DEGREE OF DEPENDENCE ON IMPORTS OF THE AUTOMOTIVE CLUSTER AND THE ECONOMIC EFFECTS ON MANUFACTURING IN THE NORTHEASTERN REGION OF MEXICO: A BOTTOM-UP METHODOLOGICAL AND ANALYTICAL APPROACH

Marcos Noé Maya, Normand E. Asuad, José M. Sánchez.

Abstract.

Economically, the automotive industry is very important for being a promoter of national exports and for the productive variety of companies that integrate its supply chain. If this industry is linked to the activities of its regional surroundings, multiplier effects will be transmitted to other local manufacturing branches and irradiated to other sub-regions and thus, contributing to its development. Otherwise, if this industry is not chained, its impact on the growth of other industries and sub-regions will be halted and there will depends on imports. Analyzing this industry through its sectoral interactions at a sub-regional level, allows for the identification of its economic-spatial impacts, using as an analytical tool a regional input-output matrix, constructed under a "bottom-up" approach.

In Mexico, a notorious case is the North-east region, which in 2008, concentrated 23% of value added and 20% of employment of the national automotive industry This activity is spatially concentrated in a corridor that includes two functional sub-regions located around the metropolitan areas of Saltillo and Monterrey (Maya, Asuad and Sánchez, 2016).

This research originated from the following basic question:

What is the degree of dependence on imports of the automotive cluster and the regional economic impact on the manufacturing sector at a sub-regional level in the Northeast region of Mexico?

The main purpose of this work is to identify at a sub-regional level, whether there is an inter- and intra sub-regional dragging effect of the automotive cluster in the manufacturing branches or, on the other hand if an economy of enclave exists, characterized by a large share of value added from imports.

The methodology used consists mainly of three parts: 1) Construction of a multi-subregional matrix by using branches of the manufacturing industry under a bottom up approach (Asuad and Sánchez, 2016); 2) Analysis of principal components to identify manufacturing clusters, including the automotive industry (Feser and Bergman, 2000); and 3) Characterization of the linkage between the automotive cluster and the regional manufacturing industry (Schuschuny, 2005), by reviewing the degree of dependence on imports, through the vertical specialization method. (Maya, Asuad and Sánchez, 2015).

The data used comes mainly from INEGI´s 2014 Economic Censuses, which record the activity of industrial manufacturing establishments. However, the regional industrial accounts were validated considering the information of the economic accounts by both state and national levels.

Unlike previous studies related to the automotive industry in North-east Mexico, this paper highlights the importance of considering buying and selling relationships between sub-regions, as well as characterizing their manufacturing chains with the automotive industry based on an input-output analysis, using regional data[1].

[1] I am grateful for the help in the matrix estimations and translation of students Luis Alberto Flores Rodríguez and William Sugrúa Martínez.

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Introduction

A lot has been written about the process of economic openness of the Mexican economy since the end of the last century and the economic drive acquired by the national industry through its specialization in exports. These have been enhanced due to foreign direct investment in manufacturing activities that relocated their production processes. An example of this, is the automotive industry which displaced factories to regions with easier access to the United States.

This article will again focus on the analysis of the North-east functional economic region of Mexico, because of both its industrial importance (with the lead of Monterrey), and of the fact that in this era of economic openness, this region contains one of the most important automotive export-oriented clusters in the country, located in Saltillo and Ramos Arizpe, although there is a strong production of body parts in Reynosa and Piedras Negras. The wide network of communication roads and the connection between sub regions facilitate exports both by land and sea in the context of the North American Free Trade Agreement. However, foreign investment that goes into assembly and supply activities neither generate important linkages with the local manufacturing industries nor configure any sub-regional complementarity in the study area.

The objective of this article is to establish the degree of dependence of the regional automotive industry on imports, through an analysis of vertical specialization, using a multi sub-regional matrix. This was constructed using a mixed approach that contains *bottom-up* data and estimates, but also estimates of automotive intermediate imports.

There are three main points to be made about this objective: First, as already mentioned, the automotive industry is concentrated in few sub-regions of the north-east region. Second, consequently, this analysis is done using an economic-functional approach, which allows for the appreciation of the interaction of between those sub-regions; there are 158 municipalities distributed in 6 states (The totality of Nuevo León and Tamaulipas, and part of Coahuila, Zacatecas, San Luis Potosí and Veracruz). It is possible then, to observe regional flows. Finally, it is important to observe the share of value added and of imports linked to regional exports.

In the absence of local information, this research uses a hybrid methodology. In other words, a mixture of data obtained "from" the region and data estimated using aggregated spatial units such as the nation or states. The lack of information and time hindered the possibility of having estimates completely "from below" (bottom-up approach). Nevertheless, this work aims at getting "as close as possible" to data obtained "from below". Given that there is some information, but incomplete, we will proceed to use a hybrid or mixed methodology.

This work consists of three parts: The first, shows the contextual importance of the automotive industry in the north-east region, making an emphasis on the economic weight of this region given its character as recipient of foreign direct investment (FDI). The second, is the methodological description which in turn is made of three parts: A description of the construction of the multi-sub regional matrix, followed by a principal components analysis in order to see if the regional clusters are linked to the automotive industry. Then, we characterize the automotive linkage with and without imports, as well as the use of the method of vertical specialization in order to show the dependence of this activity on imports. Finally, on the third part, we give the conclusions.

I. Context of the automotive industry in the economic regions of Mexico

First, we use as reference those states with the highest share of FDI related to the automotive industry. In the period 1999 to 2014, this amount added up to 296,477 million USD, out of which, 30,190 million (10%) went to sub-sector X *Construction of Transport Equipment.* Most of this amount was invested in the automotive industry (27,732 milion). More specifically, 10,616 million (38%) went to the final industry *Construction of Vehicles and Trucks* while the body parts industry, conformed by *Construction of bodyworks and trailers* and *Construction of body parts* received 17,120 million (62%)

TABLE 1.

MEXICO: TOTAL FDI, IN THE MANUFACTURE OF TRANSPORTATION EQUIPMENT AND IN THE AUTOMOTIVE INDUSTRY, BY SOME STATES, ACCUMULATED FROM 1999 TO 2014 (PERCENTAGES).

State IED	Totales	DF	Chihuahua	Puebla	EdoMex	Guanajuato	Aguascalientes	Nuevo León	Queretaro	Coahuila
Transportation Equipment Manufacturing	10%	3%	41%	48%	15%	50%	76%	6%	50%	18%
Automotive Industry	92%	98%	97%	100%	100%	100%	66%	91%	58%	100%
Terminal Industry	38%	64%	9%	55%	45%	20%	99%	20%	6%	8%
Auto Parts Industry	62%	36%	91%	45%	55%	80%	1%	80%	94%	92%

Source: Own elaboration with data of Secretariat of Economy, consulted 5 June of 2014.

It becomes obvious that the FDI in body parts is much higher than in the terminal industry. The strong articulation between the terminal automotive industry and national body parts

suppliers during the import substitution era in Mexico has disappeared and progressively, transnational body parts companies (sometimes subsidiaries of the major car assemblers) have arrived via FDI. This is the case of Coahuila, Querétaro and Chihuahua, where, for every dollar invested in the terminal industry, nine dollars are invested in supply activities. This is an early indicator of the likely disarticulation of the productive chain between national and foreign producers, in the cases of Construction of body Works and body parts.

To see the relative importance of these regions, it is necessary to identify the states that contain them. Using value added and employed population in sub sector 336 *Construction of Transport Equipment* for 2008, we get the following:

TABLE 2.

MEXICO: VALUE ADDED IN THE SUBSECTOR MANUFACTURER OF TRANSPORT EQUIPMENT BY MAIN STATES, 2008.

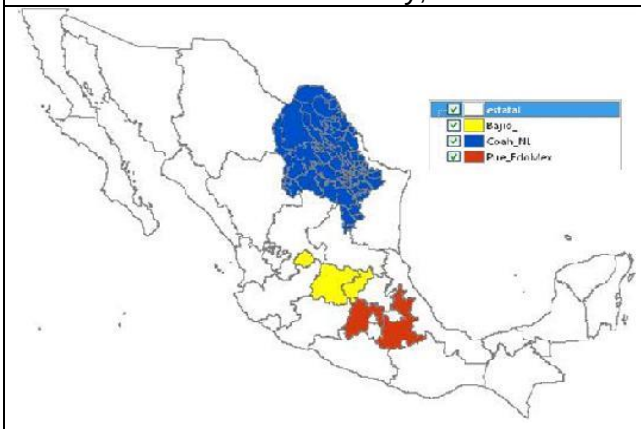
VACB at 2008 prices of subsector 336 Manufacture of State Transport Equipment with FDI.		% VACB	EMPLOYED POPULATION IN THE SUBSECTOR 336 MANUFACTURE OF TRANSPORT EQUIPMENT BY STATES WITH IED		% PO
COAH	34,991,534	16%	CHIH	110,838	21%
PUE	29,907,084	14%	COAH	65,499	12%
CHIH	23,396,407	11%	EDOMEX	45,449	8%
EDOMEX	21,185,157	10%	NL	42,134	8%
AGS	15,708,696	7%	PUE	36,774	7%
NL	15,611,926	7%	QRO.	24,265	4%
GTO.	12,902,698	6%	GTO.	19,619	4%
QRO.	10,146,843	5%	AGS	15,608	3%
Total /% of country	163,850,345	77%	otal/% del pa	360,186	67%

Source: Own elaboration with data of the Economic Census 2009, INEGI.

.Those selected states, concentrate almost 80% of national value added and 70% of national employed population in that industry. Out of this first analysis, three functional-economic regions with automotive industry can be observed. This is shown in the following map.

MAP 1

Mexico: Identification of states with the automotive regions with the largest participation in the entire industry, 2008.



Source: Own elaboration with data from INEGI

A first case is the southeast of Coahuila in which sub sector 336 is strongly linked to the south of Nuevo León. These in turn are linked to Texas, the main market for their exports. In this article, we focus on the most important region and which we call North-east region of the automotive industry.

According to the 2009 INEGI´s economic census, the value added of the automotive industry, mainly the sub-sectors: *Construction of Vehicles (3361), Construction of bodyworks and trailers (3362),* and *Construction of body parts (3363)*, is mostly generated in this region, in the municipalities of Ramos Arizpe, Saltillo, Apocada, Santa Catarina, Guadalupe, Frontera, Torreón and Piedra Negras[2].

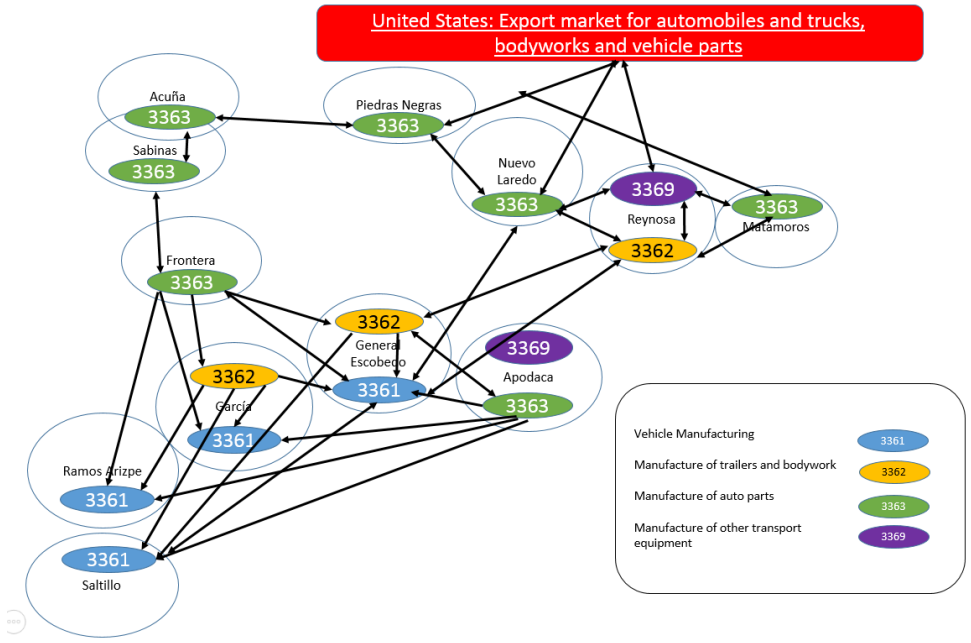
In diagram 1, we can observe a second issue: There is a network of urban nodes and demarcations spatially separated from the cluster, They are conformed by branches of suppliers (mostly *Construction of body parts)* of the terminal automotive industry. These

[2] According to the 2014 economic census, these 12 municipalities add up to 38% of employment in all sectors in this region, but for the case of the automotive industry. They congregate 36% of total valued added in the region, but 94% of valued added of the automotive industry. Particularly, the four branches considered in this part of the article, represent basically 100% of employment in the construction of vehicles and trucks, 53% of construction of bodyworks and trailers, 84% of Construction of body parts, and 98% of construction of other transportation equipment.

demarcations are probably associated with export markets and not with the regional production of vehicles.

SCHEME 1

NORTHEAST REGION OF MEXICO: NETWORK AND FLOWS OF BRANCHES ASSOCIATED TO THE MANUFACTURE OF AUTOMOTIVE TRANSFER EQUIPMENT BETWEEN THE MAIN REGIONAL URBAN NODES.



Source: Own elaboration.

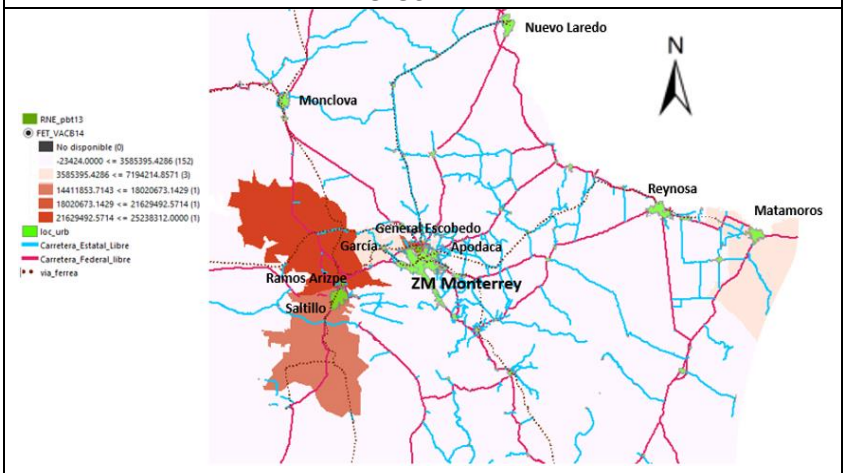
It can be observed that all industrial activity linked to the automotive industry in the north-east region puts 6 of its 8 Spatial Economic Functional Units[3] to interact with each other

The following map shows the automotive industry corridor:

[3] For more information about the delimitation of these functional units see Maya Martínez (2017) "Two branch model to measure growth and development of the economic regions of Mexico 1994-2010" " PhD thesis, . Posgrado de la Facultad de Economía de la UNAM.

MAP 2

NORTHEAST REGION OF MEXICO: URBAN NODES THAT CONCENTRATE ESPACIALLY THE REGIONAL AUTOMOTIVE CLUSTER.



Source: Own elaboration with INEGI data, Economic Censuses 2014

Communication roads articulate very well the automotive cluster in the north-east region. Not only state and federal highways give smoothness and logic to the cluster, but also railway lines that connect it to border cities, reinforcing its export-oriented nature.

I. Identification of the automotive cluster, its linkages inside the North-east region and its dependence on imports.

To accomplish the objectives, it is necessary to follow a series of methodological steps. We first estimated a multi-sub regional input-output matrix for its use as an analytical tool (Asuad & Sánchez, 2016); we then proceed to do a principal components analysis (Feser y Bergman, 2000) with and without imports (Schuschny, 2005), in those sub regions that concentrate the automotive industry; finally, we analyze the regional vertical specialization in this industry (Maya, Asuad y Sánchez, 2015).

a) The estimation and calculation of the multi- sub regional matrices was done using two other procedures necessary for the accomplishment of the objectives. We first estimated the technical coefficients of the intra- sub regional matrices, and then, the coefficients of spatial dependency between sub regions using a Moran´s index. These, by the way, were used as technical coefficients that determined inter-sub

regional exchanges For the first case, we used a coefficient of relative location[4] and a size weight. In other words, we pretended to implement an adaptation of the coefficient of location which only weighs not only the relative size of the sector or productive branch, but also the sub-region´s relative size. We, then, used intermediate consumption by sector, locating their relative concentrations. Likewise, we analyzed the relative specialization in gross production and value added. We obtained a coefficient represented by λ.

Subsequently, with the obtained sectoral coefficients, we generated a matrix in which they were cross-multiplied by each sub sector of activity. We then multiplied the value of production by the value of the cross coefficient for each sub sector of activity and we substituted the coefficients in the principal diagonal by the coefficients weighted by their corresponding size.

Values higher than 1 are transformed into the mentioned value to estimate the distribution of purchases by sub sector, according to the cross-coefficients methodology.

We can multiply the demand by the coefficients to obtain the production distribution among subsectors of economic activity. Later, we obtain the technical coefficients with a ratio between the shares of inputs used by each sector and total purchases of inputs to other sectors. We finally, get the intersectoral transactions matrix by multiplying technical coefficients by gross production in both sales and purchases.

In order to obtain the technical coefficients of purchases and sales, we analyzed the spatial dependence of Moran between sub-regions, which also established the spatial association between branches of economic activity of the SEFUs

Both, the regional matrices and those matrices created with the Moran´s Index, are introduced in the R software package. An estimate of the purchase and sales flows is done, based on adjustment vectors such as intermediate consumption and intermediate demand for of the sub-regions in the North-east region. Intermediate consumption and intermediate demand from each SEFU are determined by adding

-[4] Part of this methodoology uses the proposals of Flegg, Webber y Elliot (1997).

up all intra sub-regional matrices. With this constraint, the program creates a coefficient of spatial dependence that can be used as technical coefficient. With this procedure, intra sub-regional matrices were created (see table 3).

TABLE 3.

DIAGRAM OF MULTI-SUBJECT MATRIX OF NORTHEAST OF MEXICO.								
UEEF Laredo	Iv12	Iv13	Iv14	Iv15	Iv16	Iv17	Iv18	Iv19
Ic12	UEEF Monclova	Iv23	Iv24	Iv25	Iv26	Iv27	Iv28	Iv29
Ic13	Ic23	UEEF Monterrey	Iv34	Iv35	Iv36	Iv37	Iv38	Iv39
Ic14	Ic24	Ic34	UEEF Piedras	Iv45	Iv46	Iv47	Iv48	Iv49
Ic15	Ic25	Ic35	Ic45	UEEF Reynosa	Iv56	Iv57	Iv58	Iv59
Ic16	Ic26	Ic36	Ic46	Ic56	UEEF Saltillo	Iv67	Iv68	Iv69
Ic17	Ic27	Ic37	Ic47	Ic57	Ic67	UEEF Tampico	Iv78	Iv79
Ic18	Ic28	Ic38	Ic48	Ic58	Ic68	Ic78	UEEF Victoria	Iv89
Ic19	Ic29	Ic39	Ic42	Ic52	Ic62	Ic79	Ic	Resto del País
Own elaboration. Based on the application of the RAS Method, with data from INEGI 2014 Economic Censuses. Mexico.								

SEFU= Spatial Economic Functional Units Funcionales

Ip= Interacciones de compras Purchases´ interactions

Is=Interacciones de ventas Sales´ interactions

In the estimation of the multi SEFU matrix, it is possible to observe interactions, not only at an intra regional level, but also between sub-regions. Also, we can see how the movements of any element in the final demand vector impact each of the sub-regions both sectorial and spatially. Consequently, direct, indirect and total impacts can be determined in any sub-region by any variation in the final demand of those sub-regions.

Table 4 shows the internal interactions (sub-regional interactions) of the North-eastern region of Mexico. The results were standardized (1 is the highest interaction and 0 the lowest). 0.

TABLE 4

NORTHEAST REGION OF MEXICO: GENERAL MATRIX OF SUBREGIONAL INTERACTIONS								
	LAREDO	MONCLOVA	MONTERREY	PIEDRAS NEGRAS	REYNOSA	SALTILLO	TAMPICO	CD. VICTORIA
LAREDO	0.01	0	0.01	0	0	0	0	0
MONCLOVA	0	0.05	0.01	0	0	0	0	0
MONTERREY	0.01	0	1	0.02	0.03	0.08	0.06	0
PIEDRAS NEGRAS	0	0	0	0.02	0	0.01	0	0
REYNOSA	0	0	0.01	0	0.06	0.03	0.02	0
SALTILLO	0	0.01	0.08	0.01	0	0.24	0.03	0
TAMPICO	0	0	0.09	0	0.02	0	0.15	0.01
CD. VICTORIA	0	0	0	0	0	0	0	0.01
Source: Own elaboration with INEGI data, Economic Censuses 2014.								

We can appreciate that the economic activity tends to concentrate around the biggest urban nodes. For example, it is evident the strong pull of Monterrey, followed by Saltillo and Tampico. However, inter sub regional interactions, the objective of this work can also be observed. Although the obtained results show a high intra-sub regional concentration and a weak participation of inter- sub regional interactions, this share is in line with what we expected. For instance, in the most important inter-regional interactions show the importance of the interaction between Monterrey and the rest of the regions, both in terms of purchases and sales. In order of importance, we see the relationship with Tampico, probably for being a maritime port with connection to the exterior; with Saltillo, which acts as an industrial complement; and with border cities like Reynosa, Piedras Negras and Matamoros. Likewise, Tampico has a relation with the two most important sub regions: Reynosa and Ciudad Victoria.

b) Identification of clusters within the north east región and its sub regions. Clusters are a way in which economic agents agglomerate to obtain benefits such as the dissemination of innovations in production, a market of specialized labor, network of close suppliers, and institutions that support competitiveness (Porter, 2003).

A methodology for the identification of these industrial agglomerations is proposed by Feser y Bergman (2000), who were able to identify clusters and their components through the interdependence of productive branches or sectors and their spatial distribution.

The usage of input-output matrices is necessary to detect sectoral transactions and to see if their level of interdependence, both in purchases and sales, is strong given their degree of complementarity and thus conforming clusters with spatially located

productive branches. Through the use of input-output matrices, the principal components technique is calculated, which allows the detection of these regional clusters. (Feser y Bergman, 2000).

In input-output matrices we get purchases and sales of each productive branch through the following formula:

x11 + x12 + … + x1n + y1 = X1

x21 + x22 + … + x2n + y2 = X2

……..

Xn1 + xn2 + … + xnn + yn = Xn

Where:

x = Intermediate transactions. The first subindex is the branch of origin, and the second one, the branch of destination for seller and buyer, respectively.

y = Final demand

X =. Gross value of production

The sum of the elements in each line, defines sectorial sales and it is conformed by intermediate demand (xij) and final demand (yi). It is expressed as:

$$\sum_{j=1}^{n} \mathrm{xij} + \mathrm{yi} = \mathrm{Xi}\ (\mathrm{i} = 1, 2, \dots, \mathrm{n})$$

: In the case of columns, their sum represent sectorial purchases and are made of intermediate consumption (xij) and value added (zi), It is expressed as:

$$\sum_{i=1}^{n} xij + zi = Xj\ (j = 1, 2, \dots, n)$$

In both equations, Xi y Xj represent the gross value of production: Sales of sector i and purchases of sector j

When doing a principal components analysis, four n x n matrices need to be made with the following elements:

$$A = xij/Pi \qquad (i,j = 1, 2, \ldots, n)$$

$$B = xji/Pj \qquad (i,j = 1, 2, \ldots, n)$$

$$C = xij/si \qquad (i,j = 1, 2, \ldots, n)$$

$$D = xji/sj \qquad (i,j = 1, 2, \ldots, n)$$

Where Pi is the sum of intermediate purchases of branch i, and Pj those of branch j. si is the sum of intermediate purchases of branch j and sj those of branch j. We then calculate a correlation between the four matrices so as to establish similarities and differences between the input-output structures in the economic branches: a) similar patterns in input purchases (correlation A and B); b) Patterns in input purchases (Correlations C and D); c) Complementarity between patterns of purchases-sales (Correlation A and D) and d) Complementarity between patterns of sales purchases (Correlation C and B).

Later on, a n x n matrix is conformed using the highest of the four correlation indices that correspond to each intermediate transaction. In other words, according to Sánchez and Bracamonte (2006) " What we look for is to identify the functional relations between pairs of industries, based on the total patterns of sales and purchases between all industries". Industries with higher correlations can be considered as being part of an industrial cluster.

We then run a multivariate statistical method called principal components analysis. We do an adjustment with the varimax rotation method and identify the branches of economic activity that integrate each one of the industrial clusters, in this case those of the north-eastern region of Mexico and its subregions.

Economic branches that belong to the cluster are classified as primary, strongly associated secondary and weakly associated secondary, according to the degree of association to the grouping. This is measured with a coefficient of correlation, whose value fluctuates between 0 and 1, in which 1, is the highest degree of association.

Branches are classified as primary if they obtain 1 or equal to 0.8; as strongly associated secondary if their coefficient values are higher than 0.5 and but smaller than 0.8, and as weakly associated secondary if their values are between 0.4 and 0.5. It is important to notice that branches can be primary only in one cluster, but secondary in more than one.

The results of this methodology show that from the transactions multi-subregional matrix of the total of 272 sectors, we can extract 10 economic groupings that explain 98.58% of all regional interactions between branches, in which group 1 represents 68%, group 2, 13.55% and groups 3 and 4, 5.6% and 3.5%, respectively.

The first component groups 33% of the manufacturing industry, 33% of services and 26% of commerce; the second groups 56% of services and 28% of commerce; the third, 64% of manufacturing; fourth, 82% of manufacturing; the fifth, 44% of manufacturing; the sixth, 75% of manufacturing; the seventh, 67% of commerce; the eighth, 67% of agriculture; the ninth, 50% of manufacturing and 50% of agriculture and the tenth, with very weak levels of association, 50% of manufacturing and 50% of commerce.

The automotive industry (branches 3361, 3362 and 3363) is found in different groupings. However, to do an integral analysis, we used the natural productive chain that the Mexican Ministry of Economics (via the System of Mexican Entrepreneurial Information -SIEM-) established for the automotive industry. It is now presented, to complement the results of the principal components analysis.

TABLE 5

Branches of the automotive industry and its link with some manufacturers

Source: Own elaboration based on SIEM.

With the purpose of contrasting the results of the principal components analysis in the north east region, we point out that branch 3361, is in cluster 3, with the following branches:

TABLE 6

NORTHEAST REGION. GROUP 3: ASSOCIATION OF THE AUTOMOTIVE INDUSTRY, BRANCH 3361, MANUFACTURE OF VEHICLES AND TRUCKS			
Branch	Branch Name	11/5000 Coefficient	Type of association
3333	Manufacture of machinery and equipment for trade and services	0.9749185	Primarily
4859	Other land passenger transport	0.9735196	Primarily
3364	Manufacture of aerospace equipment	0.9526149	Primarily
3162	Manufacture of footwear	0.9426474	Primarily
4854	School and personnel transportation	0.8900942	Primarily
3361	Manufacture of cars and trucks	0.8602247	Primarily
2121	Mineral coal mining	0.8491624	Primarily
3121	Beverage industry	0.7667056	Strongly associated secondary
3311	Basic iron and steel industry	0.749908	Strongly associated secondary
3152	Manufacture of clothing	0.6246506	Strongly associated secondary
4855	Bus hire with driver	0.6209067	Strongly associated secondary
3346	Manufacture of lighting accessories	0.5954131	Strongly associated secondary
4884	Services related to road transport	0.5662033	Strongly associated secondary
4931	Storage services	0.5619206	Strongly associated secondary
3344	Manufacture of electronic components	0.5384621	Strongly associated secondary
3391	Manufacture of non-electronic equipment and disposable medical, dental and laboratory equipment and ophthalmic articles	0.5241313	Strongly associated secondary
5151	Transmission of radio and television programs	0.5182826	Strongly associated secondary
Source: self made.			

This branch is strongly and mainly associated with activities such as school transportation, passengers and personnel transportation, manufacture of machinery and equipment for trade and services, general services, manufacture of aerospace equipment and footwear, as well as extractive activites. Moreover, in manufacturing, it is strongly associated with beverages, iron and steel, garment. Finally, it is weakly associated with manufacturing of lightning accessories, electronics, etc.

This first analysis demonstrates how the assembling industry, with its natural supplier links is not associated at all at a macro regional level in the north-east region.

Let us now analyze branch 3363, which is in cluster 4. Its associations are:

TABLE 7

NORTHEAST REGION. GROUP 4: ASSOCIATION OF THE AUTOMOTIVE INDUSTRY, BRANCH 3363, MANUFACTURE OF PARTS FOR AUTOMOTIVE VEHICLES.			
Branch	Branch Name	Coefficient	Type of association
3133	Acabado de productos textiles y fabricación de telas recubiertas	.954	Primarias
3254	Fabricación de productos farmacéuticos	.954	Primarias
2122	Minería de minerales metálicos	.953	Primarias
3322	Fabricación de herramientas de mano sin motor y utensilios de cocina metálicos	.929	Primarias
3119	Otras industrias alimentarias	.898	Primarias
3335	Fabricación de maquinaria y equipo para la industria metalmecánica	.888	Primarias
3363	Fabricación de partes para vehículos automotores	.882	Primarias
3161	Curtido y acabado de cuero y piel	.853	Primarias
3253	Fabricación de fertilizantes, pesticidas y otros agroquímicos	.827	Primarias
3326	Fabricación de alambre, productos de alambre y resortes	.750	Secundarias fuertemente asociadas
4931	Servicios de almacenamiento	.614	Secundarias fuertemente asociadas
3279	Fabricación de otros productos a base de minerales no metálicos	.522	Secundarias debilmente asociadas
Fuente: Elaboración propia.			

It has strong linkages firstly with manufacturing of textiles, pharmaceuticals, hand and kitchen tools, machinery for the metal and mechanic industries, leather, fertilizers and other food industries. Among the strongly associated secondary are manufacturing of wires.

Once again, it is observed how this branch is neither linked to the assembly of vehicles in the north-east region, or at least not to all of it, nor to the supply chains such as those proposed by the SIEM.

The automotive cluster in this region, is concentrated in an industrial corridor that goes from Saltillo's metro area to the municipality of Apodaca in Nuevo León. This means that this cluster is located within the dynamics of two SEFUs: Saltillo and Monterrey. We now explain the most important groupings in each of these sub regions.

In the dynamic of the Saltillo SEFU, we see the interaction of 187 productive branches through our estimated regional input-output matrix. These are all clustered in three economic configurations that explain 99.5% of all interactions. In fact, the first one explains 90.7% of them and it is composed of a variety of activities. The

second (*Commercial and Manufacturing activities*) and third (*Commerce and Services*) concentrate almost 9%.

TABLE 8

UEEF SALTILLO. GROUP 1: ASSOCIATION OF THE AUTOMOTIVE INDUSTRY, BRANCH 3361, MANUFACTURE OF VEHICLES AND TRUCKS.			
Branch	**Branch Name**	**Coefficient**	**Type of association**
3251	Manufacture of basic chemical products	.926	Primary
3132	Manufacture of fabrics	.926	Primary
3345	Manufacture of measuring, control, navigation and electronic medical equipment	.924	Primary
3333	Manufacture of machinery and equipment for trade and services	.923	Primary
3114	Preservation of fruits, vegetables and prepared foods	.923	Primary
3252	Manufacture of synthetic resins and rubber, and chemical fibers	.923	Primary
3361	Manufacture of cars and trucks	.921	Primary
3334	Manufacture of air conditioning, heating and industrial and commercial refrigeration equipment	.921	Primary
3352	Manufacture of electric household appliances	.919	Primary
3321	Manufacture of forged and die-cut metal products	.919	Primary
3219	Manufacture of other wood products	.910	Primary
3256	Manufacture of soap, cleaners and toilet preparations	.907	Primary
3149	Manufacture of other textile products, except apparel	.902	Primary
3359	Manufacture of other electrical equipment and accessories	.898	Primary
3323	Manufacture of metal structures and products of blacksmithing	.870	Primary
3141	Carpet weaving, white and similar	.869	Primary
3371	Manufacture of furniture, except office and shelving	.865	Primary
3118	Manufacture of bakery products and tortillas	.854	Primary
3116	Slaughtering, packing and processing of meat from livestock, poultry and other edible animals	.849	Primary
3121	Beverage industry	.843	Primary
3152	Manufacture of clothing	.833	Primary
3329	Manufacture of other fabricated metal products	.828	Primary
3113	Preparation of sugar, chocolates, sweets and similar	.800	Primary
3231	Printing and related industries	.795	Strongly associated secondary
3313	Basic aluminum industry	.784	Strongly associated secondary
3327	Machining of metal parts and manufacture of screws	.774	Strongly associated secondary
3336	Manufacture of internal combustion engines, turbines and transmissions	.766	Strongly associated secondary
3328	Coatings and metallic finishes	.765	Strongly associated secondary
3312	Manufacture of iron and steel products	.723	Strongly associated secondary
Source: Own elaboration.			

The results of the analysis of principal components show that the automotive assembly industry is linked to many activities of commerce and services by its function of supplier of cars. The table above shows only the association with manufacturing branches and we can determine the degree of regional productive articulation. Again the contrast is made with the chain proposed by the SIEM and it

is evident that of the 15 links that provide to the assembly industry has a strong association only with 6 branches, 5 of primary form and 1 of secondary form but strongly associated according to The resulting coefficient. Of note is the manufacture of iron and steel products (3312) and the manufacture of other electrical equipment and accessories (3359); In the background but not less important a branch is distinguished, although it is not considered in the links of the automotive chain if it is a fundamental branch: the 3336, manufacture of internal combustion engines, turbines and transmissions, which has a secondary association But strongly associated with assembly activities.

With respect to branch 3363, it is in grouping 3 and without any other accompanying branch, it has a coefficient higher than 0.5, which means it is not associated. Branch 3362 it is inexistent in the region of influence of Saltillo. This is hardly surprising given that, in the homogeneous regionalization done in chapter 3 for the Index of Development in Regional Automotive Chains, and in the determination of those cities with presence of vehicle production, it was noted that Saltillo and Ramos Arizpe concentrated activities related to assembly. The discovery of a corridor of automotive related activities from Saltillo to Apodaca (Influence of Monterrey) presumes that an analysis of those activities´ performance needs to be done in each of the two SEFU (Saltillo and Monterrey) in which this cluster is spatially located, as well as a determine if there is complementarity or not among economic branches.

It is now the moment to analyze the input-output matrix of SEFU Monterrey and to determine its groupings and which of these belong to the automotive industry.

In the case of SEFU Monterrey, we can see two clusters that explain 98.7% of the variables and group different economic activities, with tourism and services as primary branches. On the other hand, strongly associated branches are those related to manufacturing, with the automotive industry among them (branches 22 and 27): Assembling activities, body part supply and body parts construction. Although the automotive industry in Saltillo sub region is 60% higher than in the Monterrey subregion, we can actually see a stronger articulation between this industry and manufacturing industries of Nuevo Leon.

TABLE 9

UEEF MONTERREY. GROUP 1: ASSOCIATION OF BRANCHES OF THE AUTOMOTIVE INDUSTRY.			
Branch	**Branch Name**	**Coefficient**	**Type of association**
5331	Rental services of trademarks, patents and franchises	.941	Primary
7114	Agents and representatives of artists, sportsmen and similar	.941	Primary
6219	Ambulance, organ bank and other medical treatment services	.941	Primary
2379	Other civil engineering constructions	.941	Primary
4871	Tourist transport by land	.941	Primary
3162	Manufacture of footwear	.785	Strongly associated secondary
6115	Trade Schools	.785	Strongly associated secondary
5191	Other information services	.785	Strongly associated secondary
3361	Manufacture of cars and trucks	.772	Strongly associated secondary
3363	Manufacture of parts for motor vehicles	.772	Strongly associated secondary
3312	Manufacture of iron and steel products	.769	Strongly associated secondary
3212	Manufacture of laminates and wood briquettes	.734	Strongly associated secondary
3336	Manufacture of internal combustion engines, turbines and transmissions	.732	Strongly associated secondary
3359	Manufacture of other electrical equipment and accessories	.725	Strongly associated secondary
3334	Manufacture of air conditioning, heating and industrial and commercial refrigeration equipment	.725	Strongly associated secondary
48	Manufacture of plastic products	.724	Strongly associated secondary
3369	Manufacture of other transport equipment	.723	Strongly associated secondary
3352	Manufacture of electric household appliances	.723	Strongly associated secondary
3149	Manufacture of other textile products, except apparel	.722	Strongly associated secondary
3259	Manufacture of other chemicals	.722	Strongly associated secondary
3141	Carpet weaving, white and similar	.721	Strongly associated secondary
3353	Manufacture of equipment for the generation and distribution of electricity	.721	Strongly associated secondary
3255	Manufacture of paints, coatings and adhesives	.721	Strongly associated secondary
3327	Machining of metal parts and manufacture of screws	.721	Strongly associated secondary
3329	Manufacture of other fabricated metal products	.721	Strongly associated secondary
3219	Manufacture of other wood products	.721	Strongly associated secondary
3315	Casting of metal parts	.721	Strongly associated secondary
3351	Manufacture of lighting accessories	.721	Strongly associated secondary
3362	Manufacture of bodies and trailers	.721	Strongly associated secondary
3251	Manufacture of basic chemical products	.721	Strongly associated secondary
3262	Manufacture of rubber products	.721	Strongly associated secondary
3311	Basic iron and steel industry	.721	Strongly associated secondary
Source: self made			

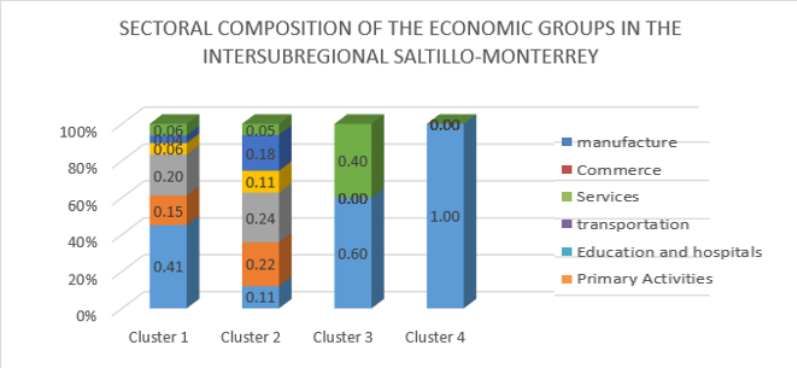
To see the economic groupings formed by the sales and purchases interaction between the economic branches of Saltillo and Monterrey, we used each of inter sub regional input output matrices, calculated from the regional matrix of the north-east region.

According to the principal component analysis of the sub regions, 4 economic clusters are formed in which the first, explains 82.16% of the inter sectorial relations. The second, third and fourth, explain 13.57%, 2.3% and 0.8%, respectively. In the first group, 41% belongs to manufacturing, 20% to services, 14% to commerce and 6% to transportation[5].. In the second group, the association basically belongs to

[5] In this group there are 14 branches primary associated to the automotive industry, like 3362, but not 3362 nor 3363

tertiary activities such as services with 24.32%, commerce with 21.62%, education and health with 17.56%, transportation with 11% and manufacturing with only 10.8%

GRAPH 1.



The third grouping only has 5 associated economic activities, out of which 3 are related to manufacturing[6], while the fourth cluster is integrated by the two most important automotive branches: *Construction of Vehicles* and *Construction of Body parts*. These two, together have a primary association, without any other accompanying branch, not even at secondary level

TABLE 10

INTERSUBREGIONAL RELATIONS ENTRESALTILLO-MONTERREY. GROUP 1: ASSOCIATION OF THE AUTOMOTIVE INDUSTRY.			
Branch	Branch Name	Coefficient	Type of association
3219	Manufacture of other wood products	.970	Primary
3259	Manufacture of other chemicals	.968	Primary
3351	Manufacture of lighting accessories	.968	Primary
3262	Manufacture of rubber products	.967	Primary
3362	Manufacture of bodies and trailers	.966	Primary
3327	Machining of metal parts and manufacture of screws	.964	Primary
3315	Casting of metal parts	.964	Primary
3255	Manufacture of paints, coatings and adhesives	.964	Primary
3251	Manufacture of basic chemical products	.964	Primary
3353	Manufacture of equipment for the generation and distribution of electricity	.964	Primary
3329	Manufacture of other fabricated metal products	.963	Primary
3334	Manufacture of air conditioning, heating and industrial and commercial refrigeration equipment	.963	Primary
3359	Manufacture of other electrical equipment and accessories	.963	Primary
3241	Manufacture of petroleum and coal products	.962	Primary
3312	Manufacture of iron and steel products	.962	Primary
3311	Basic iron and steel industry	.957	Primary
3261	Manufacture of plastic products	.951	Primary
3141	Carpet weaving, white and similar	.936	Primary
3149	Manufacture of other textile products, except apparel	.923	Primary

Source: Own elaboration.

[6] There are no involved branches in the automotie industry.

In cluster 1, there are most of the branches that supply the main linkages of the automotive industry (Strongly associated), since their coefficient of correlation is primary. However, there are not the most important branches of the industry: Assembling activities and body parts.

Cluster 4, despite having branches that lead in the industry, they have no association with any other manufacturing branch or economic activity.

TABLE 11

INTERSUBREGIONAL RELATIONS ENTRESALTILLO-MONTERREY. GROUP 4: ASSOCIATION OF THE AUTOMOTIVE INDUSTRY.			
Branch	Branch Name	Coefficient	Type of association
3361	Manufacture of cars and trucks	.980	Primary
3363	Manufacture of parts for motor vehicles	.975	Primary
3261	Manufacture of plastic products	.186	No association
3322	Manufacture of non-motorized hand tools and metal kitchenware	.096	No association
3132	Manufacture of fabrics	.095	No association
3254	Manufacture of pharmaceutical products	.068	No association
3352	Manufacture of electric household appliances	.065	No association
3222	Manufacture of paperboard and paper products	.045	No association
3162	Manufacture of footwear	.043	No association
3273	Manufacture of cement and concrete products	.037	No association
3311	Basic iron and steel industry	.028	No association
3312	Manufacture of iron and steel products	.020	No association
Source: self made			

At a macro regional level, the industry of vehicles assembly is associated as a supplier, to a diverse amount of activities such as transportation services, commerce, garment industries and to a lesser extent to extractive activities and steel / iron industries. From its natural links in the automotive production chain, secondary or weak ties are maintained with the assemblier when only a relation with the manufacture of lighting accessories is detected. On the other hand, the second most important branch of the automotive chain, the vehicle parts industry, although with limits, is better articulated with suppliers in the northeastern region as it is associated with several manufacturing industries but in particular With a greater number of supply chain activities such as the manufacture of textiles and coatings, machinery and equipment for the metalworking industry and the manufacture of wire products and springs. However, the relationship between assembly and part manufacturing does not occur generally in the Northeast.

As already mentioned, at a sub-regional level, the automotive industry is concentrated in a corridor that goes through both Monterrey and Saltillo SEFUs. We can actually, identify different degrees of articulation. In the case of Saltillo, the assembling of vehicles has a strong association with 6 out of the 15 branches of supply, being the most important Electronics Industry (3359) and Construction of Internal Combustion Engines (3336)..

Construcion of body parts is in a different group than assembling, and completely separated from other economic sectors. Construction of trailers does not exist in the sub region and hence, with no association.

The opposite situation happens in Monterrey, where the branches of the automotive industries are all strongly associated, including Construction of Vehicles, Construction of body parts and Construction of bodies. These, together with other suppliers absorb 22 of the 27 total branches. Unfortunately, most of the car production does not happen in this sub region but in Saltillo sub region, which exports 90% of its production.

The methodology used in this work allowed us to see if there is productive complementarity. Thanks to the multi sub regional matrix, it was possible to see exchanges between both subregions. We can then conclude that at a subregional level, the automotive industry is divided into two industrial clusters: One which is very well articulated in secondary supplyng branches such as Construction of bodyworks and trailers (3362), conforming 20 activities as one cluster. On the other hand, the other cluster is made of Construction of Vehicles and Construcion of body parts, which, although they are strongly associated, they have no other accompanying industry; there are isolated.

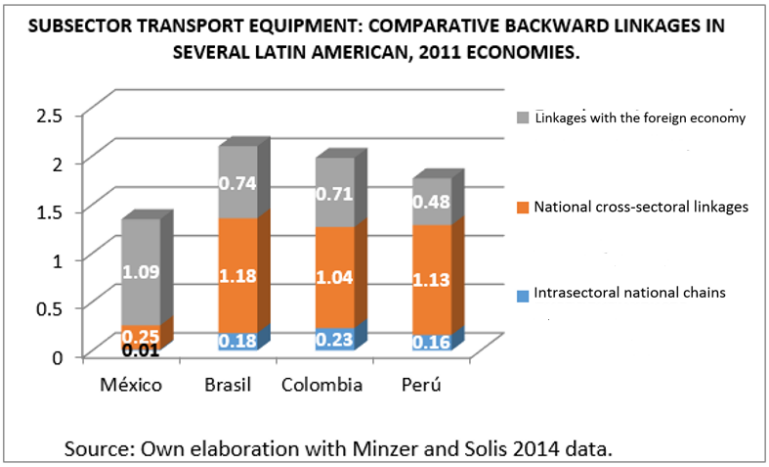
In a general way, we can conclude that the regional production of vehicles has a limited association with other manufacturing branches. Although Monterrey can have a small association, its production is not important, at least in terms of exports. Supplying branches have a strong association among themselves and within the region, but it diminishes in the final linkages, such as with the Construction of body parts and vehicle assembling. The central hypothesis of this work begins to

configurate the presence of an economy of enclave in the automotive industry of the north-east region of Mexico, and in the two sub regions (Saltillo and Monterrey) in which it is located. Now, we proceed to do an analysis of linkages in order to confirm this idea.

c) *Characterization of the automotive industry´s backward and forward liinkages, as well as its spatial verticalization.*

As a background to the present analysis, Minzer and Solis (2014) measured at a national level the very low level of backward linkages of the sub sector Construction of Transport Equipment[7]. The comparative results with other latin American economies show an alarming lack of linkage between production in this sub sector and the national economy, which is even higher than in other countries in the region[8].

GRAFH 2



Source: Own elaboration with Minzer and Solis 2014 data.

In the specific case of Mexico, a dollar value of production in this sub sector has a multiplier effect of 1.35 dollars in its suppliers. However, nationally, it only generates 26 cents for every dollar of production, either via inter sectorial relations (lnkages with other national subsectors that do not belong directly to the production of

[7]. In the sector Construction of Transport Equipment, we can find 7 branches, but those 3 involved represent 96% of valued added, 95% of employed population, 90% of economic units and 98% of intermediate consumption, according to estimates done by INEGI in the 2009 Economic Census.

[8]. The authors were capable of measure the growth in the backward linkages from the exterior: From 0.28 USD in 1999, to 0.42 USD in 2011 for every dollar of Mexican production

vehicles), or via intra sectorial linkages in the branches that conform the automotive cluster.

Once having the input-output matrix of the each of the SEFU that conforms the north east region of Mexico, as well as its relation with a multi subregional, it is possible to do conventional analyses of linkages. Among them the classic ones, we have Chenery and Watanabe (1958) who established coefficients from which it is possible to determine the existing linkages between the different sectors in an economy.

These criteria are well-founded in two types of lnkages: Backward linkages who measure the ability of a sector to "pull" others directly related to it. An external impact stimulates the activity in those sectors. Forward linkages, measure the capability of a sector to stimulate others for their supply or input capabilities. The work of Chenery and Watanabe, proposes a simple method to calculate backward and forward indicators through the averages of input-output purchases and sales (Hernandez, 2012).

The most relevant indicators are those that present above average effects. The formulas for this calculations are expressed in relative terms in order to facilitate comparisons in different situations:

$$BL^{CH\text{-}W} = i'A/((i'Ai)/n) \qquad (1)$$

$$FL^{Ch\text{-}W} = Ai/(i'Ai) \qquad (2)$$

Where i´ is line vector with value equal to 1, A is the matrix of technical cofficients and I, is a column vector with values equal to 1. BL denotes backward linkages and FL, forward linkages. The index refers to the methodology applied in their determination. These coefficients only permit the calculation of direct relations between branches, since an input-output matrix of coefficients was employed (See Fuentes y Gutiérrez, 2002).

In table 12, we present a typology of sectors to be found in a certain economy

TABLE 12

	$BL^R < 1$	$BL^R > 1$
$FL^R < 1$	Independent sectors	Industries that drive the economy
$FL^R > 1$	Core or strategic sectors	Key sectors of the economy

Base or strategic sectors, the ability for dispersión is lower than average, and the absorbsion above average. The sectors with the strongest pull (or movers of the economy) demand inputs from other intermediate sectors, given the stimulus they generate in the production of intermediate goods. Independent sector or "islands" are, in general, not very attractive since they do not provoke a huge impact on the economy; their development does not affect the development of the sectors that demand their production nor those sectors that require the "islands´s" production.

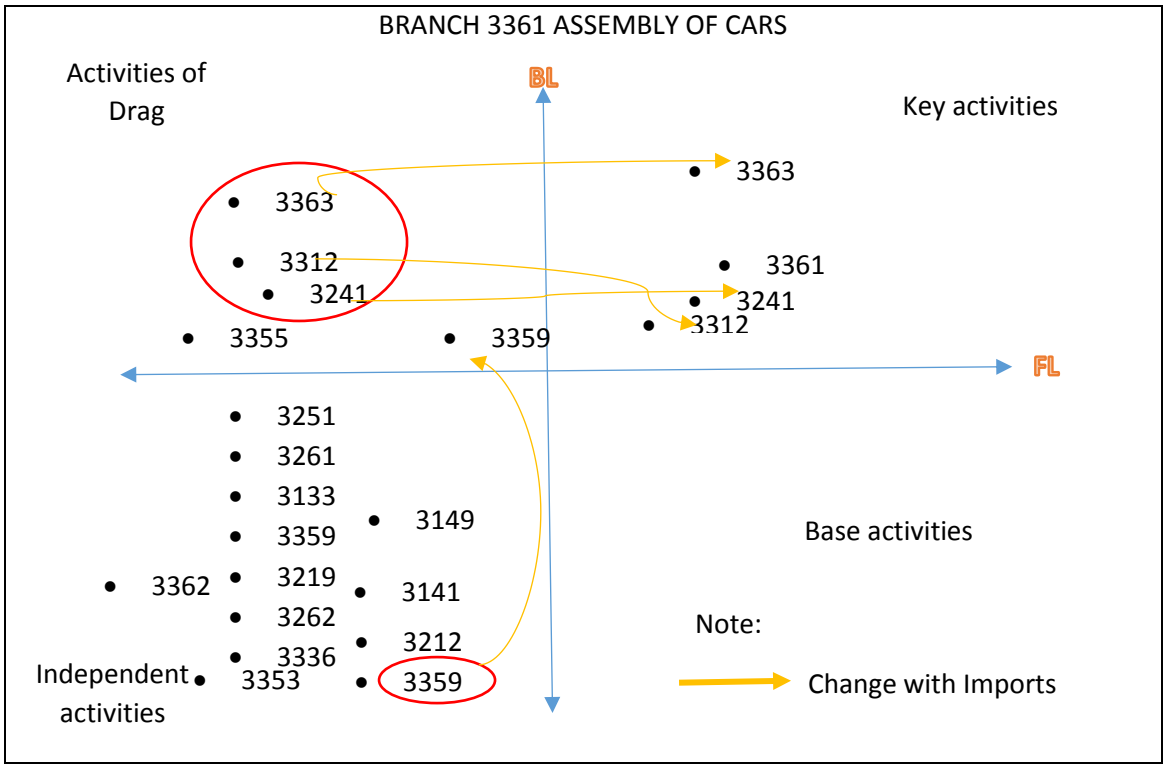
Before doing the calculations of linkages proposed by Chetenery and Watanabe (1958) it is very important to point out the perspective of Schuchny (2005) who said that these calculations must be done with "*Input-output matrices with local components, given that, if they include imported inputs an over-estimation of internal production will be done"*. In this work, we do an analysis of linkages with and without imports to see the contrast between the sub-regions´ clusters.

The results obtained from the analysis of productive chains in the automotive industry in the region are, according to Chenery and Watanabe, for three types of regional and sectoral relations: the three most important branches of Transportation Equipment Manufacturing and that make up the automotive industry[9].

Proceeding with the methodology proposed above, it applies to each of the branches of the sub-sector Manufacturer of transport equipment that make up the automotive industry, both the chains with and without imports yield the following results:

[9] The presence of the automotive industry is only in two sub-regions, a round Saltillo and Monterrey. In this analysis the aggregate of the entire northeastern region of Mexico is taken, thus using an aggregate northeast regional matrix.

For the auto assembly assembly (3361):

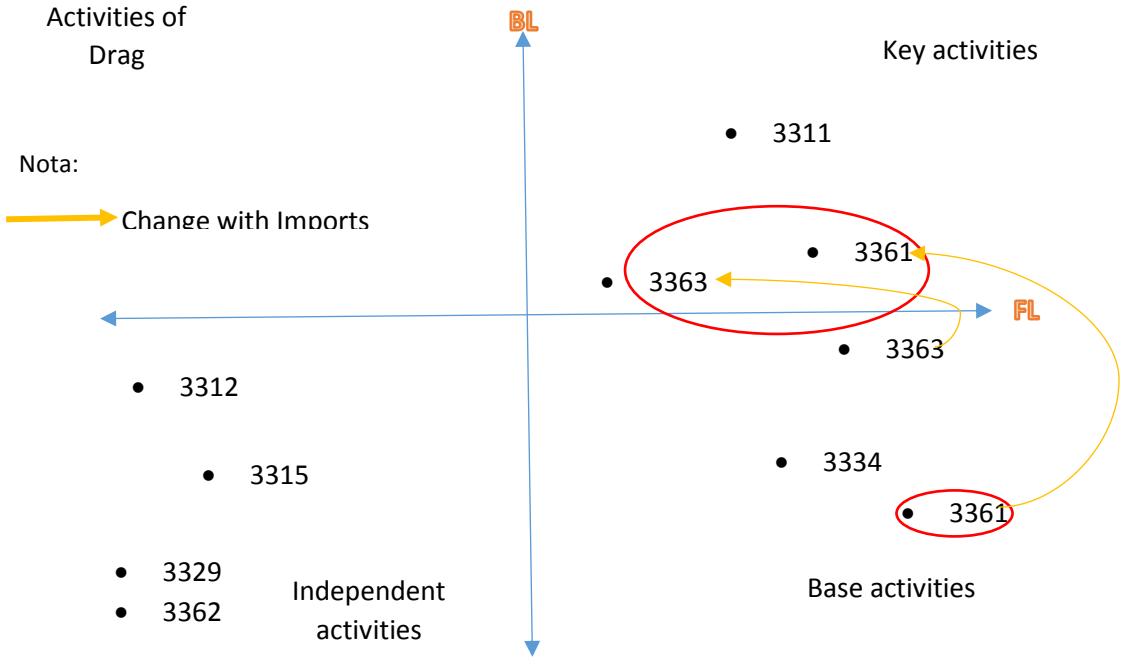


Source: Own elaboration.

The significant number of manufacturing branches in the northeast region that are unleashed from the assembly branch, with and without imports, is evident. What is striking is the fact that a manufacturing activity with imports can generate a differentiated chain. For example there are 4 branches that with imports are repositioned in the performance of the chain. For example the branch 3359 Manufacture of other electrical equipment and fittings that include imports goes from being an independent to drag economic activity. On the other hand, branches 3312 Manufacture of iron products, 3241 Manufacture of petroleum and coal products and 3363 Manufacture of parts for motor vehicles would be trawl sectors for the assembly of vehicles without imports, but with imports they are key selling And buying in the northeastern Mexican automotive chain.

For the manufacture of bodies and trailers branch 3362:

BRANCH 3362 MANUFACTURE OF TRAILERS AND BODIES.



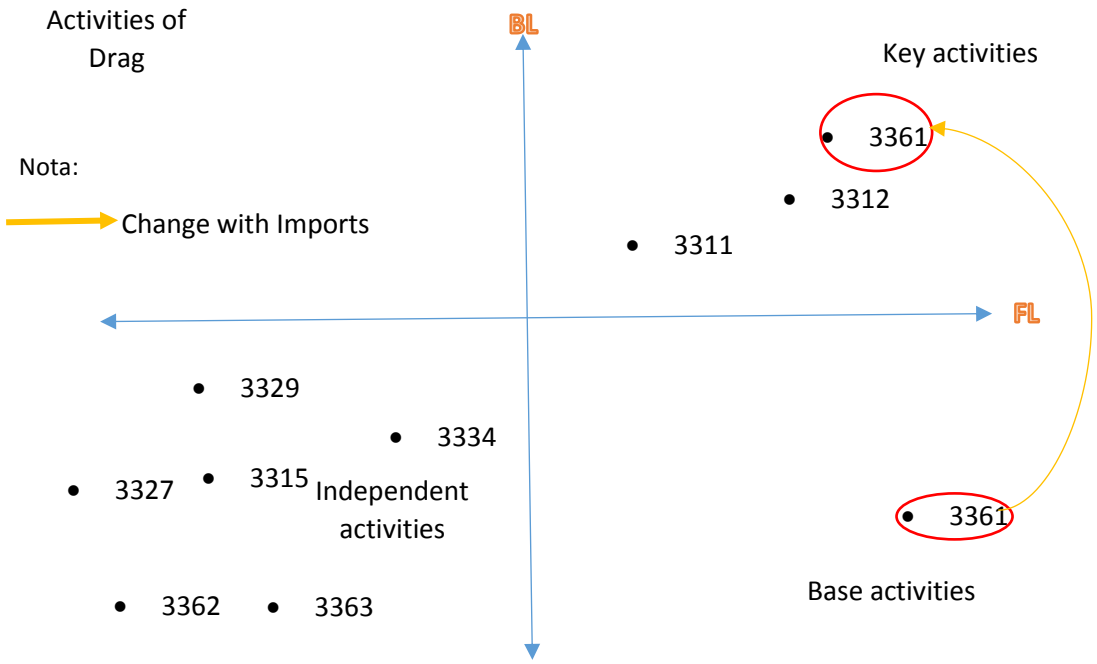
Source: Own elaboration.

For this activity, which provides automotive assembly, 4 of the 8 activities that interact with it are found as independent or isolated sectors, which do not maintain any productive relationship, with or without imports, such as the manufacture of iron products (3312), casting of metal parts (3315) and Manufacture of other fabricated metal products (3329). The manufacture of air conditioning, heating and industrial and commercial refrigeration equipment (3334) remains a customer of this activity as a base activity, with many purchases and low purchases.

On the other hand, the impact of imports in this sector is to be noticed again, since the vehicle assembly (3361) and vehicle parts manufacturing (3363) branches that were as sectors with high forward chains pass To be key sectors with imports.

Finally the manufacture of parts of motor vehicles (3363):

BRANCH 3363 MANUFACTURE OF PARTS FOR AUTOMOTIVE VEHICLES



Source: Own elaboration.

In the same way, in the vehicle parts industry a large number of regional manufacturing branches are totally unconnected, including 6 of the 10 activities of the automotive production chain, such as Machining of metal parts and manufacture of screws (3327), Manufacture of other metal products (3329), casting of metal parts (3315), manufacture of air conditioning, heating and industrial and commercial refrigeration equipment (3334), manufacture of bodies and trailers (3362) and Manufacture of parts for motor vehicles (3363). Only two activities are key to branch 3363, the basic iron industry (3311) and the manufacture of iron products (3312).
In the case of the assembly of cars (3361), it is considered by the manufacture of parts of vehicles a base activity to be supplier of this, however, with imports, the manufacture of cars becomes a key activity.

In the three cases of linkage analysis, the net import transactions are taken (Schuschny, 2005), but also with imports in order to see the effects that these generate in the regional chain. In all three cases, it is observed that imports give

greater productive articulation, since they increase the amount of interaction between the activities or branches of the regional automotive chain.

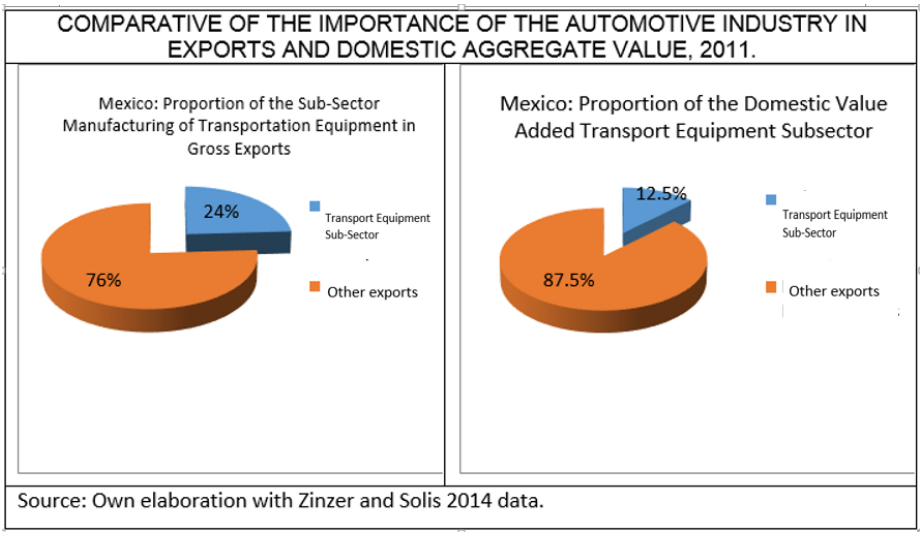
This is indicative of a need for imports in automotive manufacturing for production and that without it would reduce the scope of foreign investment in this industry.

The amount of external value added is then calculated through vertical specialization, which is included in intermediate consumption imported for regional exports.

d) Vertical Specialization and the dependence on the imports in the regional automotive industry.

Minzer y Solis (2014), point out that, in the case of Mexico, from 1999 to 2011, the sub sector *Construction of Transport Equipment,* has increased its national expenditures in foreign inputs, from 52% to 70%.

GRAPH 3



This means the local value added in the automotive industry does not have the share as gross exports of the same activity[10].

In the case of the north east región of Mexico, the vertical specialization was calculated in order to find evidence of strong dependence to imports, just as at the

[10] Dietzenbacher E., Lahr M.L (2000).

national level. For this purpose, we used a north eastern input-output matrix of total transactions[11] , which has information of 158 municipalities. However, the calculation is only contemplated for the manufacturing branches, given that for sectors 21,22 and 31 to 33, there are only estimates.

We show the results in table 13[12]:

TABLE 13

Northeast Region: Estimation of Vertical Specialization for the Regional Manufacturing Industry, 2012.		
BRANCH	Regional content of its exports	Content Imported from its exports
31-33	0.24	0.76
Source: Own estimate.		

In the north-east region, manufacturing exports incorporate 24% of domestic value and 76% of imported content.

TABLE 14

Northeast Region: Estimation of Vertical Specialization in the Automotive Industry and its main branches, 2012.		
Transportation Equipment Manufacturing (Automotive Industry)	Regional content of its exports	Content Imported from your exports
Industria Automotriz	0.15	0.85
3361	0.13	0.87
3362	0.56	0.44
3363	0.00	1.00
3369	0.997	0.003
Source: Own estimate.		

[11] The way in which it is functionally regionalized is explained in chapters 2 and 3 of Maya's thesis (2017).

[12] It is important to point out that, when estimating the regional vertical especialization, the region´s imported content was calculated with a percentage of manufacturing branches from the 2012 Input-Output national matrix. Then, this porcentge was applied to the estimated intermediate consumption by the sames branches in the North-eastern regional input-output matrix. This was validated a 84% Pearson correlation index between the national intermediate consumption and regional sectors 21,22, 23 and 31 to 33. Also, we obtained a 85% correlation index between national and regional manufacturing exports.

The results obtained for the case of the automotive industry branches, indicate that in general, there is a higher share of imported value added to their exports than local valued added from domestic production. In the weighted average of the automotive industry, we can see 85 Mexican cents of imports for every Mexican peso of exports. The internal differences of the region coincide with the structural heterogeneity of subsectors and wth the fact that the economic nature of the region is very similar to the national. For example, in branch 3361 the dependence on imports is only 13 cents for every peso of export value. However, for branches 3363, the degree of dependence on imported inputs is the highest, with 1 peso of imports for every peso of exports. Branch 3362 incorporates a little more than 50 cents of national inputs for every peso of exports, and finally, branch 3369 produces everything with national inputs.

In a competitive environment and with a sector with different productivity levels, it is likely for owner of companies in branch 3363, with an international profile, to import inputs in order to guarantee satisfactory quality standards that branch 3361 requires. At both national and regional levels, this need for higher quality in body parts has opened a window of opportunity for international players to invest in the automotive industry, and become local suppliers[13] ((Ministry of Development of San Luis Potosi,2012).

IV. Conclusions

This work established a methodological proposal which is different in many ways to the conventional regional input-output analysis, since it used a functional economic approach as a starting point. In other words, it establishes patters of areas of economic and demographic influence of the urban nodes in the North-eastern urban system. This, is a more realistic criterion than those regional delimitations based on political-administrative units; it is actually an innovative methodology.

[13] The origin of the auto parts is 31% of Japan, 26% of the United States, 23% of Germany and 20% of others (Ministry of Economic Development of the State of San Luis Potosí, 2012).

In this work, we recognize the vital importance of regional input-output matrices constructed using information “from below”, like the 2014 Mexican Economic Census, which has data from municipalities and branches of economic activity. The methodology for the construction of input-output matrices, included information “from above”, specially imports and exports, and their net balances. Also, we estimated intra regional technical coefficient, but we used Moran´s Indices for the inter regional ones, thus integrating an spatial element.

Although more research is needed in terms of proposals for the estimation of regional data that grasps the true regional nature, this work has made significant progress in the regional input-output analysis area. It is perfectible but it can lead the way to the development of a proper methodology.

The use of the RAS method allowed for the estimation with a high degree of confidence a multi sub-regional matrix which showed a more accurate vision of the regional reality.

In terms of the results obtained, we confirmed the following: A) The importance of the automotive industry, an engine of local growth and B) The hypothesis that the linkages in this industry constrain an integral regional articulation.

In this document, we only analyzed the two sub-regions with the highest concentration of related activities: SEFU Saltillo and SEFU Monterrey. It was found that the automotive industry is articulated with its first level supply branches, but weakly linked to second level industries of supply, which by the way are mostly composed of local companies, contrary to the first level transnational branches.

The analysis of vertical specialization shows that in the branches *Construction of body parts, Construction of body works and Construction of other transportation equipment*, there is a high proportion of imports for export-oriented activities. This means that, given the low productivity of suppliers and the regional structural heterogeneity, it is understandable this high proportion of imports. The results show that an average percentage higher than 70% of valued added is incorporated to automotive exports. Imports are very important in the global chain of intra firm trade in this industry.

The strategy of allowing foreign investment assuming it will provoke economic growth, makes no sense if there are no mechanism of technological transfers and linkages with local actors, which would reduce the productivity gap in the regional economy. However, multiplier effects on employment and income are limited, since there is involvement of local actors in production and most inputs are imported.

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