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Location Determinants of Japanese Automotive FDI in Mexican States, 2013-2018

Determinantes de localización estatal de la inversión extranjera directa japonesa en la industria automotriz mexicana

Leo Guzmán Anaya *, María Guadalupe Lugo Sánchez **

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Abstract

Foreign Direct Investment (FDI) location theories highlight the regional factors that influence the location and spatial distribution of the investment project. The study employs a state-level spatial panel econometric model to empirically contrast the main location factors that influence the spatial distribution of Japanese companies. The main results indicate that state characteristics related to wages, education levels, and market size influence the presence of Japanese automotive firms in Mexico. The results also highlight the presence of negative spatial externalities for the market size and education variables. Positive spatial externalities were observed from the industry agglomeration variable, which can reflect the presence of production networks in the automotive industry, especially in the case of Japanese firms. This shows that neighboring states compete for the arrival of Japanese automotive firms, and spatial effects are present.

* Departamento de Recursos Humanos, CUCEA, Universidad de Guadalajara, leo@academicos.udg.mx, https://orcid.org/0000-0002-5682-3175.
** Departamento de Recursos Humanos, CUCEA, Universidad de Guadalajara, lugsan@cucea.udg.mx, https://orcid.org/0000-0001-7765-8968.

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Resumen

Las teorías de localización de la Inversión Extranjera Directa (IED) destacan los factores regionales que influyen en la ubicación y distribución espacial del proyecto de inversión. El estudio emplea un modelo econométrico de panel espacial en el nivel estatal, para contrastar empíricamente los principales factores de ubicación que influyen en la distribución espacial de las empresas japonesas. Los principales resultados indican que las características estatales relacionadas con salarios, niveles de educación y tamaño del mercado influyen en la presencia de empresas automotrices japonesas en México. Los resultados también destacan la presencia de externalidades espaciales negativas, para las variables tamaño del mercado y de la educación. Se observaron externalidades espaciales positivas a partir de la variable aglomeración de la industria, lo que puede reflejar la presencia de redes productivas en la industria automotriz, especialmente en el caso de las empresas japonesas. El estudio muestra que los estados vecinos compiten por la llegada de empresas automotrices japonesas y los efectos espaciales están presentes.

Introduction

The importance of FDI location determinants was recognized in the 1960s, especially in explaining U.S. companies' locations in developed nations. This type of analysis is considered a macro perspective of FDI determinants. In the following decade, the emphasis switched to a micro perspective, focusing on understanding the reasons, at the firm level, why companies choose to establish their production in foreign locations instead of exporting their products to those destinations.

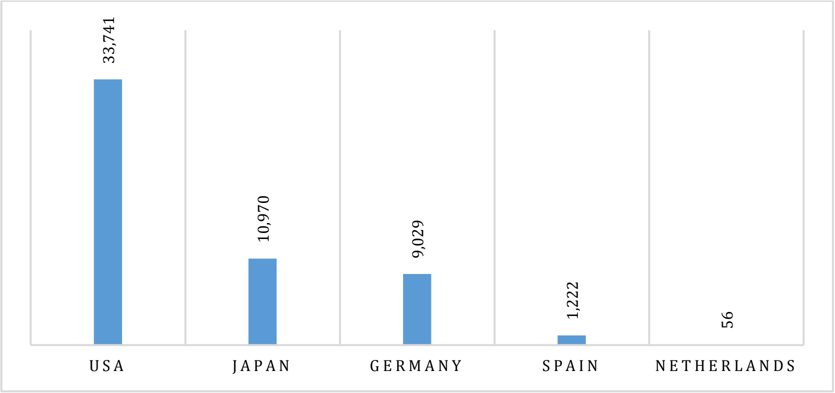
Orthodox economic theory cannot be used to examine FDI or MNEs since it assumes market structures with perfect competition. Under perfect competition, companies do not have the market strength or attributes that enable MNEs to prosper. As a result, market imperfections provide the ideal setting for MNEs to gain ownership advantages and exploit foreign manufacturing through them.

This perspective is especially evident in emerging markets where MNEs can put economic and political pressure on weaker institutions. It has been shown that local governments offer many incentives to foreign firms to establish in certain regions, expecting the positive externalities associated with FDI (Lugo-Sanchez, 2018).

In this sense, it becomes relevant to study the behavior of automotive FDI and the regional factors that influence the spatial distribution of foreign firms. The automotive industry is an interesting case study since it employs 15,000 to 25,000 parts and components throughout the production chain. Globally, in 2019, the automotive production was registered in 91.7 million units. However, in 2020 with the devastating repercussions of the COVID-19 pandemic, production fell by 16%, totaling 77.6 million units. In 2021, the industry showed signs of recovery, with production surpassing 93 million units (OICA 2021).

In Mexico, the automotive industry contributes 18% of the manufacturing GDP and employs around 850,000 workers. The COVID-19 pandemic also affected the Mexican automotive industry. Automotive production fell from 4 million units in 2019 to 3.1 million in 2021, a drop of 21% due to the pandemic. However, by 2021 total production was expected to recover with an increase of 32%: surpassing the 4 million level. Of the total output, 80% is exported, mainly to the North American market, locating the country as the fourth global exporter.

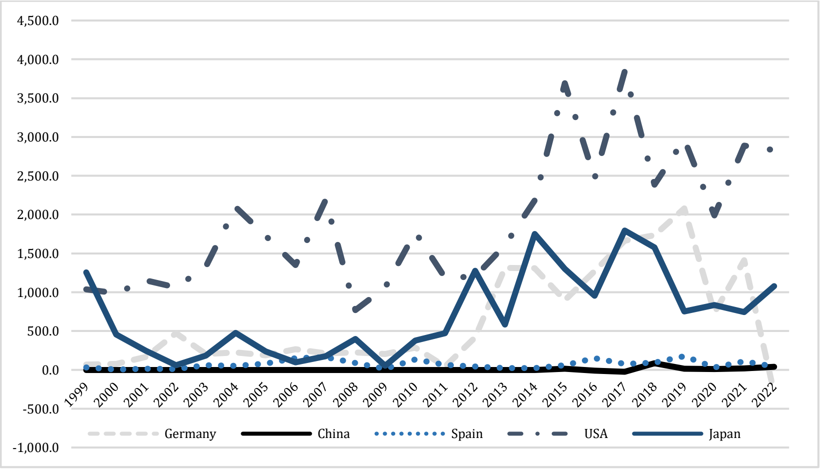
Figure 1
Accumulated FDI in the automotive industry by country of origin, 1997-2017 (millions of dollars)



Source: Author's elaboration using data from RNIE (2020)

Figure 1 presents the by-country distribution of FDI in Mexico from 1997 to 2017, and figure 2 shows the FDI in the automotive industry by country of origin for the period 1999-2022. Japanese FDI became the second source of foreign investment in the automotive industry, during the period, especially in the period after 2011 with the arrival of assemblers and supporting industry firms to Mexico's central region.

Figure 2
FDI in the automotive industry by country of origin, 1999-2022 (millions of dollars)

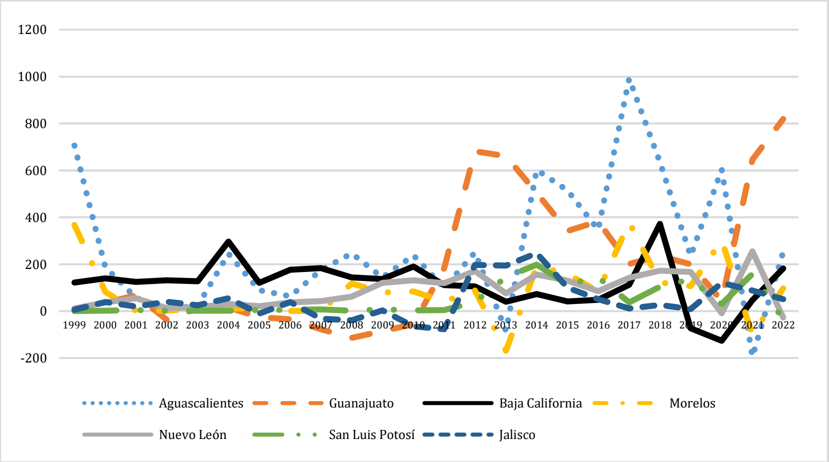


Source: Author's elaboration using data from RNIE (2022)

In the mid-1990s, the signing of NAFTA drew the interest of Japanese investors, and several companies moved their production from the United States to Mexico's northern states. Nissan's arrival in Mexico and its two plants in Aguascalientes and Morelos attracted further regional investment. However, a further surge in Japanese automotive investment was seen after the Mexico-Japan Partnership Agreement came into force in 2005, and especially from 2011 to 2017, with the arrival of major automotive assemblers such as Mazda and Toyota in Guanajuato.

The arrival of new investment projects also increased the interest of Japanese investors down the supply chain, primarily at the Tier-2 level of procurement. The evolution of Japanese FDI automotive flows by main recipient states is presented in figure 3.

Figure 3
FDI in the automotive industry by country of origin, 1999-2022 (millions of dollars)



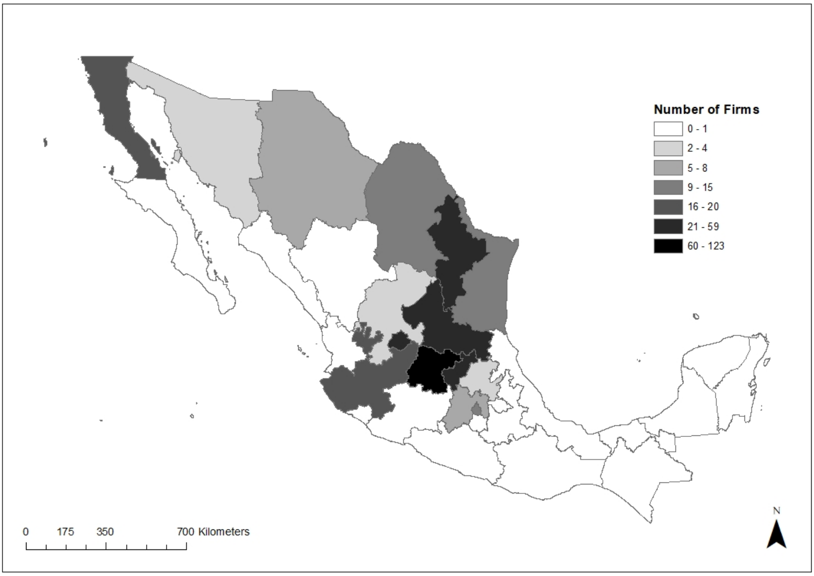
Source: Author's elaboration using data from RNIE (2022)

Most Japanese investment in Mexico is concentrated in the manufacturing sector, particularly in the automotive industry, where Japanese companies contribute to 40% of the country's total exports. Japanese automotive companies are established in several regions in Mexico, contributing to the industry's growth. Firms look for a strategic location to export to north America and south America (mainly Brazil).

Other driving factors include a growing internal market, the presence of infrastructure, competitive production costs, and a qualified labor force. In 2009 the number of Japanese companies established in Mexico was 400; by 2020, this figure had increased to over 1200 firms.

The distribution of Japanese automotive firms is concentrated in Mexico's central and northern regions. This concentration is due to the presence of Original Equipment Manufacturers (OEMs), incentivizing the agglomeration of Japanese Tier-1 and Tier-2 automotive supplier firms (see figure 4).

Figure 4
Spatial Distribution of Japanese Automotive Firms in Mexico



Source: Author's elaboration using software ArcMap 10.1. and data from Toyo Keizai (2015, 2017, 2020) and RNIE (2020)

The current study contributes to the literature on FDI location determinants. The analysis applies spatial statistical tools to measure the contribution of relevant factors that explain the location and spatial distribution of Japanese automotive firms in recipient countries.

The paper is organized as follows: The next section discusses previous theoretical and empirical evidence on FDI location determinants. Section three presents the empirical model and the data sources. Sections 4 and 5 present the results and conclusions, respectively.

1. Literature review

Theories that aim to explain FDI behavior have been developed since the 1960s. The first approaches were based on the Heckscher-Ohlin (1933), MacDougall (1960), and Kemp (1964) models. In these models, the FDI was motivated by low labor costs and exchange risks (favorable circumstances in some developing foreign markets), where higher profits could be made (Assunção et al., 2011).

According to Dunning (1998) and Caves (1996), the most important incentives that influence the location of FDI are related to the availability, costs, and quality of natural resources. This type of FDI is considered "market seeking." It is also necessary to develop the needed infrastructure to exploit these resources. The size and growth of the domestic and regional markets, the availability of skilled labor, the quality of infrastructure, competition from institutions, agglomeration economies, service support systems, and local government's macroeconomic policies all influence FDI-seeking markets, according to the authors.

The increase in FDI at the world level prompted research on the determinants that explain this type of investment. As a result, in the empirical and theoretical literature, a vast catalog of determinants tries to explain the direct investment locations of multinational companies in specific areas. Among the models discussed, the OLI (Ownership, Location, Internalization) paradigm stands out, with an institutional approach, and also the New Theory of Trade model.

Under the OLI paradigm, the FDI determinants associated with the location dimension are infrastructure, human capital, economic stability, and production costs. Dunning's eclectic or OLI paradigm encompasses both internalization theory and traditional trade theories (Dunning, 2002). It also systematizes the benefits for foreign enterprises, applying them to the chosen entry options (Faeth, 2009). The Dunning model establishes that there will be advantages to selecting the FDI if the factors of ownership advantage (O), location advantage (L), and internationalization advantage (I) are met simultaneously. The value of a company possessing assets such as cutting-edge technology, exclusive production techniques, patents, management skills, and other assets that can bring profits in the future is referred to as ownership advantage (Dunning & Lundan, 2008).

Location is essential when a company benefits from its presence in a specific market, taking advantage of special tax regimes, lower manufacturing and transportation costs, market size, access to protected markets, and lower risk. Internalizing activities, for example, helps eliminate market failures such as the imbalance of international resource allocation, lowering transaction costs, and reducing the danger of copying technologies. As a result, selecting a particular place depends on unique factors that favor it (Ietto-Gillies, 2005).

Dunning's eclectic paradigm significantly contributed to the literature by combining numerous complementary theories and establishing a collection of characteristics (ownership, location, and internalization) that affect multinational corporations' operations.

According to Assunção et al. (2013), the key to this perspective is the application of these variables to commerce, international production, and international production organization, implying that the three primary modes of internationalization may be covered by the same analytical framework (exports, FDI, and licensing).

It is essential to emphasize the influence that political variables have on FDI. According to institutional theory, corporations operate in a complicated, ambiguous, and sometimes hostile environment, and a company's decisions are influenced by institutional forces, particularly rules and incentives. In this context, institutions, or the "rules of the game," are central in determining company strategy and performance in foreign markets (Peng, 2009). Foreign investment can thus be viewed as a 'game' in which the multinational corporation and the host country's government compete to attract FDI or as a competition amongst governments to attract FDI. Government measures such as tax advantages, subsidies, and easy capital repatriation can thus impact the decision between exporting, FDI, and licensing (Faeth, 2009).

Dunning and Lundan (2008) argue that economic activity from FDI geographically concentrates in regions and that theoretical contributions that seek to explain this concentration fall into a micro dimension related to organizational attributes and characteristics or macro dimensions that fall into resource allocation aspects. State-level features are related to the macro dimension realm and are associated with regional factors. Jordaan (2009) points out that regional factors may be related to regional demand, regional production costs, regional government policies, and regional agglomeration economies, all influencing the location decision of multinational firms in the recipient country.

Previous empirical literature indicates that certain factors influence the location decision of multinational firms. Production costs are considered a determinant factor in the location of global firms. This variable is usually captured as labor costs, measured by the wage level (Coughlin et al., 1991; Friedman et al., 1996). It is assumed that firms seek locations with lower wages. A body of literature has confirmed and documented the negative relationship between wages and FDI location (Luger &

Shetty, 1985; Coughlin et al., 1991; Jordaan, 2009). However, another body of literature argues that a positive relationship between wages and FDI location is possible since foreign firms are willing to pay higher salaries for more qualified labor. In this sense, it is argued that wages incorporate the productivity level of work (Head et al., 1999; Guimaraes et al., 2000). Similarly, education attainment may play a role in attracting new FDI projects in a region.

Demand factors influence the location decision of multinational firms. Larger markets not only indicate the presence of higher demand for foreign firms' products but also indicate the presence of a larger pool of workers and developed infrastructure. Previous literature finds a positive relationship between income levels, measured by regional GDP levels, and the selection of locations for new FDI projects (Coughlin et al., 1991; Woodward, 1991; Mughal & Akram, 2011). Likewise, in previous studies, the population is included as a proxy for market size and a control variable for state or county size differences (Smith & Florida, 1994).

In previous literature, agglomeration economies are also an essential factor influencing the location decision of FDI. Agglomeration economies benefit foreign firms by providing better infrastructure, a larger pool of trained and specialized labor, support services, and lower production costs (Blanc-Brude et al., 2014). Zaheer (1995) mentions that the accumulation of foreign firms may also contribute to creating an expatriate network that may reduce "foreignness" by providing specific knowledge of the functioning of local institutions. This process may ease the recruitment process of specialized labor, such as local managers familiar with working with foreign firms. Japanese automotive firms have an agglomeration preference with an organizational and production structure that favors proximity between assemblers and suppliers (Aoki, 1990; Asanuma, 1989). Empirically, Belderbos and Carree (2002) indicate the location of Japanese FDI in a keiretsu-type of agglomeration preference, being more evident for small and medium-sized enterprises. This behavior is likewise reported by other studies, including Smith and Florida (1994).

For the case of Mexico, previous literature has shown that certain factors drive the regional distribution of FDI. Fanbasten and Göstas (2016) indicate that factors related to market size, economic stability, infrastructure, openness, and institutional and political stability determine FDI location. Also, Juarez and Angeles (2013) mention that the development level of regions and market size influence the location of foreign investment. Furthermore, the study indicates that FDI is central to widening the regional inequality gap.

Guzman-Anaya (2017) studies the location behavior of Japanese FDI in Mexico. The study finds that Japanese FDI is attracted to locations with larger populations and strategically located near the U.S. border. Also, greenfield sites are preferred. The study finds spatial dependence in the error term, meaning an absence of potential explanatory variables which might exhibit spatial dependence.

De Castro et al. (2013) compare location factors for Brazil and Mexico. The results show that FDI in Brazil follows market-seeking strategies. At the same time, FDI in Mexico is an efficiency-seeking investment closely related to economic liberalization and historic flows pulling new foreign investment.

Mollick et al. (2006) analyze state-level determinants of FDI in Mexico. The results indicate that public spending does not influence FDI location; the main factor appears to be infrastructure measured by transport and communication infrastructure. Jordaan (2009) reports that regional factors related to demand, production costs, regional policies, and agglomeration economies attract FDI in Mexico.

Escobar (2013) studies the state-level determinants of FDI and finds that educational attainment and lower delinquency rates positively correlate with FDI attraction. The author points out that there needs to be a complementary relationship between the inflows of FDI and state development. Similarly, Garriga (2013) reports results indicating that higher education levels and wages attract FDI. These results show that foreign investors prefer locations with a qualified labor force despite having to pay higher wages.

Samford and Ortega (2012) indicate that besides the traditional geographical and economic factors associated with FDI location, political factors also play an important role. Furthermore, Ortega and Infante (2016) compare economic, social, and public policies as swaying factors of FDI. The analysis reveals that only economic policies, and therefore economic performance and the presence of infrastructure, influence the attraction of foreign investment. Public and social policies do not seem to affect the location of foreign firms in different states of Mexico.

Similarly, Fonseca and Llamosas-Rosas (2019) find a positive relationship between Mexican States' FDI, linked to complex vertical FDI concentrated in the automotive industry. Positive direct and indirect effects are associated with human capital, agglomeration, and fiscal margin variables.

A body of literature also highlights the role of crime as a deterrent to new investment projects in Mexico. Escobar Gamboa (2019) reports a complementary relationship between inward FDI flows to a host state and the neighboring states. The education variables and lower delinquency rates are important determinants of investment flows. Cabral et al. (2018) analyze FDI flows to Mexican states by differentiating the type of crime. The study finds that homicides and theft have significant and adverse effects on FDI inflows, while other types of crimes have no effects. The effects are amplified for Mexico's most violent states. At a sectoral level, Ashby and Ramos (2013) argue that organized crime disincentivizes FDI flows in financial services, commerce, and agriculture. However, for oil and mining, a crime increase is associated with an investment increase. No significant effects are found between organized crime, and FDI flows for the manufacturing sector.

The results from previous empirical literature highlight factors that influence the location decisions of foreign firms. However, most of the earlier studies fail to incorporate the spatial component in the analysis, which might be present in the location decision of foreign investors. If a spatial dependence is ignored, the estimation results will suffer specification error due to variable omission and provide erroneous econometric results (Romero & Andres-Rosales, 2014; Blanc-Brude et al., 2014).

2. Empirical Model

Using spatial econometric techniques can be employed to quantify the externalities of the variables of interest. It is advised to start from the following base model, taking a classic Cobb-Douglas function of the form:

$$Y = AL^{\alpha}K^{\beta} \tag{1}$$

Where Y represents total production, L represents labor, K represents capital, and A is total factor productivity. In its log-linear form, it is represented in the form:

$$ln\ Y = \beta_0 + \beta_1\ ln\ L + \ \beta_2\ ln\ K + \varepsilon \tag{2}$$

Traditional regression models ignore spatial interactions. These models fail to quantify spatial relationships that may arise from the presence of factors that attract FDI in host countries. Tobler's first law of geography states that the interactions among spatial units increase when the distance between geographic units is shorter. Empirical analysis employing spatial dependence data must capture this relationship in the model specification. Failing to account for spatial dependence will produce specification errors stemming from variable omission (Romero & Andres-Rosales, 2014; Lesage & Page, 2009). There are several techniques to account for spatial dependence in the data. Moran's I is a technique sensitive to permutations of spatial units. The technique allows for capturing positive or negative spatial autocorrelation.

Haining (2001) defines spatial autocorrelation as "the presence of systemic spatial variation in a mapped variable." Positive spatial autocorrelation is present when adjacent observations are associated with similar values. On the other hand, if adjacent observations report contrasting values, the map shows negative spatial autocorrelation. For this analysis, spatial autocorrelation will confirm the presence of spatial diffusion, spillover, interaction, and dispersal processes from the location of decisions of FDI flows among adjacent observations.
If spatial autocorrelation is present, spatial weight matrices can be integrated to quantify these interactions. Considering spatial effects, the model can be represented as

$$y_{it-1} = \alpha + \rho W y_{it} + X_{it}\beta + \theta W X_{it} + \mu_i + \gamma_i + \varepsilon_{it} \tag{3}$$

Where α is the constant, ρ is the spatial correlation coefficient, W is the spatial weights matrix, and X is the matrix of independent variables. β and θ are vectors with estimated coefficients of the regression, ε_{it} is the error term, Wy and WX are variables with spatial lags, and μ and γ are spatial and temporal effects, respectively. The latter is included to represent spatial and temporal heterogeneity (Guan & Li, 2021). The above model is named the Spatial Durbin Model (SDM) model. Furthermore, a 1-year lag in the dependent variable is included in the model to avoid potential simultaneity and endogeneity effects on the regression results.

The spatial model introduces a spatial weights matrix (W) composed of elements (wij) that account for spatial dependence between municipalities i and j. The matrix is created to reflect the strength of dependence between municipalities. For this study, the measure of geographical distance is assumed using a queen-type contiguity measure where a 1 is recorded if two municipalities share a common border and 0 otherwise.

Empirically, in the model estimated, the total Japanese FDI in the automotive industry received by state was used as the dependent variable. The independent variables included industry labor wages by state, measured by total worker remunerations in the automotive sector in constant prices, state GDP in constant prices, education attainment levels measured by the average number of years of schooling for the population over the age of 15 according to each state, automotive production by state in constant prices, the total number of state homicides by every 100,000 people, and total population per square kilometer by state, this last variable as a control variable to account for the differences in the economic sizes of the states. The name of the variables with their respective descriptive statistics are presented in Table 1.

In the initial estimation, the starting model is referred to as the SDM (Spatial Durbin Model). Once estimated, a selection criterion such as the Hausman test or the AIC criteria (Akaike Information Criterion) is needed to choose the model that best fits the data. These selection criteria are presented in more detail in the results section.

Data for the study was gathered from the National Registry of Foreign Investment from Mexico's Secretariat of Economy (RNIE, 2020). The data solicited was unpublished information pertaining to data for Japanese Foreign Direct Investment classified by state and for the automotive industry. State data for labor statistics for the automotive industry was gathered from the survey "Encuesta mensual de la industria manufacturera" a publication from INEGI (2020a). GDP state data was also gathered from INEGI (2020b). Crime data was gathered from government statistics, specifically from the "Secretariado Ejecutivo del Sistema Nacional de Seguridad Publica" (SESNSP, 2023). The official crime statistics are published monthly and converted into yearly observations by aggregating the monthly data. The panel constructed included 17 states in Mexico that were recipients of Japanese automotive

FDI or had automotive production[1]. The period of the analysis is from 2013-2018. Data for other variables were obtained from INEGI (2020c).

3. Results

The study was conducted following the estimation of a spatial panel econometric model to analyze different factors that influence the location of Japanese firms. Including a spatial component will indicate if the factors signaled by the theoretical model and previous empirical studies are also relevant to neighboring states exhibiting spatial dependence. The variables employed and their descriptive statistics are presented in Table 1.

Table 1
Descriptive statistics

Variable	Unit of Measurement	Mean	Standard Deviation	Min	Max
Dependent Variable					
JFDI	Japanese automotive FDI by state in constant prices (2003 million pesos)	976.1	1707.8	-782.7	10873.3
Independent Variables					
L	Total labor remunerations in the automotive industry by state in constant prices (2003 million pesos)	7108.2	5817.5	349.8	27991.8
GDP	Gross Domestic Product by state in constant prices (2003 million pesos)	703923.2	669831.8	87657.6	3127842
EDU	Average years of schooling of population over 15 by state (years)	9.5	0.67	8.1	11.3
AUTO	Automotive production by state in constant prices (2003 million pesos)	114426.8	124280.1	1077.2	540798.8

[1] The sample was reduced to 17 states to eliminate zero values in the dependent variable. The states included in the sample are Aguascalientes, Baja California, Coahuila, Chihuahua, Ciudad de México, Durango, Guanajuato, Jalisco, México, Nuevo León, Puebla, Querétaro, San Luis Potosí, Sonora, Tamaulipas, Tlaxcala, and Zacatecas.

CRIME	Number of homicides by state per 100,000 people	17.1	12.5	3.1	79.7
POP	Population per square kilometer by state (number of people)	474.3	1388.3	12.8	6066.1

Source: Authors' elaboration

Initially, an Exploratory Spatial Data Analysis (ESDA) was performed. Moran's I index is employed to confirm the presence of spatial dependence; the index reveals spatial agglomeration by analyzing spatial autocorrelation among regions (Anselin, 1988). The ESDA estimations were carried out using the GEODA 1.20.0.22 version.

Table 2 shows Moran's I statistic results for the dependent variable (Japanese automotive FDI flows) for 2013-2018. The presence of statistically significant spatial autocorrelation is present for 2013 and 2017.

Table 2
Moran's I Statistic for Spatial Autocorrelation

	Moran's I		z-value
2013	0.066	*	1.08
2014	0.068		0.72
2015	-0.074		-0.13
2016	0.015		0.52
2017	-0.017	**	-1.47
2018	-0.094		-0.21

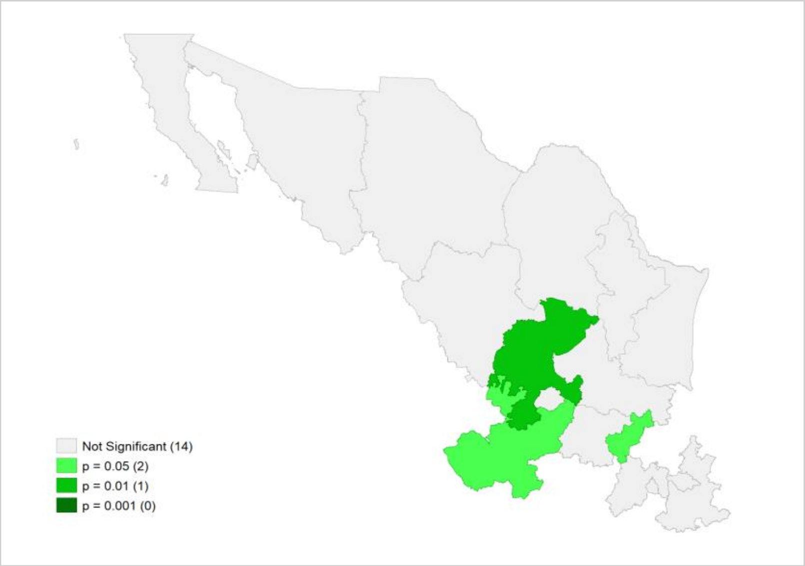
Note: *** p < 0.01, ** p < 0.05, *** p < 0.1

N = 17

Source: Authors' elaboration using the software GEODA and data from RNIE (2020)

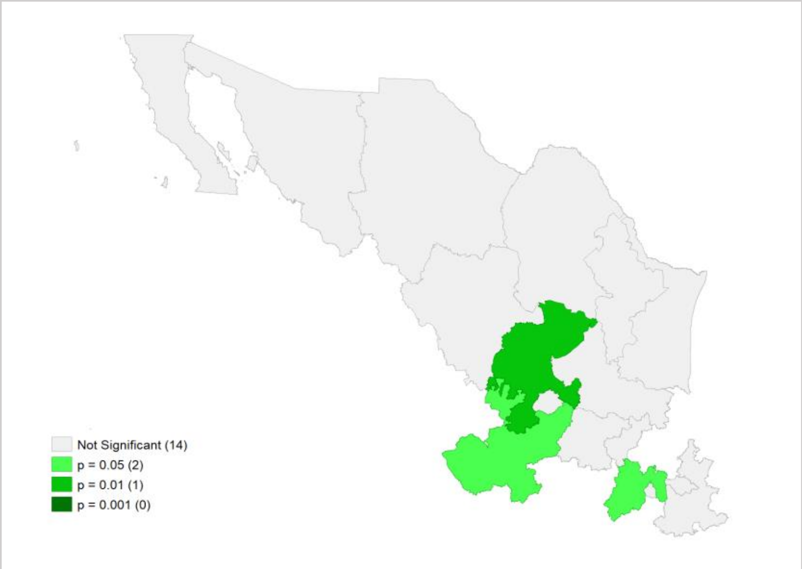
Furthermore, additional ESDA was performed on the dependent variable. As previously mentioned, Moran's I statistic evaluates the presence of spatial autocorrelation in all regions of analysis and is unable to detect local clustering. The Local Indicator of Spatial Associaton (LISA) was estimated for local spatial cluster analysis. The LISA statistic may confirm spatial dependence in individual regions (Anselin, 1995). The results from the LISA statistic are presented in figures 5 to 10.

Figure 5
LISA Significance Map for Japanese Automotive FDI (2013)



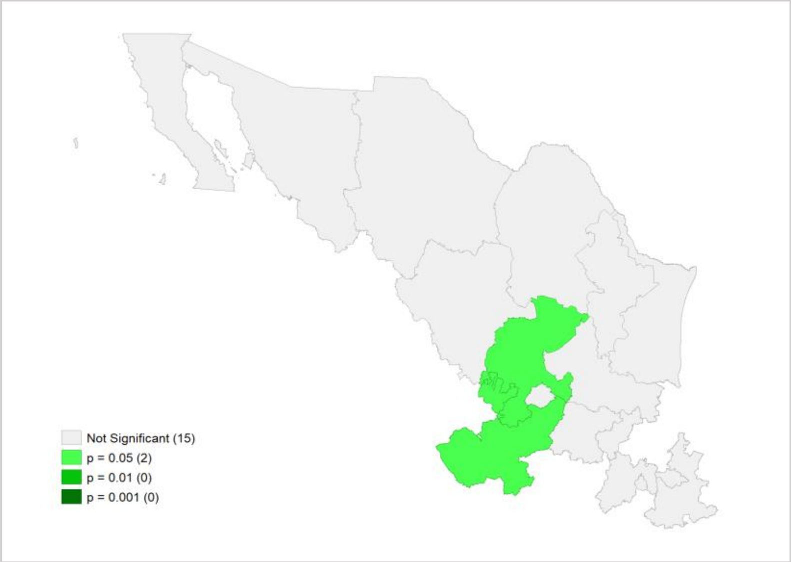
Source: Author's elaboration using the software GEODA and data from RNIE (2020)

Figure 6
LISA Significance Map for Japanese Automotive FDI (2014)



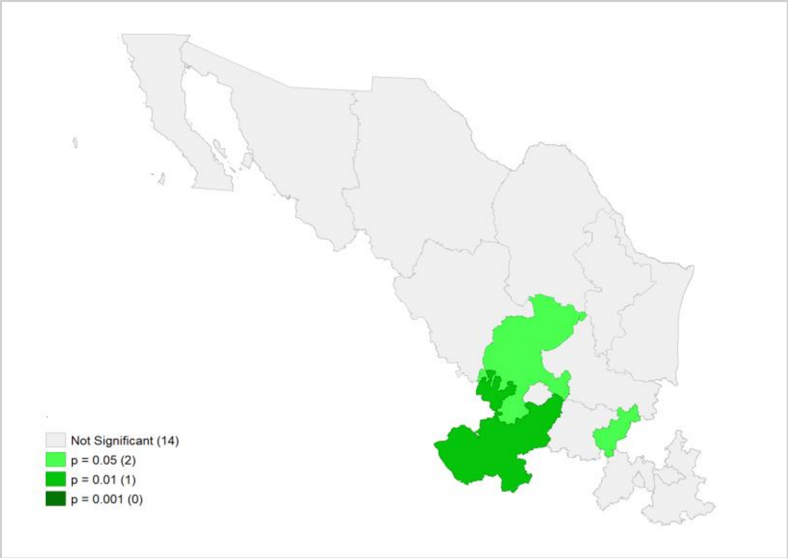
Source: Author's elaboration using the software GEODA and data from RNIE (2020)

Figure 7
LISA Significance Map for Japanese Automotive FDI (2015)



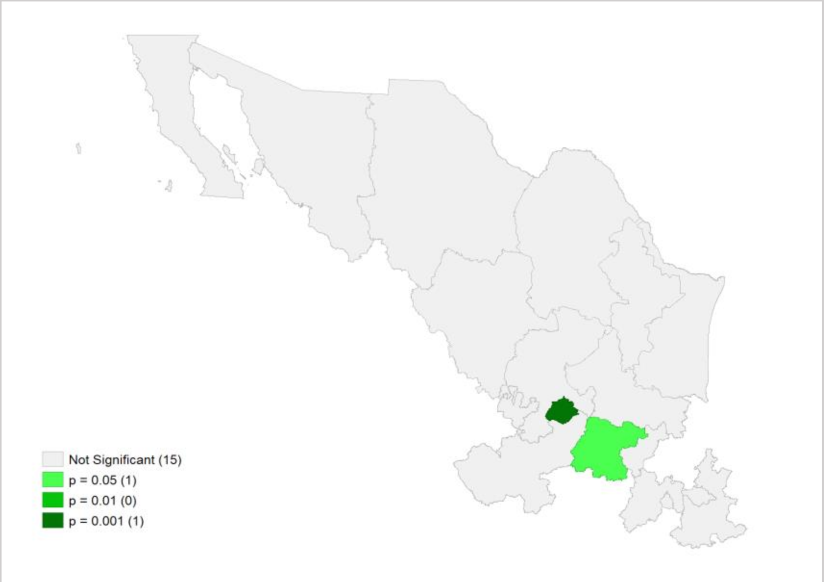
Source: Author's elaboration using the software GEODA and data from RNIE (2020)

Figure 8
LISA Significance Map for Japanese Automotive FDI (2016)



Source: Author's elaboration using the software GEODA and data from RNIE (2020)

Figure 9
LISA Significance Map for Japanese Automotive FDI (2017)



Source: Author's elaboration using the software GEODA and data from RNIE (2020)

Figure 10
LISA Significance Map for Japanese Automotive FDI (2018)

Source: Author's elaboration using the software GEODA and data from RNIE (2020)

The results from the ESDA also indicate the presence of global spatial autocorrelation in the years 2013 and 2017. Furthermore, the LISA statistic shows the presence of spatial autocorrelation with significant results of local spatial autocorrelation for all years of analysis except 2018. These findings suggest using spatial econometric techniques that capture the presence of spatial dependence in the data. Blanc-Brude et al. (2014) mention that if the spatial dependence is ignored, econometric problems will be present in the FDI analysis because observations will be partially predictable from other observations in neighboring locations.

The models were estimated following equation (3) using the software STATA 10.1 and the spatial panel model estimation modules xmsle and spregxt. The data were transformed into logarithms[2]. For the selection of the spatial model, the study follows the suggestions from LeSage and Pace (2009) and Elhorst (2010). These authors suggest estimating the SDM model as a general specification and testing for alternatives afterward. First, since we are dealing with a spatial panel model, the Hausman test can be used to test for the model with fixed or random effects. The test yielded a X^2 value of 118.96 with a p-value of 0.000, suggesting using fixed effects.

Subsequently, the SDM model was compared with the SAR (Spatial Autoregressive Model) and the SEM (Spatial Error Model) models. As Belotti et al. (2017) points out, because the SDM model can be extracted from an SEM model, one can prove through hypothesis testing that if $\theta = 0$ and $\rho \neq 0$, the model best fits the data is a SAR model. On the other hand, if $\theta = -\beta\rho$, the model that should be estimated must be an SEM model. The results of the hypotheses tests indicate that the SAR model is the one that best fits the data.

Finally, to compare the SDM and SAC models (SAR model with spatial lag in errors), the AIC (Akaike Information Criterion) was followed. The SAC model may only be estimated using fixed effects for this case. Anselin (1988) mentions that there is no traditional goodness-of-fit measure like R2 in spatial models. However, because the models are estimated using maximum likelihood, the AIC can be used to compare the relative goodness- of-fit between models. The AIC is calculated as twice the

[2] The sample included data with negative and zero values. The logarithm transformation follows the suggestion by Ashby and Ramos (2013) to deal with negative and zero values. The data transforms in logs so that lnFDI=(1+FDI) when FDI>=0 and equal to –|ln(FDI)| when FDI<0.

absolute value of the ln likelihood plus twice the number of parameters in the model. The model that obtains the lowest AIC value results is the one that best fits the data (Blanc-Brude et al., 2014). Under the AIC criterion, the use of the SDM model is suggested as the one that best fits the data. The results of the SDM and SAR model estimates are reported in Table 3.

Table 3
Results from the SDM and SAR models

Variables	SDM		z Statistic	SAR		z Statistic
lnJFDI(t-1)	0.21	***	-2.63	0.35	***	3.05
lnL	6.92	**	1.99	5.21		1.38
lnGDP	28.48	*	1.77	26.12	*	1.49
lnEDU	65.17	*	0.81	-72.34		-0.97
lnAUTO	-2.71		-1.16	-3.31		1.38
lnCRIME	0.08		0.07	0.49		0.42
W*lnL	0.42		0.07			
W*lnGDP	-57.83	*	-1.88			
W*lnEDU	-670.25	***	-4.03			
W*lnYAUTO	11.26	***	2.89			
W*lnCRIME	1.61		0.75			
Rho	0.08		0.78	0.01		0.93
AIC	387.31			416.84		

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

N= 85

Source: Authors' elaboration

The SDM model estimations show a positive value for the ρ and GDP coefficients. However, only the GDP variable is statistically significant. According to the literature, this type of relationship where $\rho > 0$ and $\theta lnGDP > 0$ is considered "complex vertical FDI." Under this scenario, a foreign firm distributes its production chain among several neighboring states to access cost-differential inputs (Escobar, 2013; Fonseca & Llamosas Rosas, 2019). The results reinforce the previous findings on Japanese multinational preferences in the automotive industry. Japanese automotive production networks under a Keiretsu-type industrial organization are not necessarily exclusive to a single OEM or region; suppliers distribute parts and components across OEMs and regions (Lugo-Sanchez, 2022; Belderbos & Carree, 2002).

The results also indicate a positive and significant effect from the labor and education variables. The findings reflect the firm's decision to search for locations with an educated workforce and the willingness to pay higher salaries for qualified workers. Using qualified labor is essential for firm growth in a competitive automotive industry. The Mexican automotive industry has observed a labor shortage in certain regions, especially in the Bajio region, where Japanese firms have agglomerated during the last decade. Firm competition for qualified labor is fierce, and Japanese companies have worked with local governments to set up human capital development programs expecting to increase the pool of qualified workers for the industry (Romero, 2020).

The automotive industry agglomeration variable was not statistically significant, possibly due to other factors absorbing the effect, such as the state GDP variable. FDI location theories suggest that firm agglomeration brings positive externalities, and previous literature finds agglomeration as an essential factor in Japanese firm location decisions. Similarly, the crime variable did not produce statistically significant results. Previous results for Mexico find no significant relationship between organized crime and FDI flows in the manufacturing sector (Ashby & Ramos, 2013).

The SDM model shows statistically significant spatial effects from different variables. Specifically, the competition effects between states indicate that an educated population in an entity brings negative externalities to the neighboring state regarding Japanese multinational location decisions. In other words, a more educated workforce in a state competes for Japanese FDI and brings negative externalities to neighboring states. Similar results are indicated for the production variable, where the GDP variable shows negative externalities.

On the other hand, the automotive industry agglomeration variable exhibits positive spatial externalities. The results indicate that industry agglomeration increases the presence of Japanese automotive firms in neighboring states, highlighting the presence of Japanese production networks that are not fixed to a specific region but span across different states in Mexico.

The results of the SAR model also highlight the relevance of the market size variable as a pull factor of Japanese automotive FDI in Mexico. Post-estimation diagnostic checks were conducted. For the SAR model, The Dicky Fuller test indicated a value of -2.39, signaling that the dependent variable has a stationary process, confirming the use of spatial panel estimation techniques. The L.M. lag test value was 78.57, corroborating the presence of spatial autocorrelation in the lagged spatial dependent variable. These results suggest the use of the SAR and SDM models. However, the panel exhibited the presence of multicollinearity; the result of the Farrar-Glaber multicollinearity test resulted in a X^2 of 122.82. The correlation matrix shows multicollinearity among the state GDP, labor, and automotive production variables. For this reason, the model was estimated once more, eliminating the GDP and labor variables. The elimination of the variables corrected the presence of multicollinearity[3]. The results from the estimations are presented in Table 4.

Table 4
Results from the SDM and SAR models

Variables	SDM		z Statistic	SAR		z Statistic
lnJFDI(t-1)	0.16		1.47	0.33	***	2.82
lnEDU	118.04	*	0.81	-30.01		-0.44
lnAUTO	0.87		-1.16	-0.51		-0.26
lnCRIME	-0.13		0.07	0.52		0.44
W*lnEDU	-564.17	***	-3.39			
W*lnYAUTO	1.75	**	2.89			
W*lnCRIME	1.43		0.67			
Rho	0.08		0.77	0.02		0.21
AIC	386.63			395.26		

Note: *** p < 0.01, ** p < 0.05, * p < 0.1
N= 85

Source: Authors' elaboration

The results from the reduced SDM model indicate a positive and statistically significant effect from the education variable, confirming the previous findings. Also, spatial effects from the education and industry agglomeration variables are present. Similar to the results of the previous model, a competition effect is present in education levels among states. Higher education levels in one state reduce Japanese automotive FDI flows in neighboring states. The automotive industry agglomeration variable exhibits positive spatial effects. These findings reinforce the location preference of Japanese firms in production networks that span across regions in Mexico.

[3] The results of the Farrar-Glaber statistic resulted in a X^2 value of 3.76., with a p-value of 0.28.

Conclusions

FDI location theories highlight the reasons behind firms deciding to invest abroad and the regional factors that influence the location and spatial distribution of the investment project. Theoretical contributions and previous empirical work highlight factors such as the size and growth of the domestic and regional markets, the availability of skilled labor, the quality of infrastructure, competition from institutions, agglomeration economies, service support systems, crime levels, and local governments' macroeconomic and attraction policies as factors that influence FDI location decisions.

Considering what is reported by previous literature and the limitations from previous findings, the contribution of this work is the empirical identification of the main factors that influence the location of Japanese multinationals. To achieve the research goal, a state-level spatial panel econometric model was constructed to empirically contrast the main location factors that influence the spatial distribution of Japanese companies. An ESDA was carried out to confirm the presence of spatial dependence in the data. Results from Moran's I statistic indicate the presence of spatial autocorrelation in the dependent variable for the years 2013 and 2017. Further analysis found the presence of spatial clustering in all years of analysis except for 2018. The ESDA results suggest using spatial econometric techniques to account for spatial dependence in the data.

The main results indicate that state characteristics related to wages, market size, and education levels influence the presence of Japanese automotive firms in Mexico. The results support previous findings in the literature on FDI flows to Mexico (Fanbasten & Göstas, 2016; Juarez & Angeles, 2013; Jordaan, 2009). Considering the spatial component in the data, the results also highlight the presence of negative externalities for the market size and education variables. These findings suggest that neighboring states compete for the arrival of Japanese automotive firms, and negative spatial spillover effects are present. A complementary relationship between Japanese FDI inflows and state development is confirmed as in previous findings for Mexico (Escobar, 2013; Guzman-Anaya, 2017).

Positive spatial externalities were observed from the industry agglomeration variable, which reflects the presence of production networks in the automotive industry that incentivize the location of

Japanese firms. The results suggest the presence of "complex vertical FDI." Under this scenario, Japanese automotive firms distribute through production chains among neighboring states to access cost-differential inputs. The results coincide with previous work in Japanese industrial organization systems that follow a Keiretsu-type production scheme (Lugo-Sanchez, 2022; Belderbos & Carree, 2002).

Theoretical models, including the eclectic paradigm, the institutional approach, the new theory of trade, and the Heckscher-Ohlin theoretical model, support the study's results. The results confirm previous empirical findings for the case of Mexico, specifically those related to studying the spatial distribution of Japanese automotive firms.

The crime variable was not statistically significant in the econometric results. However, in previous literature, crime has been a deterrent to FDI inflows to Mexico (Escobar Gamboa, 2019; Cabral et al., 2018). The lack of statistically significant results suggests that Japanese firms do not consider this variable in their location decisions. Ashby & Ramos (2013) report similar findings for the manufacturing industry. However, further research is encouraged in this area.

Policy recommendations from the study suggest that state governments should prioritize the development of human capital as a critical factor in attracting Japanese investment projects. Also, according to the analysis, state development must hold a complementary relationship with Japanese FDI inflows. State-level cooperation with Japanese development agencies (e.g., JICA) may aid this area. For example, previous cooperation projects between JICA and CONALEP (a Mexican technical school) aimed at the automotive industry have registered positive results (Romero, 2020).

Policy coordination between states may also increase the arrival of Japanese projects, specifically by providing the required infrastructure to continue developing the global value chains that span regions and integrate Japanese automotive production under a Keiretsu-type industrial organization. Previous studies argue that only economic policies, such as the presence of infrastructure, influence the attraction of foreign investment. Public and social policies do not seem to affect the location of foreign firms in different states of Mexico (Ortega & Infante, 2016; Lugo-Sanchez, 2018).

Finally, future research should focus on the spatial externalities from Japanese automotive FDI regarding knowledge, technology, or productivity spillovers in the industry and analyze the integration of endogenous firms in the Japanese automotive production networks.

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References

[1] Anselin, L. (1988). *Spatial Econometrics: Methods and Models*. London, England: Kluwer.
[2] Anselin, L. (1995). "Local indicators of spatial association". *Geographical Analysis*, 27(2), 93–115.
[3] Aoki, M. (1990). "Toward and Economic Model of the Japanese Firm". *Journal of Economic Literature*, 28(1), 1-27.
[4] Asanuma, B. (1989). "Manufacturer-supplier Relationships in Japan and the Concept of Relation Specific Skill". *Journal of the Japanese and International Economies*, 3(1), 1-30.
[5] Ashby, N., and Ramos, M. (2013). "Foreign Direct Investment and Industry Response to Organized Crime: The Mexican Case". *European Journal of Political Economy*, 30, 80-91.
[6] Assunção, S., Forte, R., and Teixeira, A. A. C. (2011). "Location Determinants of FDI: a Literature Review". *FEP Working Papers,* (433), 23–67. doi: 10.1057/9781403907493_2
[7] Belderbos, R, and Carree, M. (2002). "The Location of Japanese Investments in China: Agglomeration Effects, Keiretsu and Firm Heterogeneity". *Journal of the Japanese and International Economies,* 16(2), 194-211.
[8] Belotti, F., Hughes, G., and Mortari, A. P. (2017). "Spatial Panel-data Models Using Stata". *Stata Journal*, 17(1), 139-180.
[9] Blanc-Brude, F., Cookson, G., Piesse, J., and Strange, R. (2014). "The FDI Location Decision: Distance and the Effects of Spatial Dependence". *International Business Review*, 23(4), 797-810.
[10] Cabral, R., Mollick, A., and Saucedo, E. (2018). "The Impact of Crime and Other Economic Forces on Mexico's Foreign Direct Investment Flows". *Banco de México Working Papers*, 2018-24, 1-37.
[11] Caves, R. (1996). *Multinational Firms and Economic Analysis*. Cambridge, England: Cambridge University Press.
[12] Coughlin, C., Terza, J. V., and Arromdee, V. (1991). "State Characteristics and the Location of Foreign Direct Investment in the United States". *The Review of Economics and Statistics,* 73(4), 675-678.
[13] De Castro, P. G., Aparecida, F. E., and Carvalho, C. A. (2013). "The Determinants of Foreign Direct Investment in Brazil and Mexico: An Empirical Analysis". *Procedia Economics and Finance*, 5, 231-240.

[14] Dunning, J. H. (1998). "Location and the Multinational enterprise: A neglected factor". *Journal of International Business Studies,* 29(1), 46-66.

[15] Dunning, J. H. (2002) Trade, Location of Economic Activity and the Multinational Enterprise: A Search for an Eclectic Approach. In Dunning, J. H. (Ed.), *Theories and Paradigms of International Business Activity – the Selected Essays of John H. Dunning* (52-76). Cheltenham: Edward Elgar Publishing Limited.

[16] Dunning, J. H., and Lundan, S. M. (2008). Theories of Foreign Direct Investment. In Dunning, J. H., and Lundan, S. M. (Eds.), *Multinational Enterprises and the Global Economy* (79-115). Cheltenham: Edward Elgar Publishing Limited.

[17] Elhorst, J. P. (2010). "Applied Spatial Econometrics: Raising the Bar". *Spatial Economic Analysis*, 5, 9-28.

[18] Escobar, O. (2013). "Foreign direct investment (FDI) determinants and spatial spillovers across Mexico's states". *The Journal of International Trade and Economic Development*, 22(7), 993-1012.

[19] Faeth, I. (2009). "Determinants of Foreign Direct Investment – A Tale of Nine Theoretical Models". *Journal of Economic Surveys,* 23(1), 165-196.

[20] Fanbasten, N., and Göstas Escobar, A. (2016). *Determinants of Foreign Direct Investment: A panel data analysis of the MINT countries*. (Master's Thesis). Department of Business Studies, Uppsala University.

[21] Fonseca, F. and Llamosas-Rosas, I. (2019). "Spatial Linkages and Third-region Effects: Evidence from Manufacturing FDI in Mexico". *The Annals of Regional Science,* 62, 265-284. https://doi.org/10.1007/s00168-019-00895-1

[22] Friedman, J., Hung-Gay, F., Gerlowski, D. A., and Silberman, J. (1996). "A note on 'State Characteristics and the Location Choice of Foreign Direct Investment within the United States'". *The Review of Economics and Statistics,* 78(2), 367-368.

[23] Garriga, A. (2017). "Inversión extranjera directa en México: comparación entre la inversión procedente de los estados unidos y del resto del mundo". *Foro Internacional,* 57(2), 318-320.

[24] Guan, H., and Li, Q. (2021). "Spatial Spillover Effects of Economic Growth Based on High- Speed Railways in Northeast China". *Complexity,* (2021), 1-11. doi: https://doi.org/10.1155/2021/8831325

[25] Guimares, P., Figueiredo, O., and Woodward, D. (2000). "Agglomeration and the location of Foreign Direct Investment in Portugal", *Journal of Urban Economics,* 47(1), 115-135.

[26] Guzman-Anaya, L. (2017). "Spatial Determinants of Japanese FDI Location in Mexico", *México y la Cuenca del Pacífico,* 17, 13-35.

[27] Haining, R.P. (2001). "Spatial Autocorrelation". In Neil J. Smelser and Paul B. Baltes (Eds.). *International Encyclopedia of the Social & Behavioral Sciences.* Pergamon. https://doi.org/10.1016/B0-08-043076-7/02511-0.

[28] Head, K. C., Ries, J. C., and Swenson, D. L. (1999). "Attracting Foreign Manufacturing: Investment Promotion and Agglomeration". *Regional Science and Urban Economics*, 29(2), 197-218.

[29] Ietto-Gillies, G., (2005). *Transnational Corporations and International Production: Concepts, Theories and Effects*. Cheltenham: Edward Elgar Publishing.

[30] INEGI (2020a). "Encuesta Mensual de la Industria Manufacturera". *Instituto Nacional de Geografía y Estadística.* México: Instituto Nacional de Geografía y Estadística.

[31] INEGI (2020b). "Producto Interno Bruto de las Actividades Económicas por Entidad Federativa". *Instituto Nacional de Geografía y Estadística.* México: Instituto Nacional de Geografía y Estadística.

[32] INEGI (2020c). "Censo de Población y Vivienda 2020". *Instituto Nacional de Geografía y Estadística.* México: Instituto Nacional de Geografía y Estadística.

[33] Jordaan, J. A., (2009). *Foreign Direct Investment, Agglomeration and Externalities*. England: Ashgate.

[34] Juarez, R., and Angeles, C. (2013). "Foreign Direct Investment in Mexico Determinants and its Effects on Income Inequality". *Contaduría y Administración,* 58(4), 201-222.

[35] Lesage, J., and Pace, R. (2009) *"Introduction to Spatial Econometrics".* New York: Chapman and Hall.

[36] Luger, M., and Shetty, S. (1985). "Determinants of Foreign Plant Start-ups in the United States: Lessons for Policy Makers in the Southeast". *Vanderbilt Journal of Transnational Law*, 18, 223-245.

[37] Lugo-Sanchez, M. G. (2018). "The Role of Public Policies in Attracting Japanese FDI in Mexico". In Falck Reyes, M. and Guzmán-Anaya, L. (Eds.). *Japanese Direct Investment in Mexico's Transport Equipment Sector. Macro Impact and Local Responses* (81-102). Singapore: Springer.

[38] Lugo-Sanchez, M. G. (2022). *The Role of Public Policies, Agglomeration and the Keiretsu in the Spatial Distribution of Japanese Automotive Production Networks in Mexico's Bajio Region 2016-2020*. (Doctoral Thesis). Centro Universitario de Ciencias Económico Administrativas, Universidad de Guadalajara.

[39] Mollick, A. V., Ramos-Duran, R., and Silva-Ochoa, E. (2006). "Infrastructure and FDI Inflows into Mexico: A Panel Data Approach". *Global Economy Journal*, 6(1), 1-27.

[40] Mughal, M. M., and Akram, M. (2011). "Does market size affect FDI? The Case of Pakistan". *Interdisciplinary Journal of Contemporary Research in Business*, 2(9), 237-247.

[41] Ortega, P. G., and Infante, Z. J. (2016). "Determinantes de la inversión extranjera directa en la región de la Cuenca del Pacífico". *México y la Cuenca del Pacífico*, 5(14), 79-102.

[42] Peng, M. (2009). Institutions, Cultures and Ethics. In Peng, M. (Ed.), *Global Strategic Management* (90-122). Cincinnati: South-Western Cengage Learning.

[43] RNIE (2020). "Registro Nacional de Inversión Extranjera Directa". *Secretaría de Economía.* México: Secretaría de Economía.

[44] RNIE (2022). “Registro Nacional de Inversión Extranjera Directa”. *Secretaría de Economía.* México: Secretaría de Economía.

[45] Romero, M.E. (2020). “La Cooperación japonesa para el desarrollo. El estado de Guanajuato en México, donde los objetivos del sector publico y privado se encuentran”. *Revista Administración Pública y Sociedad*, 9, 66-86.

[46] Romero, Q. L., and Andres-Rosales, R. (2014). *Técnicas Modernas de Análisis Regional*. México:Plaza y Valdés.

[47] Samford, S., and Ortega, P. G. (2012). “Subnational Politics and Foreign Direct Investment in Mexico”. *Review of International Political Economy*, 21(2), 467-492.

[48] SE (2020). “Información estadística general de flujos de IED hacia México desde 1999”. *Secretaría de Economía.* México: Secretaría de Economía. Available in: <.https://datos.gob.mx/busca/dataset/informacion-estadistica-de-la-inversion-extranjera-directa/resource/06ad9dbb-cbd2-4b17-9586-daf78326308a >.

[49] Smith, D. F., and Florida, R. (1994). “Agglomeration and Industrial Location: An Econometric Analysis of Japanese-Affiliated Manufacturing Establishments in Automotive-Related Industries”. *Journal of Urban Economics*, 36(1), 23-41.

[50] SESNSP (2023). “Datos abiertos de incidencia delictiva”. *Secretariado Ejecutivo del Sistema Nacional de Seguridad Pública.* Available in: <https://www.gob.mx/sesnsp/acciones-y-programas/datos-abiertos-de-incidencia-delictiva?state=published.>.

[51] Toyo Keizai (2015) “Kaigai Shinshutsu Kigyou Souran-Kuni Betsu”. *Toyo Keizai.* Tokyo, Japan: Toyo Keizai.

[52] Toyo Keizai (2017) “Kaigai Shinshutsu Kigyou Souran-Kuni Betsu”. *Toyo Keizai.* Tokyo, Japan: Toyo Keizai.

[53] Toyo Keizai (2020) “Kaigai Shinshutsu Kigyou Souran-Kuni Betsu”. *Toyo Keizai.* Tokyo, Japan: Toyo Keizai.

[54] Woodward, D. (1992) “Locational Determinants of Japanese Start-ups in the United States”. *Southern Economic Journal,* 58, 690-708.

[55] Zaheer, S. (1995) “Overcoming the Liability of Foreignness”. *Academy of Management Journal,* 19(1), 63-86.