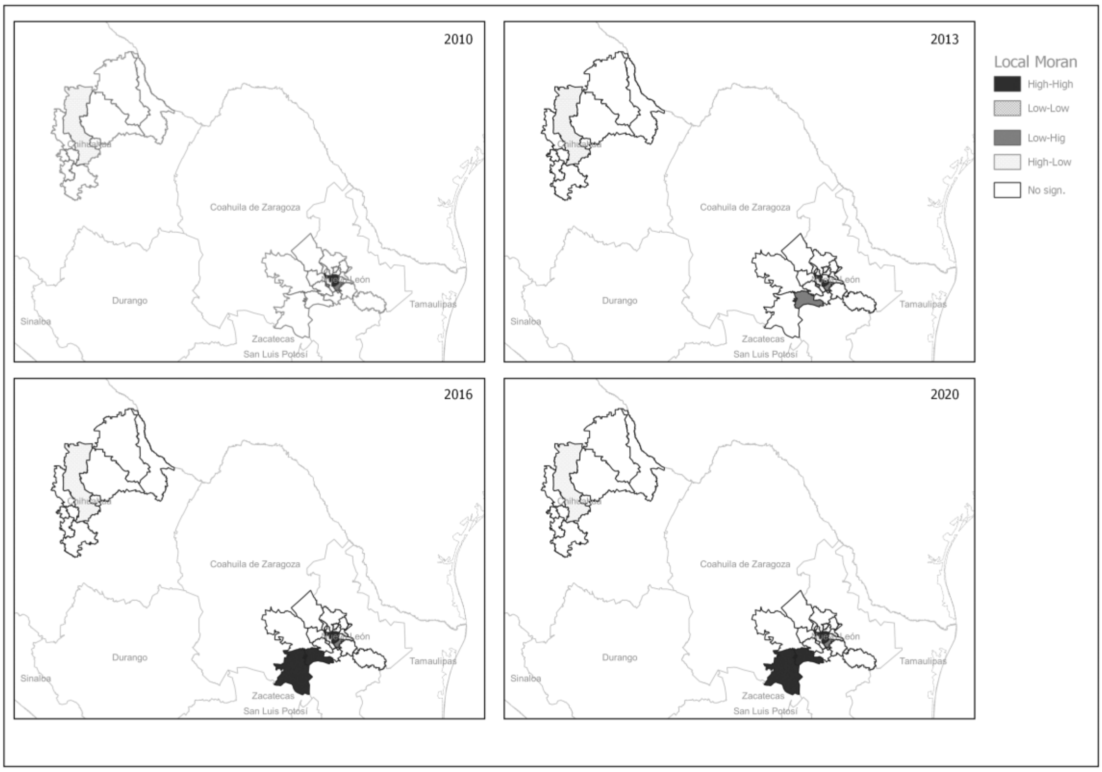
Year	Economic Units	Moran´s I	pseudo p -value
2010	480	0.188	0.022
2013	539	0.169	0.037
2016	704	0.275	0.008
2020	796	0.250	0.010

Source: based on INEGI (2020), indicated years.

3.3 Local spatial autocorrelation

A detailed inspection on the agglomeration patterns of the location of the economic units of the AAI sector is made using LISA. The results are shown in Fig. 3 and Fig. 4, which depict information of four years so as to get an idea of the evolution of the agglomeration patterns over a 10-year period, between 2010 and 2020.

Fig. 3. Representation of the groupings of economic units of the AAI sector through the local spatial association indicator, indicated years.

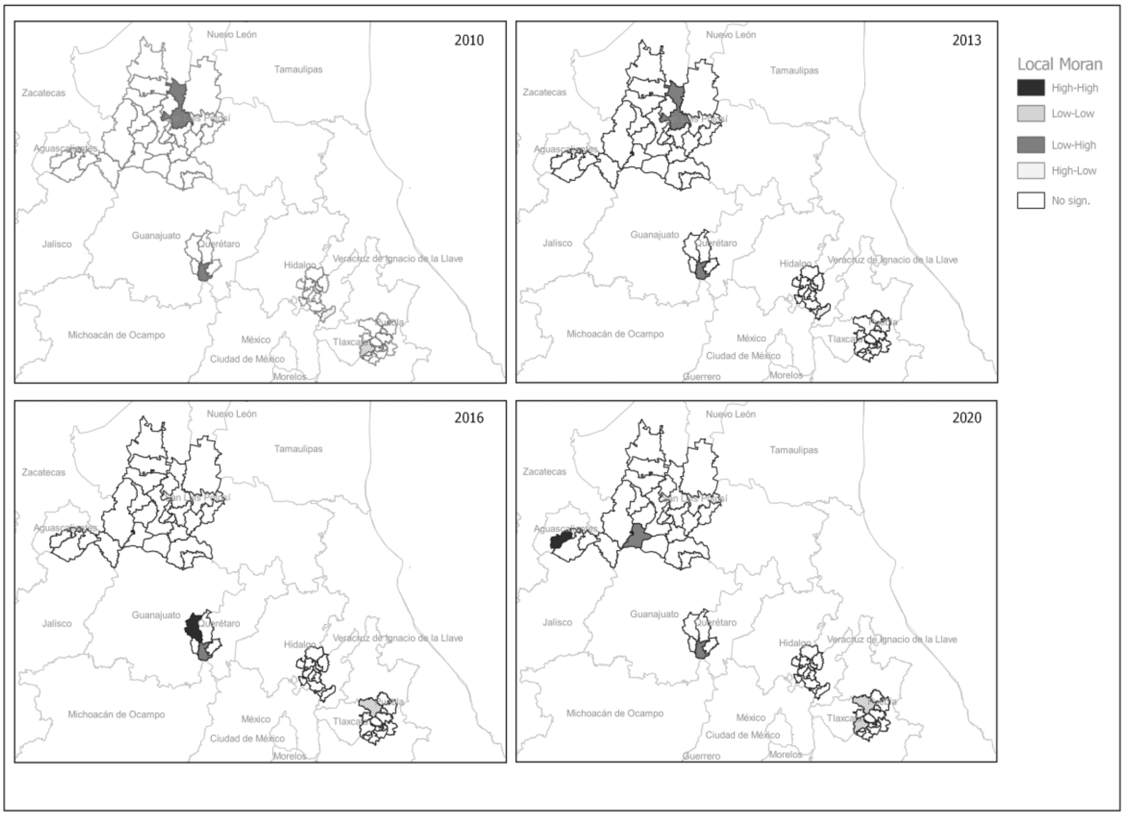


Source: based on INEGI (2020) indicated years

The agglomeration patterns of Figures 3 and Figure 4 are consistent with those shown in the kernel maps, since it is possible to identify a set of municipalities in the state of Nuevo León that constituted an AAI agglomeration space between 2010 and 2020, which is indicative of the emergence of clusters associated with agglomeration economies. Another set of local units exhibiting agglomeration patterns appears in Querétaro and Aguascalientes, although only in the two last years.

In Chihuahua capital, it is possible to identify an isolated type of cluster, that is, an area with high values in the number of economic units of the AAI sector surrounded by neighbors with low values. In the states of Tlaxcala and Puebla, there is a grouping that accounts for “depressed” territorial spaces: spaces with a low relative count of economic units in the sector, also surrounded by spaces with a low count.

Fig. 4. Representation of the groupings of economic units of the AAI sector through the local spatial association indicator, indicated years.



Source: based on INEGI (2020) indicated years

Thus, based on the information from both the maps representing the LISA and heat maps, it is possible to identify three AAI clusters within the micro-regions analyzed: Monterrey, Querétaro and Aguascalientes.

The AAI sector has become a key element in global economic dynamics in at least two aspects: its capacity for technological diffusion and the absorption of technologies from other activities (Rocha, 2017). China´s role in the sector is decisive, since it is the largest producer of vehicles and its companies began a process of expansion at a global level. Reaching countries such as Mexico has impacts related to the volume of incoming investment, employment and infrastructure (Gachúz & Montes, 2020).

Furthermore, the most important groups are found in states or provinces where activities such as aerospace and nanotechnology industries, which together and under certain conditions, could contribute to the process of diffusion and absorption of technological capabilities and, eventually, to regional development (Flores et al., 2017; Luna-Ochoa et al., 2016), through dissemination of knowledge and promotion of innovation, although these factors are conditioned by the so-called absorption capacity (Claver-Cortés et al., 2016).

4. CONCLUSIONS

Many of the companies are part of an industrial park, which has gradually been promoted to develop economic activities dedicated to this sector, where Chinese companies are increasingly present within Mexican territory, primarily in those areas considered strategic for entering the U.S. market and, with that, the global market.

We identified clusters in the AAI sector in Mexico: one in the northeast in the states of Nuevo León and Coahuila, another in in the dynamic center state of Querétaro, two in the west in Aguascalientes and San Luis Potosí, and one more in Puebla. It was found that their density and size increased in the period studied.

We found that the spatial distribution of the economic units of the AAI sector is not random but concentrated in space that means the presence of agglomeration economies in the sector. The identification of these forces requires policy measures to strengthen them and contribute to regional development.

It is necessary to further analyze the real and effective supply chains between the economic units of the sector, possibly by the analytical approach of value chains to identify the weaknesses in chain scaling and dissemination of knowledge and regional innovation processes.

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Acknowledgment

This publication has been funded by the Consejería de Economía, Ciencia y Agenda Digital de la Junta de Extremadura and by the European Regional Development Fund of the European Union through the reference grant GR21161.