https://doi.org/10.21670/ref.1909030

Articles

Flexibilization of the input-output model to determine productive interdependencies in the border city of Reynosa, Tamaulipas, 2013

Flexibilización del modelo de insumo-producto para determinar interdependencias productivas en la ciudad fronteriza de Reynosa, Tamaulipas, 2013

Rodrigo Vera Vázquez[a]* https://orcid.org/0000-0001-9200-4428
Miguel Angel Langle Flores[a] https://orcid.org/0000-0002-6260-5537

[a] El Colegio de Tamaulipas, Ciudad Victoria, Tamaulipas, Mexico, e-mail addresses: ecovera2007@gmail.com, angel120425@hotmail.com

Received on December 7, 2018.
Accepted on June 27, 2019.
Published on August 14, 2019.

*Corresponding author: Rodrigo Vera Vázquez, e-mail ecovera2007@gmail.com

Abstract

Strategies of regional economic policy are suggested for the border municipality of Reynosa, Tamaulipas, resulting from the analysis of economic data of 2013. A regional input-output matrix and its corresponding multiplier analysis are constructed taking as starting point Leontief and Flegg, Webber and Elliot models. Besides, the influence of the industrial activity is classified and a structural vision of the productive chains is provided, following Rasmussen. The results show the marginal nature of the multipliers of production, employment, income and value added in non-manufacturing productive activities.

Keywords: Reynosa, Tamaulipas, input-output, manufacturing, economy.

Resumen

Con información económica del año 2013, se sugieren estrategias de política económica regional para el municipio fronterizo de Reynosa, Tamaulipas. A partir de los modelos de Leontief y Flegg, Webber y Elliot, se construye una matriz de insumo-producto regional y su correspondiente análisis de multiplicadores. Para complementar el procedimiento, se tipifica la influencia de la actividad industrial y se brinda una visión estructural de los encadenamientos productivos siguiendo a Rasmussen. Los resultados muestran el carácter marginal de los multiplicadores de producción, empleo, remuneración de los asalariados y valor agregado en las actividades productivas no manufactureras.

Palabras clave: Reynosa, Tamaulipas, insumo-producto, manufactura, economía.

CITATION: Vera, R. & Langle, M. A. (2019). Flexibilización del modelo de insumo-producto para determinar interdependencias productivas en la ciudad fronteriza de Reynosa, Tamaulipas, 2013. [Flexibilization of the input-output model to determine productive interdependencies in the border city of Reynosa, Tamaulipas, 2013]. *Estudios Fronterizos*, *20*, e030. doi: https://doi.org/10.21670/ref.1909030

Introduction

The manufacturing, maquiladora, and export services industries located in the north of Mexico have transformed the economies of the municipalities on the border with the United States. Economic data for 2013 indicate that of the 80 municipalities on the U.S. border, eight account for more than 75% of the total gross border output (Instituto Nacional de Estadística y Geografía [Inegi], 2014). The bloc comprising Tijuana, Mexicali, Nogales, Ciudad Juárez, Piedras Negras, Reynosa, Nuevo Laredo, and Matamoros is an established productive power.

In Reynosa, Tamaulipas, the poor performance of nonmanufacturing industries has dissipated any sign of economic diversification. There, the local system has few intersectoral linkages, especially with the high-performing sectors of computer equipment and electronic component manufacturing. In ideal scenarios for (Walrasian) buying and selling of intersectoral inputs, manufacturing specialization would explain a commercial behavior that is characterized by influencing the economic growth of other productive activities. Accordingly, there are some contributions that identify the regional economic profile of Reynosa nevertheless a systematic review of its sectoral linkages is lacking. Thus, the application of an input-output model is essential for examining the functioning of the local productive structure.

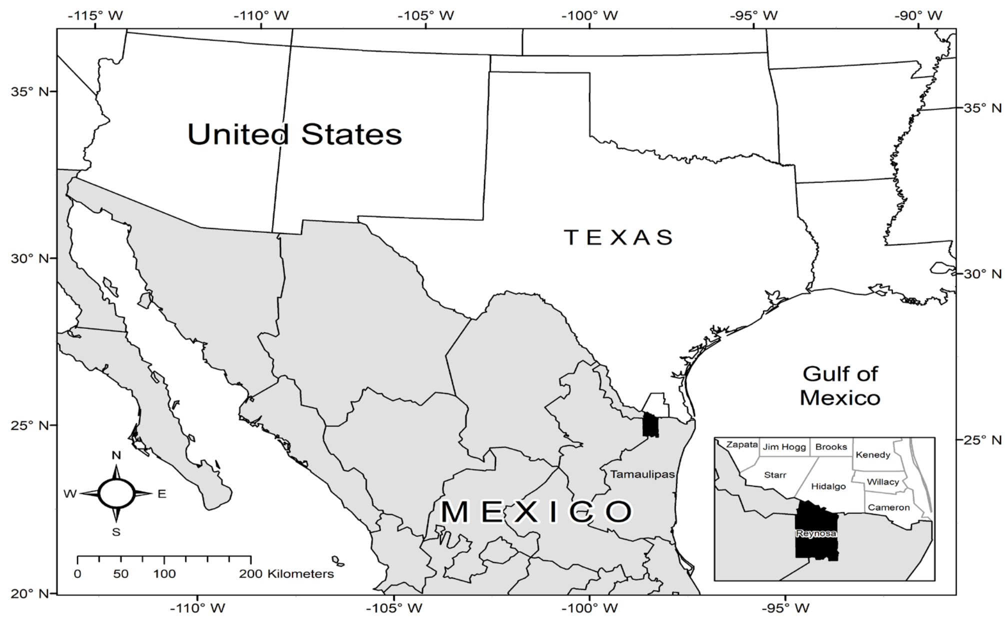
The above raises two key questions: *1*) Considering national sectoral behavior, what economic subsectors existed in this city by the end of the study period (2013)? *2*) Which of these subsectors exhibited the greatest productive interrelationships due to their ability to create a buying and selling network in the local economy?

The objective of this study is to determine the productive interdependencies between the various economic activities of the border city of Reynosa (see Figure 1). The results are expected to potentially improve the definition of the city's industrial profile by classifying the subsectors according to the significance of their interdependencies, using different applications of regional economic analysis techniques – specifically, the Leontief models (Leontief, 1936; 1941).

The suitability of estimating a regional input-output matrix and its corresponding accounting multipliers is discussed throughout this article. The regionalization was based on Flegg, Webber & Elliot (1995) and Flegg & Webber (1997), while the Rasmussen model (1956) was used as a reference for the analysis of productive chains.

It is hoped that the methodology used in this study can provide an input for future studies analyzing sectoral interdependencies at the municipal level as well as for the design of public policies for regional economic development.

Figure 1: Geographical location of the municipality of Reynosa



Source: El Colegio de Tamaulipas (Coltam) Geographical Information System (GIS).

Theoretical Foundation for the Circular Flow of Productive Interdependencies in an Economy

According to Miller & Blair (2009), the idea of explicitly developing interindustry activity accounting dates back to 1758; at that time, the French economist Quesnay (1759) developed an economic table that represented the economy as a circular flow of inputs and outputs between different economic sectors. Later, in the 19th and 20th centuries, Walras (1874), Pareto (1906), Bortkiewicz (1907), and Cassel (1924) refined Quesnay's ideas by developing the concept of general equilibrium. In this context, Leontief (a student of Bortkiewicz) formalized these approaches in his doctoral thesis "The economy as a circular flow". He applied an empirical implementation to the theory of general equilibrium through a two-sector, input-output system that enabled associating supply and demand in an economy. Consequently, Leontief's model (Leontief, 1936; 1941) was recognized in the latter part of the 20th century with the United Nations' recommendations regarding the System of National Accounts (Organización de las Naciones Unidas [ONU], 2018). Today, Leontief's input-output analysis continues to be one of the most widely used methods in economics. Its main applications concern the proportional stability of intersectoral transactions (technical coefficients), the development of regional matrices, and general equilibrium models (Aroche, 2013).

Leontief's model (Leontief, 1936; 1941) has led to two analytical approaches: static and dynamic. Although the former, which is used in this study, is considered one of the most useful tools for regional and sectoral economic analysis, it fails to predict changes in the components of final demand because multipliers record nontemporal effects on production. Hence, the dynamic version is being considered as an alternative to resolve these limitations (Fuentes, Brugués & González, 2015; Fuentes & Castillo, 2012; Johnson, 1986). The dynamic approach considers that some inputs contribute to the production process but are not immediately used. Therefore, it is necessary to incorporate capital goods to explain production growth (Miller & Blair, 2009). However, the solution methods include the use of specialized software to resolve dynamic optimization problems and are beyond the scope of this article.

From Leontief's Model to Flegg's Flexibilization

Initially, the regional matrices were developed using surveys (direct methods). However, to save time and decrease instrumentation costs, alternative techniques (indirect and hybrid methods)[1] for building input-output tables were developed.

Of all the indirect methods based on location coefficients, the approach by Flegg et al. (1995; Flegg & Webber, 1997) is considered the most accurate for generating regional coefficients from national coefficients, notwithstanding the discussion concerning the value of the delta parameter (Bonfiglio, 2005; Bonfiglio & Chelli, 2008; Kronenberg, 2011). Flegg & Tohmo (2011) indicated that 0.25 is the most suitable value for estimating regional multipliers.

It should be noted that Inegi stopped generating national input-output matrices for Mexico in the 1980s (Aroche, 2013). However, in 2008 and 2013, Inegi produced national matrices for 2003 and 2008, respectively, and in January 2018, the institution published an input-output matrix for the Mexican economy in 2013. Consequently, more work has focused recently on the empirical development of regional input-output matrices using indirect methods based on location coefficients (Albornoz, Canto & Becerril, 2012; Castro, 2010; Chapa et al., 2009; Chiquiar, Alvarado, Quiroga & Torre, 2017; Dávila, 2002; Fuentes, 2005; González, Díaz & Leal, 2010; Valdés, 2014). Similarly, the regional model is practical for analyzing multiplier effects and productive linkages at the municipal level (Fuentes, 2003; Martínez & Gómez, 2008; Salinas, González, León & Rodríguez, 2017; Tapia, Vite, Salazar & Zamora, 2010).

One of the more prominent subnational studies is that of Fuentes (2003), who estimated input-output interdependencies in the border city of Mexicali, Baja California. To estimate the municipal input-output matrix (IOM), Fuentes used a synthetic indirect method (supply-demand adjustment) to modify the IOM coefficients for the state and then to produce estimates of the municipal IOM coefficients. Fuentes believed that interindustry transactions have the same patterns as state transactions and calculated the regional demand and supply of goods and services as such. Since Mexicali is a city that has historically been dedicated to agriculture, the procedure used to estimate productive interdependencies was ideal, since nonmanufacturing sector activity is key to that city's economic structure. Reynosa's economic profile

[1] Indirect and hybrid methods incorporate better information (quantitative and qualitative) from official sources, specialized partial surveys, and expert opinions in the area as well as a mathematical process for balancing external data (Bravo & Castro, 2006; Chapa, Ayala & Hernández, 2009; Fuentes, 2005).

is dominated by manufacturing, and in the absence of a state IOM, it is considered appropriate to use an indirect method based on location coefficients to estimate regional technical coefficients.

Thus, the greatest challenge for researchers in using regional economic analysis techniques to identify productive interdependencies is adaptation of the Leontief model (Leontief, 1936; 1941) based on the flexibilization offered by Flegg et al. (1995) and Flegg & Webber (1997).

This study uses the national input-output matrix for 2013 (Inegi, 2018); it comprises 20 sectors, 79 subsectors, 262 branches, and 822 economic classes, and its values are expressed in millions of 2013 pesos.

A disaggregation level of 50 economic subsectors was used in this study because the economic census information at the national and municipal levels is incongruent. For example, because there are no data for the agricultural sector, working with a higher level of sectoral disaggregation (branch or class) would increase the bias generated by the scarcity of information at a subnational level.

Regarding the regionalization of the national IOM, municipal intersectoral trade coefficients were derived using the *FLQ* formula presented in Flegg et al. (1995) and Flegg & Webber (1997) with a delta parameter value of 0.25. Per Miller and Blair (2009) and due to the unavailability of the total gross domestic product vector, the Total Remunerated Personnel vector (Inegi, 2014) was used. Using this same vector and the national GDP, the structure for municipal gross production was estimated. Lastly, using matrix algebra, an intersectoral transaction matrix was produced for the economy of Reynosa.[2]

Methodology

Basic Input-Output Model

Per Miller & Blair (2009), the following matrix notation synthesizes the Leontief model:

$$AX + Y = X$$

Where:
A = matrix of technical production coefficients ($a_{i,j}$),
X = column vector of gross production values, and
Y = column vector of final demand.

[2] Due to space limitations, the results of the application of the interregional Leontief model to Reynosa are presented in the appendices. Interested readers may request the authors to provide the databases that support the results and were used to produce the input-output multipliers in Table 2.

Each technical coefficient is calculated as follows:

$$a_{i,j} = x_{i,j} / x_j \qquad (i,j=1,2,...,n)$$

where
$x_{i,j}$ = value of sales of intermediate inputs of sectors *i* to *j*, and
x_j = value of gross production for sector *j*.
Clearing the *Y*:

$$Y = X(I - A)$$

where
I = matrix identifier, and
$(I - A)$ = Leontief matrix.
To solve for *X*, multiply $(I - A)^{-1}$, the inverse of the Leontief matrix by *Y*.
$X = (I - A)^{-1} Y$

The necessary inputs for this system's solution are the technical production coefficients ($a_{i,j}$) and the values for the final demand vector (Y). If (X) and ($a_{i,j}$) are known, the values of (Y) can be obtained directly:

$$Y = X(I - A)$$

Regionalization of the Input-Output Model

The objective purpose is to find an estimator ($t_{i,j}$) for the percentage of technical production coefficients ($a_{i,j}$) supplied within the region itself. Knowing this estimator enables us to calculate the regional coefficients of intersectoral trade ($r_{i,j}$), which are expressed as follows:

$$r_{i,j} = t_{i,j}\, a_{i,j} \qquad (i, j = 1,2,\dots, n)$$

The formula proposed by Flegg et al. (1995) and Flegg & Webber (1997) to find the ($t_{i,j}$) estimator for the percentage of technical production coefficients ($a_{i,j}$) supplied within the region is as follows:

$$FLQ_{i,j} = CILQ_{i,j}\, \lambda_r^{\delta} \qquad i,j = 1,2,\dots, n$$

where
$FLQ_{i,j}$ = Flegg Location Quotient (Flegg et al., 1995; Flegg & Webber, 1997),
$CILQ_{i,j}$ = cross-industry location quotients, and
λ_r^{δ} = weighting factor for the relative size of the region (r).

As a result,

$$\begin{array}{ll} CILQ_{i,j} = LQ_i \,/\, LQ_j & i,j = 1,2,\ldots,\ n \\ LQ_i = \ (PRT_{i,r} / \ PRT_r) \ / \ (PRT_i \ / \ PRT) & i,r = 1,2,\ldots,\ n \\ \lambda_r^{\delta} = log_2\ [1 + (PRT_r \ / \ PRT)] & r = 1,2,\ldots,\ n \end{array}$$

where
LQ_i and LQ_j = simple location quotients.
PRT = Total Remunerated Product.

Once the value of $t_{i,j}$ is obtained, it is multiplied by the corresponding national coefficient ($a_{i,j}$) to estimate the regional coefficients of intersectoral trade ($r_{i,j}$).

In turn, the regional input-output model is formulated and resolved in a manner similar to the basic model. According to Dávila (2015), the solution is expressed in the following terms:

$$X^r = (I - A^{rr})^{-1} Y^r$$

where
A^{rr} = matrix of regional coefficients of intersectoral trade (*rij*),
X^r = column vector of gross production values for region *r*,
I = identity matrix, and
$(I - A^{rr})$ = Leontief matrix for the regional model.[3]

Domestic interregional flows are obtained as a residual between the total domestic inputs of the national IOM and those within the region. Thus, in matrix notation,

$$A = \begin{bmatrix} A^{rr} & A^{rs} \\ A^{sr} & A^{ss} \end{bmatrix}$$

where
A^{rr} = matrix of regional coefficients for region *r*,
A^{sr} = matrix of coefficients for interregional imports of domestic inputs from *r* to the rest of the country (region *s*),
A^{rs} = matrix of coefficients for interregional exports of domestic inputs from *r* to *s*, and
A^{ss} = matrix of regional coefficients for region *s*.

[3] For clarity, to estimate the results presented in this article, the analysis was limited to the matrix of regional coefficients of intersectoral trade A^{rr}.

$$X = \begin{bmatrix} X^r \\ X^s \end{bmatrix}$$

where
X^r = column vector of gross production values for region r, and
X^s = column vector of gross production values for region s.

$$Y = \begin{bmatrix} Y^r \\ Y^s \end{bmatrix}$$

where
Y^r = column vector of final demand for region r, and
Y^s = column vector of final demand for region s.

$$I = \begin{bmatrix} I^r & O \\ O & I^s \end{bmatrix}$$

where
I^r = identity matrix for r, and
I^s= identity matrix for s.
The system solution is obtained in the same way as in the standard model.

Production, Employment, Employee Compensation and Value-added Multipliers

One of the main uses of an input-output model is determination of the effect of exogenous changes on an economy. This process is called impact analysis, and the aggregate measures used in this analysis are called input-output multipliers. The most commonly used multipliers are those that estimate the effects of exogenous changes on industrial production, employee compensation due to increased production, employment generated in each industry due to new production, and the added value created by each productive sector due to increased production (Miller & Blair, 2009).

The production multiplier for sector *j* is defined as the total value of the production of an economy's industries needed to satisfy the final demand for the production of sector *j* when demand increases by one monetary unit. The total "backward" multipliers indicate the necessary increase in the gross value of production of an economy's various sectors due to an increase in the final demand of a sector of activity. The total "forward" multipliers indicate the regional increase in the gross production value of a sector needed to satisfy a one-unit increase in the final demand of all sectors of the local economy (Miller & Blair, 2009).

Direct effects represent the additional demand for inputs generated by an increase in sectoral final demand, while indirect effects result from the chain reaction of all economic sectors as a result of the additional demand for inputs from the sector that initially changed its final demand. However, not all economic activities have the same capacity to produce multiplier impacts on others (Dávila, 2015).

Per Dávila (2015), the production model solution can be expressed as follows:

$x = (I - A)^{-1}\, y$
If
$L = (I - A)^{-1}$,
then
$x = Ly$.

The elements for the inverse Leontief matrix (L) can be grouped in four submatrices:

$$L = \begin{bmatrix} L_{11} & L_{12} \\ L_{21} & L_{22} \end{bmatrix}$$

Based on the above, the total production multipliers (m) (subscript o) for the region analyzed (superscript r), are obtained by adding the columns with the elements (L_{11} and L_{21}) of the inverse Leontief matrix (L) of the interregional model:[4]

$$m_o^r = i' \begin{bmatrix} L_{11} \\ L_{21} \end{bmatrix}$$

Therefore, to calculate the total employment multipliers (l_c), a diagonal matrix must first be computed using the coefficients of the share of remunerated jobs in the gross output of each sector. To do this, the row vector of remunerated jobs is multiplied by the inverse of a diagonal matrix made up of the gross production values:

$$l'_c = l'\hat{x}^{-1}$$

Next, this matrix must be multiplied by the inverse Leontief matrix (L) of the interregional model, and the result is multiplied by the inverse of the previously calculated matrix:

$$m_i^{II} = i' l'_c L(\hat{i}'_c)^{-1}$$

The sum of the columns of the resulting matrix shows the total employment multipliers. Lastly, to calculate the total multipliers of the value added and of employee compensation, we proceed in a similar manner by replacing the values corresponding to each variable in the two previous equations (Dávila, 2015).[5]

[4] For clarity, to estimate the results presented in this article, the analysis was limited to sub-matrix L_{11} so as to be consistent with the delineation of the previously mentioned A^{rr} matrix.

[5] The multipliers for employee compensation and value added are obtained from the national IOM data for 2013 regarding employee compensation and gross value added.

Analysis of the Productive Chains

Classical structural analysis focuses on the identification of backward (BLR) and forward (FLR) productive linkages that quantify direct and indirect effects. In other words, the linkages enable the identification of the sectors with the greatest potential pulling effect or sectors that are associated with many other sectors. Backward linkages measure a sector's capacity for stimulating the development of other sectors that use its inputs. Forward linkages occur when one sector provides an output that is the input of another sector, which in turn is a stimulus for a third sector that is the input of the first sector (Chenery & Watanabe, cited in Schuschny, 2005).

Productive chains have their origins in studies by Chenery & Watanabe (1958), Rasmussen (1956), and Ghosh (1958), who established a four-part sector classification:[6]

- Base: these chains have lower-than-average backward linkages and higher-than-average forward linkages; they generate little demand but much supply.
- Drivers: these chains demand inputs from other intermediate sectors, thereby stimulating the production of intermediate goods.
- Independent or isolated: these chains are usually unattractive because they have a minor impact on the economy; their development does not significantly affect the sectors that demand their products nor those that use them as intermediate products.
- Key: these chains have some higher-than-average backward and forward linkages; they are important because of the demand they produce and the supply they stimulate in other sectors.

Rasmussen (1956), in particular, suggests two measures based on Leontief's inverse matrix to quantify the direct and indirect backward (BLR) and forward (FLR) effects that a sector may experience. The normalized measures are obtained from the following expressions (Table 1):

[6] It is acknowledged that there are alternative techniques for calculating productive interdependencies and establishing sectoral classifications for both national and sub-national economies. These alternatives include the hypothetical extraction method developed by Dietzenbacher, Linden & Steenge (1993) and network theory. The studies by Chraki (2016) and Llano (2009) stand out as the best examples of the hypothetical extraction method, while network theory has evolved out of many contributions, notably the seminal work of García & Ramos (2003) and studies by Hurtado & Martínez (2017), Molina & Gutiérrez (2015), and Fuentes, Cárdenas & Brugués (2013).

$BLR = (ni'(I - A)^{-1}) \ / \ (i'(I - A)^{-1}i)$
$FLR = (n\ (I - A)^{-1}i) \ / \ (i'(I - A)^{-1}i)$

where
$(I - A)^{-1}$ is the Leontief inverse matrix,
i' is a row vector with values equal to the unit,
A is the matrix of technical coefficients,
i is a vector column with values equal to one, and
n is the total number of sectors.

Table 1: Sector Classification According to Linkages BLR and FLR Effects per Rasmussen (1956)

	BL < 1	BL > 1
FL < 1	Independentit	Driver
FL > 1	Base	Key

Source: Created by the authors based on Rasmussen (1956).

Results

Building the Reynosa 2013 Input-Output Matrix: Context of the Starting Point

To determine how the industrial sector in Reynosa's economy is structured, this section incorporates some regional economic analysis techniques, including the average annual growth rate of the total gross output, the location quotients of the total remunerated personnel, the input-output multipliers, and an analysis of the productive chains.

Average Annual Growth Rate of the Total Gross Output

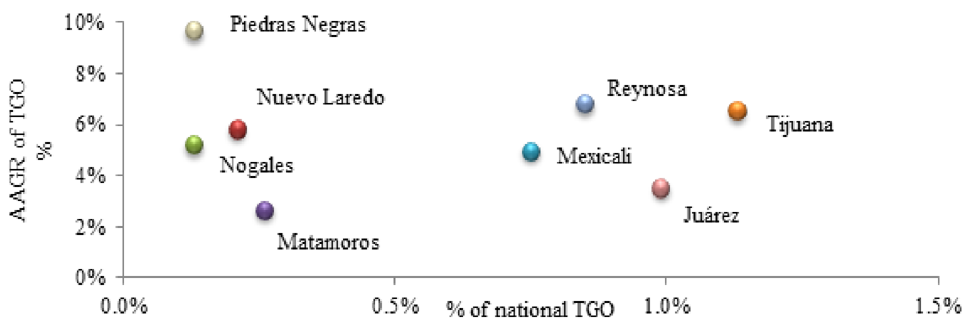
Mexico's northern border is made up of six states that represent 24% of Mexico's total gross output. There are 80 municipalities along the border with the U.S.; eight of these represent 18% of the border state output. Therefore, the output of the other 72 municipalities is not significant. The municipalities of Tijuana, Mexicali, Nogales, Ciudad Juárez, Piedras Negras, Reynosa, Nuevo Laredo, and Matamoros account for more than 75% of the total gross output of Mexico's northern border region (Inegi, 2014).

When examining the average annual growth rate (AAGR) of the total gross output (TGO) of the most important border municipalities from 2003-2013,[7] Piedras Negras, Coahuila (9.7%) stands out as the highest performer, followed by Reynosa (6.79%), with Tijuana (6.51%) and Nuevo Laredo (5.79%) close behind. Reynosa's estimated growth exceeded that of Nogales (5.18%), Mexicali (4.94%), Ciudad Juárez (3.49%), and Matamoros (2.64%).

[7] The analysis of the AAGR of the TGO is based on economic census data published by Inegi (2004; 2014).

In contrast, when examining the relationship between AAGR and municipal share of the national TGO, Tijuana (1.13%) and Ciudad Juárez (0.99%) were the border cities with the highest contributions, followed by Reynosa (0.85%) and Mexicali (0.75%). These four cities far exceeded the contributions of Matamoros (0.26%), Nuevo Laredo (0.21%), Piedras Negras (0.13%), and Nogales (0.13%) (see Figure 2).

Figure 2: Mexican Border Cities: Average Annual Growth Rates of Gross Domestic Output (2003-2013) and Share of the National Total Gross Output (2013) in Percentages (%)



Source: Created by the authors based on Inegi's data (2004; 2014).

The relationship between the AAGR of the municipal TGO and its share of the national TGO suggests that Reynosa is frequently considered by companies looking for places to invest and locate. Of all the border cities, Reynosa is considered the most important in the northeastern region. This raises two key questions: *1*) Considering national sectoral behaviors, which subsectors of the economy were identified in Reynosa by the end of the study period (2013)? *2*) Which of these subsectors exhibited the highest productive linkages by having a better capacity for structuring a buying and selling network in the local economy? To answer the first question, the location quotient tool was used. To address the second question, we built an interregional input-output matrix for Reynosa based on Flegg et al. (1995) and Flegg & Webber (1997).

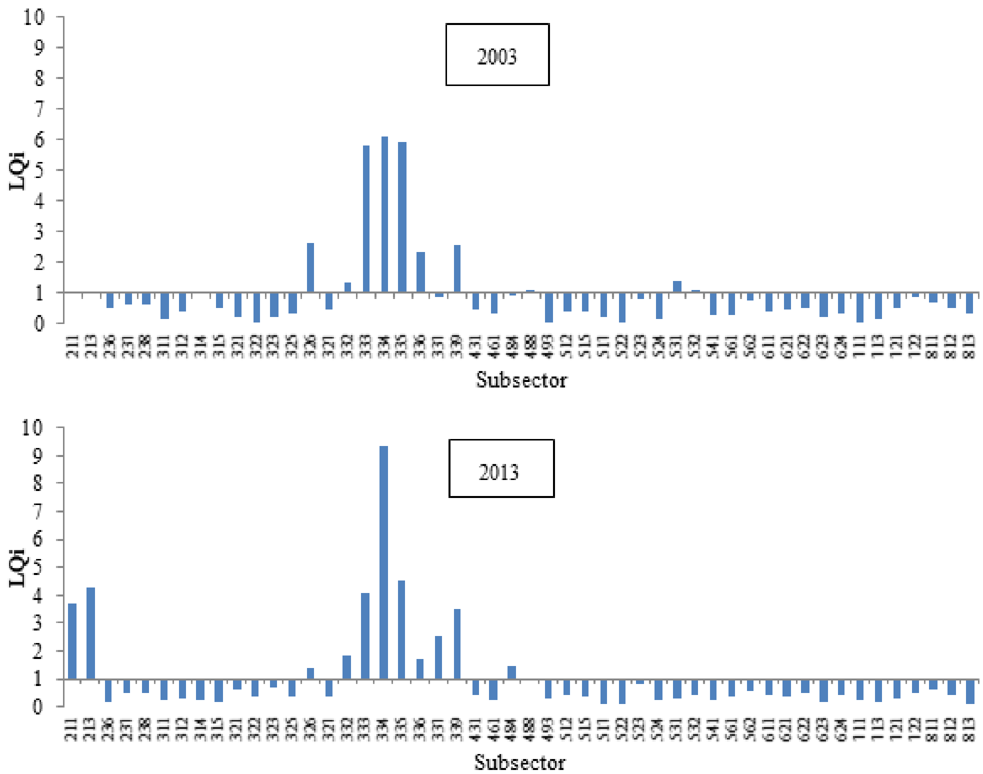
Location Quotients

Location Quotients (LQ)[8] are used to explore the evolution of the municipal economic structure and to identify the relative importance of each economic sector in terms of production. The LQ is ideal for comparing the weight of a sector in a region (Reynosa) to the weight of that same sector in a reference economy (Mexico); three results can be produced: strong regional presence (LQ > 1), weak regional presence (LQ < 1), and self-sufficiency (LQ = 1).

[8] The formula for estimating the location quotient is as follows: LQi = ((ei / et) / (Ei / Et)) where "e" is the total employee compensation for the region (Reynosa), "E" is the national total employee compensation, "I" refers to the subsector of economic activity, and "t" refers to the total economy.

Figure 3 shows Reynosa's location quotients for 2003 and 2013. It is very clear that in terms of paid personnel, computer equipment and electronic component manufacturing is the dominant sector in the municipality, followed by oil and gas extraction activities. This is confirmed by the weak presence in the region of most of the subsectors corresponding to the tertiary economy, with the exception of cargo transport services.

Figure 3: Reynosa: Location Quotients (LQi) 2003 and 2013



Source: Created by the authors based on data from Inegi (2014).

Note 1: The nomenclature for the corresponding subsector can be found in Table 2.
Note 2: The 2003 database does not contain information on the total employee compensation in Reynosa for subsectors 211, 213, or 314.[9]

Before proceeding with the interregional input-output model, the location quotients confirm that the manufacturing, maquiladora, and export services industries have been dominant since 2003 and that the region has maintained its hegemony in computer and peripheral equipment manufacturing as well as in motors and electric

[9] Due to the unavailability of the sectoral vector for gross domestic product, per Miller & Blair (2009), sectoral information on total employee compensation was used to calculate the location quotients. The data are from the economic census conducted by Inegi for 2003 and 2013 (Inegi, 2004; 2014). The total employee compensation variable was selected to avoid inconsistencies between the location quotients and the indirect method used to regionalize the national IOM.

generators manufacturing (Dávila & Escamilla, 2013; Esqueda, 2018; Esqueda & Trejo, 2014; Pérez, Ceballos & Cogco, 2012).[10]

Interregional Input-Output Model

This section presents the analysis of the production multipliers (multiplier effect) and the total multipliers (weighted multiplier effect) for the main macroeconomic variables, which

are employee remuneration, employment, and value added. The results are summarized in Table 2.

Table 2: Reynosa: Weighted Multipliers
(Total Output, Employment, Salaried Worker Remuneration, and Value Added)

		Multipliers			
		Reynosa			
		Output	Employment	Salaried Worker Remuneration	Value Added
Secondary, Nonmanufacturing	211 – Oil and Gas Extraction	1.009	1.166	1.034	1.004
	213 – Support Activities for Mining	1.040	1.094	1.068	1.026
	236 – Construction of Buildings	1.314	1.182	1.172	1.238
	237 – Heavy and Civil Engineering Construction	1.262	1.184	1.223	1.199
	238 – Specialty Trade Contractors	1.143	1.042	1.094	1.070
Secondary, Light Manufacturing	311 – Food Manufacturing	1.138	1.287	1.343	1.215
	312 - Beverage and Tobacco Product Manufacturing	1.272	1.737	1.629	1.278
	314 - Textile Product Mills, except apparel	1.358	1.177	1.308	1.385
	315 - Apparel Manufacturing	1.288	1.138	1.234	1.419
	321 - Wood Product Manufacturing	1.141	1.087	1.122	1.158
	322- Paper Manufacturing	1.230	1.417	1.367	1.392
	323- Printing and Related Support Activities	1.252	1.188	1.244	1.312
Secondary, Heavy Manufacturing	325- Chemical Manufacturing	1.252	1.823	1.377	**1.530**
	326- Plastics and Rubber Products Manufacturing	1.168	1.179	1.194	1.216
	327- Nonmetallic Mineral Product Manufacturing	1.189	1.327	1.360	1.332

[10] When manufacturing is in a procyclical condition, it is a sign of future contractions, as was the case for the electronics industry in Reynosa. From 2008 to 2013, the number of jobs declined from 42 232 to 33 392. In addition, the value of its gross output decreased from 11 billion to 9 billion pesos (Inegi, 2009; 2014).

		Multipliers			
		Reynosa			
		Output	**Employment**	**Salaried Worker Remuneration**	**Value Added**
Secondary, Heavy Manufacturing	332- Fabricated Metal Product Manufacturing	1.178	1.164	1.195	1.189
	333- Machinery Manufacturing	1.364	1.369	1.350	1.304
	334- Computer and Electronic Product Manufacturing	**2.130**	**2.161**	**2.137**	**2.177**
	335 - Electrical Equipment, Appliance, and Component Manufacturing	**1.455**	1.429	1.452	**1.448**
	336 - Transportation Equipment Manufacturing	**1.426**	1.804	**1.740**	**1.461**
	337 - Furniture and Related Product Manufacturing	1.082	1.050	1.066	1.085
	339 - Miscellaneous Manufacturing	1.307	1.189	1.235	1.263
Tertiary Activities	431 - Wholesale of Groceries, Food, Beverages, Ice, and Tobacco	1.085	1.273	1.509	1.048
	461 - Retail Sale of Groceries, Food, Beverages, Ice, and Tobacco	1.101	1.103	1.102	1.065
	484 – Truck Transportation	1.078	1.056	1.052	1.042
	488 – Support Activities for Transportation	1.158	1.177	1.133	1.087
	493 – Warehousing and Storage	**1.624**	1.252	1.361	**1.448**
	512 - Motion Picture and Sound Recording Industries	1.209	1.479	**1.641**	1.204
	515 – Broadcasting	1.327	**3.749**	**3.273**	1.375
	517 – Telecommunications	**1.419**	**2.785**	1.523	1.210
	522 - Credit Intermediation and Related Activities	1.223	**3.048**	1.384	1.223
	523 - Securities, Commodity Contracts, and Other Financial Investments and Related Activities	1.062	1.410	1.075	1.068
	524 - Insurance Carriers and Related Activities	1.190	**2.607**	**1.759**	1.337
	531 - Real Estate	1.028	1.158	1.203	1.015
	532 - Rental and Leasing Services	1.206	1.256	1.389	1.123
	541 – Professional, Scientific, and Technical Services	1.151	1.227	1.132	1.109
	561 - Administrative and Support Services	1.047	1.010	1.012	1.025
	562 - Waste Management and Remediation Services	1.188	1.108	1.141	1.133

		Multipliers			
		Reynosa			
		Output	Employment	Salaried Worker Remuneration	Value Added
Tertiary Activities	611 – Educational Services	1.039	1.020	1.008	1.020
	621 – Ambulatory Health Care Services (NAICS 621)	1.127	1.080	1.035	1.083
	622 - Hospitals	1.151	1.109	1.038	1.106
	623 - Nursing and Residential Care Facilities	1.295	1.087	1.085	1.242
	624 - Social Assistance	1.194	1.098	1.112	1.246
	711 - Performing Arts, Spectator Sports, and Related Industries	1.138	1.205	1.233	1.088
	713 - Amusement, Gambling, and Recreation Industries	1.322	1.547	1.584	1.368
	721 – Accommodation	1.149	1.303	1.380	1.101
	722 - Food Services and Drinking Places	1.114	1.042	1.063	1.087
	811 - Repair and Maintenance	1.390	1.069	1.211	1.212
	812 - Personal and Laundry Services	1.090	1.072	1.164	1.059
	813 - Religious, Grant-making, Civic, Professional, and Similar Organizations (NAICS 813)	1.178	1.126	1.112	1.143

Source: IOM Reynosa, 2013.

Note 1: The numbers in bold are the five highest values.

Once the two effects have been measured, the table of multipliers is organized by grouping economic activities according to their sector classification: *a*) secondary, nonmanufacturing, *b*) secondary, light manufacturing, *c*) secondary, heavy manufacturing, and *d*) tertiary activities.

Secondary, Nonmanufacturing Sector

Although oil and gas extraction is an activity that boosts the economy through the direct and indirect jobs it generates, the results as of 2013 showed that this activity's productive interdependencies were not very influential in the local economy (they did not show significant multipliers). In contrast, construction-related activities (building and civil engineering construction) maintained above-average values, particularly in terms of output. In other words, each additional peso in the value of their output increases the total output of the rest of the Reynosa sectoral economy by 1.3 pesos.

Secondary, Light Manufacturing Sector

This sector consists of a number of industrial activities that involve the processing of consumer goods and that do not involve a successive productive process of transformation. Beverage and tobacco product manufacturing stood out among the industries in this group because its influence on the local economy was significant in terms of employment and employee compensation. For example, a one-unit increase in employment in this industry generates 1.7 new jobs in Reynosa's overall economy. Similarly, a one-unit increase in employee remuneration increases the remuneration of employees in Reynosa's other productive activities by 1.6 pesos.

Secondary, Heavy Manufacturing Sector

The activities with the largest production multipliers were found in heavy manufacturing. In this group, the manufacture of computer equipment and communication and electronic accessories was the most dynamic of the four macroeconomic groups studied. The results show that for each job added in this subsector, 2.1 jobs are added to the local economic system.

Another dynamic subsector is the manufacture of transportation equipment, which was ranked among the highest in terms of output, employee compensation, and value added. For each peso added to this subsector, 1.4 pesos (output), 1.7 pesos (employee compensation), and 1.4 pesos (value added) are created in the overall economy of Reynosa. Also noteworthy is the performance of the chemical industry, which achieved above-average multipliers in the four macroeconomic variables.

Tertiary Activities Sector

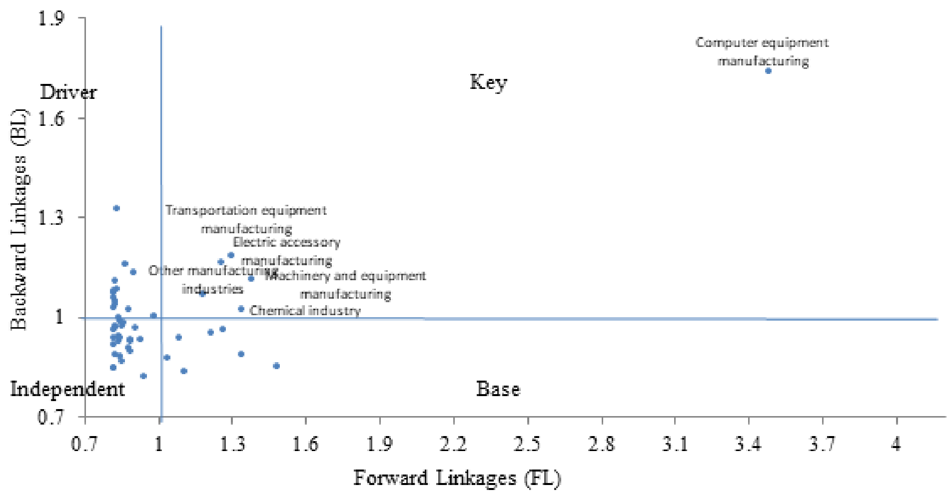
When a new job is created in the radio and television subsector, Reynosa's employment grows by 3.7 jobs. This industry is so buoyant that when there is a one-peso increase in the variable of employee compensation, the employee compensation for all local economic activities increases by 3.2 pesos. Similarly, bonding companies, insurance carriers, and pension funds are also highly ranked in terms of their employment and employee compensation multipliers; this shows their ability to influence the behavior of the local economy.

It is worth noting that the economic subsectors with the lowest values are in the Tertiary Activities group, particularly with regard to value added and employee compensation. The results indicate that services do little to stimulate Reynosa's economy. It is important to point out that in developed economies the tertiary sector is a very significant catalyst of economic growth due to its intersectoral linkages (Berlingieri, 2014).

Productive Chains

Figure 4 presents the results of the sectoral classification of productive chains based on the Rasmussen criteria (Rasmussen, 1956): seven of them are classified as base activities, 24 are classified as independent, eight are classified as driving forces, and six activities comprise the group of key sectors.

Figure 4: Reynosa: Classification of Economic Subsectors According to Production Linkages



Source: Created by the authors based on the Reynosa IOM, 2013.

The Rasmussen model enables us to extract two alternatives for the industrial policy profile to be implemented in a region.

One alternative acknowledges that poor sectoral diversification is reflected in the breakdown of numerous local productive chains, which diminishes the potential for reinforcing the internal market (González & Barajas, 2004; Pérez, Ceballos & Cogco, 2014, pp. 201-202). This alternative does not discriminate against industries that are unattractive (independent sectors), or those that do not have a significant impact on the sectors that demand their products.

The other alternative acknowledges that specialization in a few industries leads to better regional competitive advantages, thereby stimulating exports (Porter, 2003). Thus, advocates of specialization want to promote subsectors with growth potential, and that can bring along other economic areas that can become key industries. This ideology highlights the regional vocation by viewing the manufacturing sector as the main engine of growth, but it also excludes certain economic activities and territorial distributions (Becerril, 2012).

The influence of manufacturing on regional productive interdependencies is obvious in Reynosa. Some examples are seen in the key subsectors dedicated to the manufacture of computer equipment, machinery and equipment, electrical appliances, transportation equipment, and the chemical industry. These subsectors are notable not only for their strong demand for intersectoral inputs but also as suppliers of intermediate products. They are also a necessary waystation for the economy's diverse sectoral flows. From the perspective of regional economic specialization, these industries would have to be considered when developing local public policy, despite the risk of allocating resources to sectors heavily dependent on the U.S. economic cycle.

However, if the aim is to reduce the dependence of the local economy on a few subsectors, those that are in the base and driver quadrants must be considered due to the significance of their intersectoral sales and purchases, respectively. Tertiary economic activities, in particular storage services, repair and maintenance services for motor vehicles, and telecommunications, stand out among the driver subsectors. Regarding the base subsectors, the importance of metal product manufacturing is noteworthy. From the perspective of sectoral diversification, these activities must be included in the local public agenda since their presence in the economic system stimulates the production and consumption of intermediate goods, thereby reducing dependence on manufacturing, maquiladoras, and export services. The diversification strategy would involve focusing institutional efforts on local enterprises to reduce foreign trade risks.

Conclusions

In this study of the historical performance of the average annual growth rate (2003-2013) of the total gross output (TGO) of the most important border cities in northern Mexico (Tijuana, Ciudad Juárez, Reynosa, Mexicali, Matamoros, Nuevo Laredo, Piedras Negras, and Nogales), it was confirmed that during this period Reynosa was among the cities with the best performance both in terms of growth and in TGO share. Reynosa's performance was comparable to those of Tijuana, Mexicali, and Ciudad Juárez. These four cities have become the border cities with the most economic influence in terms of the value of their TGOs.

The regional performance data analyzed here perpetuate the ongoing debate between specialization (a group of companies in the same sector that support the argument that growth is driven by industries with regional competitive advantages) and economic diversification (companies from different sectors that provide services for firms and workers, advocating growth resulting from the development of the industrial base).

If the aim is to reinforce the manufacturing sector's position as the main driver of economic growth in Reynosa, one would have to consider the influence of heavy manufacturing on regional productive interdependencies. This is supported by the high levels of employment generated by the manufacturing of computer equipment, electrical accessories and transportation equipment (heavy manufacturing). This study demonstrated that the manufacturing capacity installed in this region produces strong demand for intersectoral inputs and the supply of intermediate products, creating a necessary waystation for the rest of the economic flows.

Despite the above, caution must be exercised regarding the specialization of the manufacturing, maquiladora, and export services industries. Industry concentration has not fostered a virtuous mechanism that develops local integration through commercial exchanges. This is reflected in *1*) the marginal value of the multipliers for production, employment, employee compensation, and value added for the rest of the productive activities; *II*) the weakness of the productive chains in nonmanufacturing activities; and *III*) the inadequate presence of the tertiary sector (in terms of production) with respect to its national counterpart.

When examining the system's flows and productive chains using an interregional input-output matrix, it was demonstrated that heavy industry does not necessarily imply that all subsectors generate high multipliers. An example of this is the results obtained for the plastic and rubber industry and industries linked to the manufacture of metal products.

Furthermore, if the intention is to reduce the local economy's dependence on a few subsectors, the hegemony of light manufacturing (manufacture of textiles and clothing) and tertiary economic activities (storage services, bonding companies, and companies linked to telecommunications) must be considered. The results showed that the presence of these activities in the economic system stimulates the production and consumption of intermediate goods. Thus, by supporting the performance of these activities, Reynosa's economic growth would be fostered by solidifying the local supply chains.

In view of the above and regardless of the preferred approach (specialization or diversification), we recommend a forward-looking regional growth policy that promotes the system's different expressions.

Regarding the methodology used, it is noted above that the lack of information on gross internal output at the municipal level thwarts a detailed analysis of the operation of the productive framework. Furthermore, the lack of current information (data are only available up to 2013) limits the accuracy of the estimated results. However, the models based on Flegg et al. (1995), Flegg & Webber (1997), and Rasmussen (1956) are suitable for examining the behavior of a city's productive sector structure.

Although agriculture does not dominate Reynosa's productive sector, we recommend incorporating information on this sector (compatible with the economic census). This would lead to improved estimates in the regional input-output model. In any case, what is needed is a comprehensive tool that can examine the production of goods and services in detail. With such a tool, the development of a municipal social accounting matrix or a general equilibrium model would be very useful as a reference framework for a regional structural analysis.

References

Albornoz, L., Canto, R. & Becerril, J. (2012). La estructura de las interrelaciones productivas de la economía del estado de Yucatán. Un enfoque de insumo-producto. *Región y Sociedad*, *24*(54). 133-174. Retrieved from http://www.scielo.org.mx/pdf/regsoc/v24n54/v24n54a5.pdf

Aroche, F. (2013). La investigación sobre el modelo insumo–producto en México. Orígenes y tendencias. *Estudios Económicos*, *28*(2), 249-264. Retrieved from http://www.redalyc.org/pdf/597/59728813003.pdf

Becerril, I. (November 29, 2012). Pobre desempeño del sector industrial. *El Financiero*. Retrieved from http://biblioteca.iiec.unam.mx/index.php?option=com_content&task=view&id=18536&Itemid=146

Berlingieri, G. (2014). *Outsourcing and the Rise in Services* (CEP Discussion Paper 1199). Retrieved from http://eprints.lse.ac.uk/51532/1/dp1199.pdf

Bonfiglio, A. (2005). *Can Non-survey Methods Substitute for Survey-based Models? A Performance Analysis of Indirect Techniques of Estimating I-O Coefficients and Multipliers* (Quaderno di Ricerca n. 230). Retrieved from http://docs.dises.univpm.it/web/quaderni/pdf/230.pdf

Bonfiglio, A. & Chelli, F. (2008). Assessing the Behaviour of Non-survey Methods for Constructing Regional Input-Output Tables Through a Monte Carlo Simulation. *Economic Systems Research*, *20*(3), 243-258. Retrieved from https://www.researchgate.net/publication/24078924_Assessing_the_Behaviour_of_Non-Survey_Methods_for_Constructing_Regional_Input-Output_Tables_through_a_Monte_Carlo_Simulation

Bortkiewicz, L. von (1907). *Value and Price in the Marxian System*. Retrieved from http://classiques.uqac.ca/classiques/Bortkiewicz_ladislaus_von/value_and_price_marxian_system/value_price_marxian_system.pdf

Bravo, H. M. & Castro, J. (2006). *Construcción de una matriz de contabilidad social con agua para el estado de Guanajuato* (Working paper, number 176). Retrieved from http://www.libreriacide.com/librospdf/DTAP-176.pdf

Cassel, G. (1924). *Theory of Social Economy*. New York, United States: Harcourt, Brace and Co.

Castro, G. (2010). *Matriz insumo-producto y análisis estructural para el estado de Michoacán en el año 2003. Aplicación de un método de regionalización con corrección para el acarreo cruzado* (Master's Thesis). Retrieved from https://www.cise.uadec.mx/downloads/tesis/Maestria2008-2010_CRG.PDF

Chapa, J., Ayala, E. & Hernández, I. (2009). Modelo de insumo-producto para el noreste de México. *Ciencia Universidad Autónoma de Nuevo León*, *XII*(4), 409-416. Retrieved from https://dialnet.unirioja.es/descarga/articulo/3128859.pdf

Chenery, H. & Watanabe, T. (1958). International Comparison of the Structure of Production. *Econométrica*, *26*(4). Retrieved from https://www.jstor.org/stable/1907514

Chiquiar, D., Alvarado, J., Quiroga, M. & Torre, L. (2017). *Regional Input-Output Matrices, an Application to Manufacturing Exports in Mexico* (Working Papers, No. 2017-09). Retrieved from http://www.banxico.org.mx/publicaciones-y-prensa/documentos-de-investigacion-del-banco-de-mexico/%7B12AAF90C-8036-6BBD-1A4E-9DE123FE2280%7D.pdf

Chraki, F. (2016). Análisis insumo-producto multirregional e integración económica del TLCAN. Una aplicación del método de extracción hipotética. *Asociación de Cuadernos de Economía*. Retrieved from http://www.elsevier.es/en-revista-cuadernos-economia-329-pdf-S021002661630053X

Dávila, A. (2002). Matriz de insumo-producto de la economía de Coahuila e identificación de sus flujos intersectoriales más importantes. *Economía Mexicana. Nueva Época*, *XI*(1), 79-162. Retrieved from http://www.economiamexicana.cide.edu/num_anteriores/XI-1/04_ALEJANDRO_DAVILA.pdf

Dávila, A. (2015). ¿Por qué y cómo elaborar modelos interregionales de insumo-producto mediante la aplicación de métodos indirectos de estimación? In A. Dávila (Coord.), *Modelos interregionales de insumo-producto de la economía mexicana* (pp. 7-26). Retrieved from https://www.cise.uadec.mx/downloads/LibrosElectronicos/LibroModelosInterregionales.pdf

Dávila, A. & Escamilla, A. (2013). Apertura comercial, cambios en la estructura productiva y desempeño de la economía de los estados de la frontera norte de México: 1993-2004. *Región y Sociedad*, *XXV*(56), 9-42. Retrieved from http://www.scielo.org.mx/pdf/regsoc/v25n56/v25n56a1.pdf

Dietzenbacher, E., Linden, J. A. van der & Steenge, A. (1993). The Regional Extraction Method: EC Input-Output Comparisons. *Economic System Research*, *5*(2), 185-206. Retrieved from https://www.tandfonline.com/doi/abs/10.1080/09535319300000017

Esqueda, R. (2018). Disparidades en el desarrollo regional de Tamaulipas, México. *Revista de Economía Institucional*, *20*(38), 235-262. Retrieved from http://www.scielo.org.co/pdf/rei/v20n38/0124-5996-rei-20-38-00235.pdf

Esqueda, R. & Trejo, A. (2014). Desarrollo local, competitividad y apertura económica en Tamaulipas. *Región y Sociedad*, *XXVI*(59), 113-150. Retrieved from http://www.scielo.org.mx/pdf/regsoc/v26n59/v26n59a4.pdf

Flegg, A. T. & Tohmo, T. (2011). Regional Input-Output Tables and the FLQ Formula: A Case Study of Finland. *Regional Studies*, *47*(5), 703-721. Retrieved from https://hal.archives-ouvertes.fr/hal-00725360/document

Flegg, A. T., Webber, C. D. & Elliot, M. V. (1995). On the Appropriate use of Location Quotients in Generating Regional Input-Output Tables. *Regional Studies*, *29*(6), 547-561. Retrieved from https://www.tandfonline.com/doi/abs/10.1080/00343409512331349173

Flegg, A. T. & Webber, C. D. (1997). On the Appropriate use of Location Quotients in Generating Regional Input-Output Tables: Reply. *Regional Studies*, *31*(8), 795-805. Retrieved from https://www.tandfonline.com/doi/abs/10.1080/713693401

Fuentes, N. A. (2003). Encadenamientos insumo-producto en un municipio fronterizo de Baja California, México. *Frontera Norte*, *15*(29), 151-184. Retrieved from http://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S0187-73722003000100006

Fuentes, N. A. (2005). Construcción de una matriz regional de insumo-producto. *Problemas del Desarrollo*, *36*(140), 89-112. Retrieved from http://www.redalyc.org/articulo.oa?id=11820092005

Fuentes, N., Brugués, A. & González, G. (2015). Modelo insumo-producto regional dinámico. *Revista de Economía*, *XXXII*(84), 79-107. Retrieved from http://www.revista.economia.uady.mx/2015/XXXII/84/3.pdf

Fuentes, N. A., Cárdenas, A. & Brugués, A. (2013). Análisis estructural de la economía de Baja California: Un enfoque de redes sociales. *Región y Sociedad, XXV*(57), 27-60. Retrieved from http://www.scielo.org.mx/pdf/regsoc/v25n57/v25n57a2.pdf

Fuentes, N. A. & Castillo, G. del (2012). Reelaboración del modelo multisectorial dinámico para la planeación estratégica de la economía mexicana y simulación del Programa de Facilitación Comercial. *Economía Mexicana Nueva Época, XXI*(1), 5-33. Retrieved from http://www.scielo.org.mx/pdf/emne/v21n1/v21n1a1.pdf

García, A. & Ramos, C. (2003). Las redes sociales como herramienta de análisis estructural input-output. *Revista Hispana para el Análisis de Redes Sociales, 4*(5), 1-21. Retrieved from http://revista-redes.rediris.es/html-vol4/vol4_5.htm

Ghosh, A. (1958). Input-Output Approach to an Allocation System. *Economica*, (25), 58-64.

González, G. & Barajas, M. (2004). Los procesos de aprendizaje en la industria maquiladora. ¿Una senda predefinida? In J. Carrillo & R. Partida (Coords.), *La industria maquiladora mexicana: Aprendizajes tecnológicos, impactos regionales y entornos institucionales* (pp. 4-7). Retrieved from https://www.researchgate.net/profile/Jorge_Carrillo7/publication/268406984_La_Industria_Maquiladora_Mexicana_Aprendizajes_tecnologicos_impactos_regionales_y_entornos_institucionales/links/55db8eb708aec156b9afedd8/La-Industria-Maquiladora-Mexicana-Aprendizajes-tecnologicos-impactos-regionales-y-entornos-institucionales.pdf

González, R., Díaz, M. & Leal, F. (2010). Identificación de sectores estratégicos en la economía de Aguascalientes. *Investigación y Ciencia, 18*(49), 40-47. Retrieved from http://www.redalyc.org/pdf/674/67415178007.pdf

Hurtado, A. & Martínez, E. (2017). Redes binarias y la matriz insumo-producto: Una aplicación regional. *Trayectorias, 19*(45), 57-76. Retrieved from http://trayectorias.uanl.mx/45/pdf/3.pdf

Instituto Nacional de Estadística y Geografía (Inegi). (2004). *Censo Económico 2004. Sistema Automatizado de Información Censal (SAIC)*. Retrieved from http://www.beta.inegi.org.mx/app/saic/

Instituto Nacional de Estadística y Geografía (Inegi). (2009). *Censo Económico 2009. Sistema Automatizado de Información Censal (SAIC)*. Retrieved from http://www.beta.inegi.org.mx/app/saic/

Instituto Nacional de Estadística y Geografía (Inegi). (2014). *Censo Económico 2014. Sistema Automatizado de Información Censal (SAIC)*. Retrieved from http://www.beta.inegi.org.mx/app/saic/

Instituto Nacional de Estadística y Geografía (Inegi). (2018). *PIB y Cuentas Nacionales. Matriz de Insumo Producto. Base 2013*. Retrieved from http://www.beta.inegi.org.mx/temas/mip/

Johnson, T. (1986). A Dynamic Input-Output Model for Small Regions. *Review of Regional Studies, 16*(1), 14-23. Retrieved from http://journal.srsa.org/ojs/index.php/RRS/article/view/16.1.3/758

Kronenberg, T. (2011). Regional Input-Output Models and the Treatment of Imports in the European System of Accounts (ESA). *Review of Regional Research, 32*(2), 175-191. Retrieved from https://www.researchgate.net/publication/271923370_Regional_input-output_models_and_the_treatment_of_imports_in_the_European_System_of_Accounts_ESA

Leontief, W. (1936). Quantitative Input-Output Relations in the Economic System of the United States. *Review of Economics and Statistics*, *18*(3), 105-125.

Leontief, W. (1941). *The Structure of American Economy 1919-1939*. New York, United States: Oxford University Press.

Llano, C. (2009). Efectos de desbordamiento interregional en España: Una estimación a través del modelo input-output interregional. *Investigaciones Regionales,* (16), 181-188. Retrieved from https://repositorio.uam.es/bitstream/handle/10486/668295/DesbordamientoInterregional_Llano_IR_2009.pdf?sequence=1&isAllowed=y

Martínez, E. & Gómez, R. (2008). Complejidad de las relaciones sectoriales en la educación. *Inceptum,* (4), 83-97. Retrieved from https://www.inceptum.umich.mx/index.php/inceptum/article/download/42/34

Miller, R. & Blair, P. (2009). *Input-Output Analysis: Foundations and Extensions*. Retrieved from http://static.gest.unipd.it/~birolo/didattica11/Materiale_2012/_Materiale_2015/Miller_Blait-input-output_analysis.pdf

Molina, A. H. & Gutiérrez, R. R. (2015). Reformulación del modelo de Leontief a través de redes de Petri. *Ciencia y Tecnología,* (15), 83-96. Retrieved from https://www.palermo.edu/ingenieria/pdf2015/15/CyT_15_06.pdf

Organización de las Naciones Unidas (ONU). (2018). *Handbook on Supply, Use and Input-Output Tables with Extensions and Applications*. Retrieved from https://unstats.un.org/unsd/nationalaccount/docs/SUT_IOT_HB_wc.pdf

Pareto, V. (1906). *Manual of Political Economy*. New York, United States: A. M. Kelley.

Pérez, J., Ceballos, G. & Cogco, A. (2012). Los planteamientos del desarrollo local y su relación con la industria y los encadenamientos productivos: un análisis de la dinámica manufacturera en la estructura sectorial en las principales ciudades del estado de Tamaulipas, 2004. In A. R. Cogco, M. Rodríguez & J. Pérez (Coords.), *Acciones y reflexiones para la reconstrucción de la política social en México. Una mirada desde lo local* (pp. 83-106). Retrieved from http://riuat.uat.edu.mx/bitstream/123456789/1505/1/1505.pdf

Pérez, J., Ceballos, G. & Cogco, A. (2014). Los factores que explican la mayor aglomeración de la industria de alta tecnología en la frontera norte de México: El caso de Matamoros y Reynosa. *Estudios Fronterizos*, *15*(29), 173-206. Retrieved from http://ref.uabc.mx/ojs/index.php/ref/article/view/51/66?lan=es_ES

Porter, M. (2003). The Economic Performance of Regions. *Regional Studies*, *37*(6&7), 549-578. Retrieved from https://pdfs.semanticscholar.org/de0e/a94b-8048b7e7ce4d1ac7193d9bfb9847f735.pdf

Quesnay, F. (1759). *Le Tableau Économique* (Edited and translated into English by M. Kuczynski & R. L. Meek). London, United Kingdom: Macmillan.

Rasmussen, P. (1956). *Studies in Inter-Sectorial Relations*. Copenhagen, Denmark: Einar Harks.

Salinas, E., González, M., León, A. & Rodríguez, F. (2017). La actividad forestal en el desarrollo económico de Chignahuapan, Puebla. *Región y Sociedad*, *XXIX*(69). Retrieved from http://www.redalyc.org/pdf/102/10250503007.pdf

Schuschny, A. R. (2005). *Tópicos sobre el modelo de insumo-producto: Teoría y aplicaciones* (Serie estudios estadísticos y prospectivos, 37). Retrieved from https://repositorio.cepal.org/bitstream/handle/11362/4737/S0501011_es.pdf?sequence=1

Tapia, G., Vite, M., Salazar, I. & Zamora, R. (2010). Riesgos de un incremento del gasto en educación en el valor bruto de la producción del municipio de Huetamo. Un análisis de insumo–producto. *Ecorfan*, *1*(1), 31-50. Retrieved from https://dialnet.unirioja.es/descarga/articulo/4029493.pdf

Valdés, M. (2014). *Apertura comercial y desempeño de la economía del estado de Jalisco. Un análisis multisectorial de insumo-producto* (Doctoral thesis). Retrieved from https://www.cise.uadec.mx/downloads/tesis/Doctorado2010-2013_VIM.PDF

Walras, L. (1874). *Elements of Pure Economics.* Paris, France: Guillaumin & Cie.

Rodrigo Vera Vázquez
Mexican. Dean of El Colegio de Tamaulipas. Doctorate in Social Sciences from El Colegio de Michoacán and a Master's Degree in Integrated Environmental Management from El Colegio de la Frontera Norte. Both programs are registered with Conacyt's PNPC at an international level. His areas of research include cross-border economic geography and regional development. He is an assessor for Conacyt's research projects and public sector social programs. Among his most recent publications is Eagle Ford Shale Play: Petroleum-Mining Industrial Geography in South Texas, 2008-2015. *Trayectorias, 19*(45), 3-36.

Miguel Angel Langle Flores
Mexican. Bachelor's Degree in Chemical Engineering and a Master's Degree in Economics (PNPC) from the Universidad de Guanajuato. Doctorate in Regional Economics (PNPC) from the Universidad Autónoma de Coahuila. He is currently a professor and researcher at El Colegio de Tamaulipas and a member of the Regional and Urban Economics Research Network. His areas of research include regional economies and regional multisectoral models. Among his most recent publications is Langle M., Dávila A. & Valdés M. (2019). Productive displacement in the southern region of Mexico. In A. Dávila (Coord.), *Modelos económicos de las regiones de México*. Mexico: Universidad Autónoma de Coahuila, Miguel Ángel Porrúa.