Regional vertical specialization of the automotive chain in the Central North region of México and its main effects on regional production structure: A spatial approach using an Input-output regional table*.

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Abstract

The importance of automotive industry in México since the opening of the Mexican economy in 1994, brought about that the country would be convert in one of the main world exporters. Nevertheless, just a few regions of the nation were specialized in this industry. This is the case of the Central North region of México, which has also been characterized by its high participation in the regional production. Nevertheless, the high dependency of the regional exports from the imports evidences that this industry has vertical specialization because it belongs to a global value chain. Within the region causes are formed two patterns of regional economic growth highly differentiated that make up the structural heterogeneity: The enclave economy and local economic activities.

This duality in growth generates two gaps showing dependence on imports for exports and a steady flow of foreign direct investment in providers that not allowing to link the local economy with the exporter modern sector. By not articulate local traditional activities with the exporter sector is recorded duality also in the regional development because the multipliers of investment are nullified in employment, income, consumption and welfare of people in the region.

Therefore, the aim of this article is to characterize the vertical specialization of the automotive chain in the Central North region of México as well as identify and measure the dual economy created by the automotive industry as an enclave economy in the region, using an input-output regional table as a way to measure and characterize the analysis of a regional enclave economy.

Hence the methodology consists of the following stages:

1. The regional dual productive structure and the cluster or enclave economy of the automotive industry. This analysis is addressed to characterize the economic activities of the region and their spatial distribution taking into account as criteria: productivity, technology, employment and exports. To identify them it will be applied diverse index

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numbers combined with the use of LISA and MORAN Indexes analysis in order to spell out their sectorial and spatial attributes.

2. The vertical specialization of the automotive industry in the region. This analysis will be done through the identification of the exports of the automotive industry and incorporating external value to the region by quantifying the imported content of imports to exports and their participation in the so called global value chains through indicators of domestic and foreign value added embedded in its exports. For this analysis it is applied a multi-regional matrix based on the ICIO model Input-output tables inter countries methodology. Then once it has be defined the Leontief inverse, will be defined the domestic and foreign value added. It is worth to mention that it will be utilized the input-output table of the Central-North region to the analysis of automotive chain, which has been developed by the CEDRUS research group and whose data refer to the year 2008.

3. The linkages and economic interactions of the productive structure of the region and the effects of the automotive chain. This stage is done through traditional indexes of economic linkages and multipliers of income, employment and production, focusing the analysis on the automotive chain and its effects on the rest of the economic sectors of the region. Furthermore it will be applied a diffusion model, in order to assess the extent that the subset of economic activities that make up the regional automotive industry is linked to other activities in that region. This will be done through the pretopologic approach, which let to characterize the closures and interiors of subsets of branches that make up the block from the automotive industry to clarify its functional role as an enclave.

Keywords: enclave, region, input output matrices, vertical specialization, global chain.

I. INTRODUCTION:

The economic opening undertaken in Mexico since the beginning of the 1980s, has had mixed results in social terms. On the one hand, it has managed to penetrate the North American market, particularly the US and Mexican exports have increased dramatically. Also, some margin of employment associated with these activities has also increased. However, this activities despite to be very important for the high volume of foreign currency entering the country imports a high proportion of inputs and capital goods, so they have a limited opportunity domestic companies to be providers and provoke a brake to the multiplier effect of the opening on employment. One of the best ways to appreciate this phenomenon is to analyze the regions that receiving foreign direct investment, which allows to study not only the spatial changes as infrastructure development and migration that triggers the creation of new manufacturing plants, but to reveal the structural change that has had in the regional economic sectors and explain the existence of a productive duality characterized by strong differences in productivity, advanced technology, modern organizational processes, final market and origin of investment (domestic or foreign direct) coming into production that region. This economic duality results in a null link between national and foreing economic sectors allowing the modern sector becomes an enclave economy.

To analyze the case in this article we will discuss the auto industry, which concentrates a modern sector with high productivity associated with its constant technological innovation in its processes and that it is pioneer of flexible specialization in their work organization and manufacturing of vehicles and is an example of an activity driven foreign direct investment as part of a global value chain incorporating imported inputs and establishes linkages closed local suppliers that do not contribute to the development of local supplier firms so a node unrelated to the regional economy is created. This makes it possible to see the degree of structural heterogeneity around this activity and seen regionally.

In the case of Mexico, we found several regions of automobile production but the Central North Region has a value of 35% of the national production chain in this industry, which makes a zone specializing in the manufacture of cars and trucks, manufacturing parts of steering and suspension, brake system parts and parts of transmission systems (Asuad et al, 2015).

In this region the automotive industry is implanted with the opening of the assembly plant in Silao Guanajuato but now concentrated in cities like Leon, Aguascalientes, San Luis Potosí, Celaya, among others (Asuad ibid.). This region is home to many auto parts plants, whose main products are stamped, electrical components, brakes and parts, rubber products for engine and transmission parts for cars (Ministry of Economy, 2012).

Once given the context of this investigation, this paper is divided into five parts: the first briefly outlines the hypothesis, the research objective and the questions that serve as a hub of exploration on the subject. In the second part, an explanation of what it means an economic enclave and its theoretical explanation since the Latin American structuralist perspective.

In the third part, we describe the methodology used in the article, which includes four sections of analysis; it begin precisely with the approach and calculation of structural heterogeneity based on the analysis of productivity among manufacturing branches. It reinforces the idea trough of spatial correlation of auto branches and a functional representation of the value added of supplier activities and intermediate consumption of the local terminal industry. In paragraph 2 will be analyzed the way to obtain regional matrix of total transactions and regional imports. Subsequently vertical specialization is analyzed, which measures the percentage weight of imports and local added value that incorporates the region's exports. Finally we show the usefulness of the determinant of the regional matrix to analyze the weight of imports of several regional economic sectors, the auto industry between them.

In the fourth part of this work we show the results obtained in each of the methodologies used and applied for the north central region that focusing on economic branches that are in the auto supply chain in the region. In the fifth and last part is given at length the conclusions of this work.

HYPOTHESIS:

The existing production chain in the branches of the automotive industry in the north central region is weak because there is a significant proportion of imports that are incorporated into the gross value of exports of vehicles due to the existing technological and economical duality between the companies that make chained branches which in turn causes the impact in terms of growth in income, employment, welfare and regional consumption is limited.

GOAL OF THE RESEARCH:

This paper seeks to establish the existence or the trend towards regional enclave economy in the manufacture of export vehicles in the northern central region and the impact this has on the economic growth and development in the region through three ways: 1) The analysis of structural heterogeneity and correlation of economic branches of the region; 2) The amount of the local added value and of imports that are incorporated into the value of regional exports through vertical specialization of each automotive link; and 3) a comparative analysis of the regional weights that interactions automotive branches have in the regional economy with and without imports. For these calculations the input-output table regional estimated be used.

RESEARCH QUESTIONS:

This article analyzes the automotive industry enclave of north central region through four general fundamental questions:

• What is an enclave economy?

• How can you explain that an enclave in the automotive industry would create gaps in regional growth and development?

• What theoretical and methodological approaches describe and explain enclave economy elements in the regional automotive industry and the formation of regional gaps?

• Can we speak of the existence or the trend toward automotive enclave in the north central region?

Corroboration of the hypothesis and explanation of the results of the application of each technique will show in Section IV.

II. ENCLAVE ECONOMY AND THEORETICAL RESEARCH.

A specific definition of enclave economy is the next: an economic activity detached from the other productive sectors. Cademartori (2010) states that the production control is external to the local actors in areas of economy enclave. This reproduces a regional duality in which there are two types of economic actors: a modern technologically productive sector, which is the center of the enclave and linked to the world market, and on the other hand, there is a periphery of traditional activities totally unrelated to the first and even threatened by it.

The previous idea, assumes the existence of an uneven economic structure of productive sectors formed by a mosaic of companies with different levels of productivity. This duality is present at the national level and the regional level. This phenomenon is called structural heterogeneity, and can be observed at national or regional level and analyze the auto industry in its industrial branches that form it.

The concept of structural heterogeneity leads us to the study of Latin American structuralist currents posed by the coexistence of industries with a level of productivity similar to those of developed countries and other economic sectors with lower productivity compared with those countries (Chena, 2010). Even some authors of this current accuse the industrialization process of the largest Latin American economies of be the guilty the generator of such structural heterogeneity, and that the development policy did not get to "a primitive sector, whose scales of productivity and income per capita allowed only subsistence ". Although it introduced incentives to "industries whose productivity was similar to the average of the national economy, and a modern stratum, linked export sectors which operate with margins equal or higher in productivity than the average of developed economies" (Pinto 1976)[4].

The structural heterogeneity or economic duality between modern and lagging sectors in a region causes a vicious cycle that necessarily brings about a number of issues that impact on regional development by generating social gaps that result in labor inequality, technological dependence and poverty. Prebisch explains that the investment coming into Latin America is not sufficient to absorb the population of working age, and part of the workforce still continue in low productivity, low income or unemployment. This does not generate sufficient savings margins for society and causes insufficient accumulation of domestic investment. Of this way, it start the dependence on foreign investment which will come to modern sectors perpetuating the duality and paying the concentration of wealth in the region (Estay , 1990).

One way to reverse the structural heterogeneity is to generate its own technology and endogenous innovation to detonate modern sectors diffusers of knowledge to sectors with lower productivity, managing to raise the training of the workforce. The presence of sectors

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[4] Pinto (ibid) adds that in the central countries, there is a tendency to structural homogenization due to the spill the leading sectors towards the stragglers sectors in progress and technical innovation, to elevate productivity and margins equalized. In Latin American economies, the opposite effect occurred, since the modern sectors are increasingly isolated from the rest of the economy.

with high productivity differential correlates to the existence of social strata of high and low income.

On the other hand, the discrimination of the credit system in developing countries contributes to the structural heterogeneity by providing all facilities to companies with strong economic interests that allows them to be solvent and in turn opens the door to invest in technological innovation, with positive impacts in productivity and economic growth rate (Aglietta and Orlean, 1982), while other sectors with no access to credit are unable to invest in technological improvements to make them more productive and competitive, making them grow less and even stagnate or have to exit the market.

Chena proposes as a first step to identify the structural heterogeneity, calculate el average of labor productivity (ratio of value added and employed population in such activities), which is directly related to the use of technology. The subsectors which are above the average are considered modern and those under the average are considered lagging sectors.

III. STAGES METHODOLOGICAL ANALYSIS

    a. Structural heterogeneity.

As seen in the previous section the structural heterogeneity can be evidenced by calculating the productivity of the workforce employed in manufacturing. Calculating productivity is obtained from the following expression:

    AV / OP = Productivity of a sector i in region j

Variables are:

• AV: Value Added sector i in region j

• OP: Population employed in a sector i in a region J

After calculating the labor productivity of each of the economic sectors in the region or selected spatial dimension it proceeds to determine the average regional productivity and economic activities that are above and below the average, the former being those of higher productivity because they incorporate in their production processes the use of technology, and the latter those with low productivity by having a technological gap applied in their production processes. The standard deviation show the degree of dispersion that exists in the branches of the region's productivity, this want to say difference between the branches with highest and lowest productivity. This way we can see the degree of heterogeneity in the economy of the study. The structural heterogeneity was estimated for 1999 and 2009 to achieve see the change in this indicator.

b. Construction of the Input Product Matrix of the Central North Region.

Before performing the input-product matrix regional , the zone Central-North was built through a functional economic approach, that is, by identifying the most important cities concentrating population, value added and employment. These cities have radial ranges of functional economic influence. The way in which we group functionally smaller municipalities that are in a middle distance is through a method based on probabilistic flows, specifically the gravitational model Reilly[5].

The methodology for the development of an input-output matrix of the Central-North region was under estimation technique by adjustment coefficients location and intersectoral interactions of a national matrix for 2008, through Flegg Weber and Elliot (1995), followed by the team of the CEDRUS of the UNAM[6]. The national matrix is 260 economic branches but in the Matrix of Central-North region are 225 activities. Were discounted some because were considered irrelevant by its little value in the total.

For the calculation of the regional matrix, we did matrix of domestic consumption and imported intermediate consumption in the region. First, we calculated the share of national imports by dividing the national matrix of imports between the national total transactions matrix obtained from INEGI 2008, with the aim of obtaining the percentage share of imports branch or sector. As a parallel process, the central-north regional matrix of total transactions is subtracted of the national total transactions matrix. The result was the estimation of intermediate consumption matrix of Mexico less the North Central matrix or "other regions". Due to their greater similarity to the national behavior will apply the sectoral import ratio calculated in the first step and the result was obtaining the matrix of imports from all other regions without the north-central region. Almost to culminate, it was subtracted to the national matrix of total imports matrix the of "other regions". The result was a matrix of regional imports was obtained. Finally, if we subtract the total transactions matrix of the north central region of regional imports, we get the matrix of domestic transactions of the north-central region.

$$ZT_{RCN} = \begin{bmatrix} ZT(1,1), ZT(1,2) & \cdots & ZT(1,225) \\ \vdots & \ddots & \vdots \\ ZT(225,1), ZT(225,2) & \cdots & ZT(225,225) \end{bmatrix}$$

ZTRCN Z is the matrix of total transactions T in intermediate consumption of the center-north (RCN) region. In this matrix, purchases and sales of the study region generated by the 225 domestic sectors are including imports (purchases made by companies in the region or outside of it, which may include intermediate production from abroad or from other national regions).

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[5] For a detailed analysis of regionalization techniques review Asuad (2001).
[6] See work Quiñones (2015). Other studies using the same methodology of regionalization of the matrix were followed by Soto (2000), Fuentes (2003) and Dávila Flores (2002).

For this regional matrix of total transactions (ZTRCN) it was estimated the equivalent domestic transactions (ZDRCN) and imports (ZMRCN) to obtain a vector of regional imports from all sectors within it.

$$ZT_{RCN} = \begin{bmatrix} ZTrcn(1,1), ZTrcn(1,2) & \cdots & ZTrcn(1,225) \\ \vdots & \ddots & \vdots \\ ZTrcn(225,1), ZTrcn(225,2) & \cdots & ZTrcn(225,225) \end{bmatrix}$$

$$ZM_{RCN} = \begin{bmatrix} ZMrcn(1,1), ZMrcn(1,2) & \cdots & ZMrcn(1,225) \\ \vdots & \ddots & \vdots \\ ZMrcn(225,1)(ZMrcn(225,2) & \cdots & ZMrcn(225,225) \end{bmatrix}$$

ZD_RCN = ZT_RCN - ZM_RCN

$$ZD_{RCN} = \begin{bmatrix} ZDrcn(1,1), ZDrcn(1,2) & \cdots & ZDrcn(1,225) \\ \vdots & \ddots & \vdots \\ ZDrcn(225,1), ZDrcn(225,2) & \cdots & ZDrcn(225,225) \end{bmatrix}$$

c. Vertical specialization: the weight of imports and local value added in the total value of exports.

Vertical specialization occurs when in each country participating in the global production chain specializing in some stage of production, and their requirements are necessarily to import inputs for manufacturing goods that will be for export. Vertical specialization is essentially measured by the weight of the import content of exports, for which the analysis of input-output tables is useful (Hummels et al, 1999). According Dietzenbacher, to appreciate the impact of vertical specialization in a input-product matrix approach is necessary to obtain the weighted average import multipliers using sectoral exports as weights.

To fully understand the concept of vertical specialization, Hummels et al (1999) mentions that a country imports a type of asset that will serve as input for the production export to that country[7]. Therefore, this type of production and analysis allows knowing the current features of economic globalization such as the fragmentation of global production and international trade that allows you to see the linkages between countries for the production of final goods.

To check the degree of dependence on imports in the automotive industry nationally we estimated the vertical specialization using arrays of total transactions and import 2008.

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[7]Hummels also mentions the example of horizontal specialization, in which countries trade goods that are produced from start to finish in a single country.

$$AVE = AV\,(1 - A)^{-1}\,e^{x} \qquad (1)$$

Donde:

AVE = Value Added for Export

AV = Value Added

e^{x} = Exports

The domestic value-added incorporated in exports of goods in the country is calculated. Using Mathematica V.9 program, we obtain the next results to national level:

$$ZDMX = ZT\_MX - ZM\_MX$$

$$\begin{bmatrix} ZD(1,1), ZD(1,2) & \cdots & ZD(1,225) \\ \vdots & \ddots & \vdots \\ ZD(225,1), ZD(225,2) & \cdots & ZD(225,225) \end{bmatrix} * \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} - \begin{bmatrix} A(1,1), A(1,2) & \cdots & A(1,225) \\ \vdots & \ddots & \vdots \\ A(225,1), A(225,2) & \cdots & A(225,225) \end{bmatrix}^{-1} \begin{bmatrix} ex(1) \\ ex(2) \\ ex(225) \end{bmatrix}$$

Also, to calculate the weight of imports over exports is calculated from the following expression:

$$ME = M\,(1 - A)^{-1}\,ex \qquad (2)$$

where:

ME = Amount of imports necessary to export

M = intermediate Imports

$$\begin{bmatrix} ZM(1,1), ZM(1,2) & \cdots & ZM(1,225) \\ \vdots & \ddots & \vdots \\ ZM(225,1), ZM(225,2) & \cdots & ZM(225,225) \end{bmatrix} * \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} - \begin{bmatrix} A(1,1), A(1,2) & \cdots & A(1,225) \\ \vdots & \ddots & \vdots \\ A(225,1), A(225,2) & \cdots & A(225,225) \end{bmatrix}^{-1} \begin{bmatrix} ex(1) \\ ex(2) \\ ex(225) \end{bmatrix}$$

With this estimate we proceed to calculate the domestic value added incorporated in the region for export of goods in the region. For this calculation, the regional matrix of domestic transactions ZD_RCN and the matrix of value added (VA) are used:

$$AVE = ZD\_RCN\,(I - A)^{-1}\,e^{x} \qquad (3)$$

$$\begin{bmatrix} ZDrcn(1,1), ZDrcn(1,2) & \cdots & ZDrcn(1,225) \\ \vdots & \ddots & \vdots \\ ZDrcn(225,1), ZDrcn(225,2) & \cdots & ZDrcn(225,225) \end{bmatrix} * \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} - \begin{bmatrix} Arcn(1,1), Arcn(1,2) & \cdots & Arcn(1,225) \\ \vdots & \ddots & \vdots \\ Arcn(225,1), Arcn(225,2) & \cdots & Arcn(225,225) \end{bmatrix}^{-1} \begin{bmatrix} ex(1) \\ ex(2) \\ ex(225) \end{bmatrix}$$

The result is a column vector[8] showing the Added Value incorporated to the exports into each of the 225 economic branches (AVEi) as a proportion of total exports of each of said branches (Texi):

$$0 \leq \frac{AVE}{Texi} \leq 1$$

Now you can see the same proportion that has the foreign intermediate consumption in the value of regional exports seeing the weight that imports have in the regional exports [9].

As in the case of value added, the result is a column vector[10] that show the weight of the Imports incorporated into each of the 225 economic branches Exports (MEI) as a proportion of total exports of each of said branches (Texi):

$$0 \leq \frac{ME}{Texi} \leq 1$$

With equations 3 and 4 it is possible to know the proportions value-added local in each industry. In the case of the branches that make up the automotive industry it is possible to know its proportion of dependence on imports for export.

$$[(AVEi / Te^{xi}) + (MEi / Te^{xi})] = 1 \qquad (4)$$

Where:

AVEi = Added Value for Export sector i

Texi = Total exports of sector i

MEi = Imports for Export sector I

By measuring the participation of local or regional proportions of added value for exports plus imports of inputs the sum is 1. It should be added that imports will consider the inputs that come from outside the north-central region, It may imply that come from other regions within Mexico or international[11].

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[8] Multiplying the matrix ZD_RCN which is 3x3, by its inverse Leontief (I-A)-1 , which is a square matrix of 3x3 the result is another square matrix of 3x3. But when multiplied in turn by a column vector of exports ex, nx1, the result of Value Added Domestic (AVE) is also a column vector nx1.

[9] Obviously M is the matrix of regional imports estimated for the region ZM_RCN.

[10] As in footnote 8.

[11] It is assumed that imports in the branches associated specifically to the regional automotive industry come not only from others regions inside of México mostly because official data indicate that there are companies that matter in the supply industry 90 % of its inputs or direct material US. This situation was encouraged from tariff reduction in auto parts (Ministry of Economy, 2012).

d. Determinant of the Input-Output Matrix of Central-North Region with and without imports.

It is necessary to understand the architecture of a structure using measures to evaluate the existence of sectors (or economic branches) that are "dominants" over others, as well as the relationships between them (Lantner and Lebert, 2013).

The matrix of technical coefficients can see relationships (cash flows of goods, information, etc.) that occur between the different economic activities, which are represented by vertices (sectors and branches) and arcs (exchanges xij) by way of graphs[12]. Considering the determinant (and theorems that arise from their properties) and from the point of view of Leontief, indicators of interdependence, autarky, and domain / dependence are obtained, whose relations can be appreciated through the use of graphs . Using this method is relevant because the calculation of the matrix allows warn global environment effects of changes to the structure (Lantner and Lebert, 2013). In this analysis both use matrices as graph theory (networks) is made.

For purposes of our analysis the degree of influence that a sector of the economy through the analysis of determinants and subdeterminants[13], and observing the degree of connectivity that occurs in an economic system with and without the influence of imports; it is possible to observe how imports cover holes and they improve the degree of links sectors and in some cases there will be sectors with higher percentage of participation in overall economic activity[14].

IV. RESULTS OF EACH OF THE METHODOLOGICAL ASPECTS APPLIED IN THE CENTRE-NORTH REGION.

i.   Structural heterogeneity in Mexico and in the Central-North Region.

The questions guide to be answered are:

• What characterizes a dual economy in what is called structural heterogeneity and how they can be applied to the analysis of the economy of the north central region?

• How does the structural heterogeneity in the economic activities that make up the regional automotive industry?

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[12] To simplify the representation of these relationships through graphs, it is assumed that the relations between sectors are considered linear, because 1) it has been found that in the long term, in some cases, their behavior is stable and 2) some indicators can be used to study the static structure or compare two stages of a structure that evolves on two different time moments.

[13] In the words of Lantner: "The determinants of a matrix (input-output or not) are a good indicator of the overall influence of diffusion through an economic structure that has an intensity or number of relationships between sectors within it. The determinants can be calculated from a combination of substructures, which do not carry the same weight of spreading its influence (Lantner, in Dietzenbancher and Lahr, 2000).

[14] An indicator that is the cornerstone to analyze the evolution of trade (also applied to other areas) between countries and regions, is the determinant of the matrix. By definition, the determinant of a matrix is given by the sum of all products of the n terms of the matrix, which are related to each other somehow, becoming a significant indicator of the readiness of the structure (Lantner and Lebert , 2013).

Nationally, it is noteworthy that there is strong structural heterogeneity marked by strong economic sectors that have large productivity gaps with respect to a majority economic community that is below average levels.

TABLE 1. MEXICO: EVOLUTION OF ITS MODERN SECTORS FOR YOUR LEVEL OF PRODUCTIVITY			
1999	AV/OP	2009	AV/OP
Basic industries of iron and steel	1086.6	Industry snuff	6274
Industry snuff	792.7	Industries nonferrous metals, except aluminum	2622
Manufacture of cars and trucks	761.4	Manufacture of basic chemicals	2510
Industries nonferrous metals, except aluminum	675.0	Basic industries of iron and steel	2014
Manufacture of iron and steel materials purchased	599.6	Manufacture of cars and trucks	1630
Pharmaceutical Manufacturing	489.3	Manufacture of iron and steel	1503
Manufacture of basic chemicals	425.7	Manufacture of resins and synthetic rubbers and chemical fibers	1131
Manufacture of forged and stamped metal products	414.0	Manufacture of fertilizers, pesticides and other agrochemicals	896
Manufacture of fertilizers, pesticides and other agrochemicals	401.6	Pharmaceutical Manufacturing	866
Manufacture of cement and concrete products	390.0	Grinding grains and obtaining seeds and oils and fats	783
Manufacture of rubber, resins and chemical fibers	352.7	Manufacture of cement and concrete products	739
Other food industries	350.6	Manufacture of petroleum and coal	724
Manufacture of soap, cleaning and toilet preparations	338.3	Manufacture of soap, cleaning and toilet preparations	704
Manufacture of paints, coatings, adhesives and sealants	281.0	Animal food processing	612
Manufacture of railway equipment	280.4	Manufacture of pulp, paper and cardboard	547
Manufacture of pulp, paper and cardboard	260.2	Manufacture of paints, coatings, adhesives and sealants	545
Manufacture of other chemicals	256.0	Beverage industry	528
Milling grain and oilseeds	238.0	Other food industries	502
Beverage industry	236.4	Basic aluminum industry	485
AVERAGE	185	AVERAGE	482
STANDARD DEVIATION	185	STANDARD DEVIATION	789
COEFFICIENT OF VARIATION	1	COEFFICIENT OF VARIATION	1.64
Source: Compiled with data from INEGI, Economic Census 1999 and 2009.			

The national productivity increased from 1999 to 2009, however, the structural heterogeneity did in the same way (see increasing the standard deviation). Among the industry's leading branches with higher productivity at the national level are the manufacture of cars and trucks, in both years was among the top five. Branches suppliers, manufacturers of bodies and trailers as well as manufacturing parts for vehicles are among the branches with productivity below the national average.

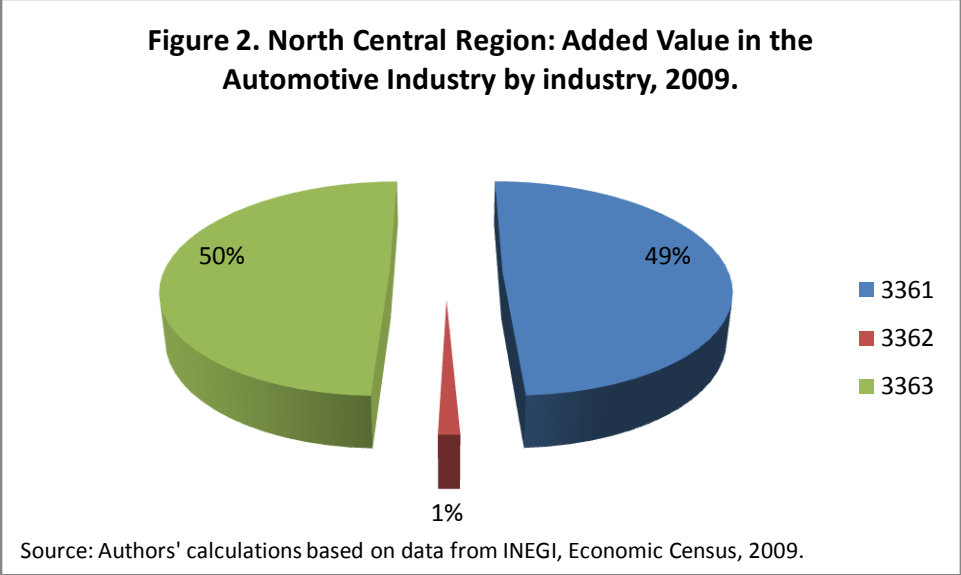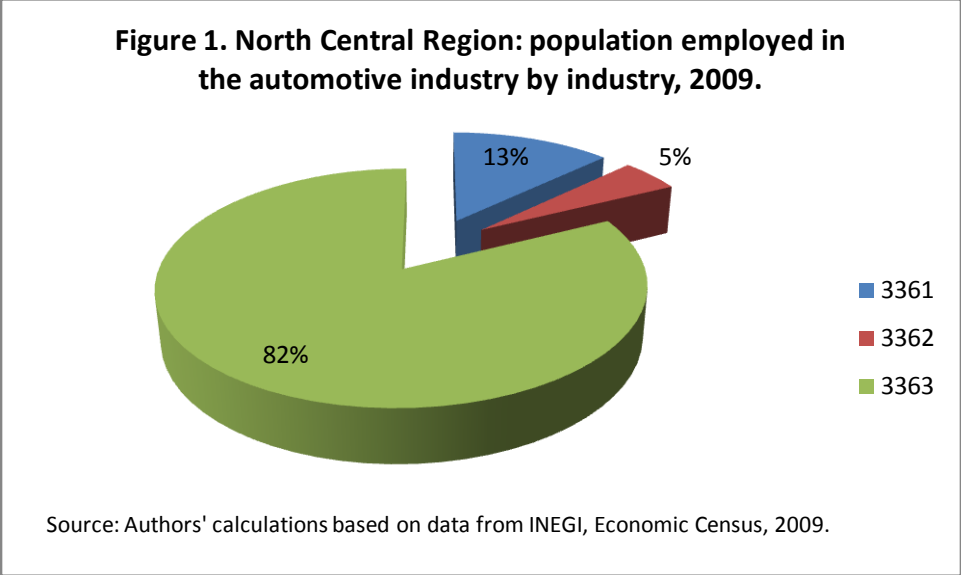For analysis in the Central-North, the same variables are identified:

TABLE 2: NORTH CENTRAL REGION: EVOLUTION OF MODERN SECTORS FOR ITS HIGH LEVEL OF PRODUCTIVITY.			
1999		**2009**	
BRANCH	AV/OP	**BRANCH**	AV/OP
Industry snuff	3825	Industry snuff	5784
Manufacture of cars and trucks	2359	Industries nonferrous metals, except aluminum	2131
Manufacture of fertilizers, pesticides and other agrochemicals	608	Manufacture of basic chemicals	2020
Industries nonferrous metals, except aluminum	400	Basic industries of iron and steel	1523
Manufacture of basic chemicals	296	Manufacture of cars and trucks	1139
Grinding grain and oilseeds	200	Manufacture of iron and steel	1012
Manufacture of machinery and equipment for trade and services	138	Manufacture of resins and synthetic rubbers and chemical fibers	640
Pharmaceutical Manufacturing	111	Manufacture of fertilizers, pesticides and other agrochemicals	405
Manufacture of soap, cleaning and toilet preparations	65	Pharmaceutical Manufacturing	375
Slaughter, packaging and processing of livestock and poultry meat	55	Manufacture of cement and concrete products	248
Manufacture of parts for motor vehicles	34	Manufacture of petroleum and coal	233
Beverage industry	30	Manufacture of soap, cleaning and toilet preparations	213
Manufacture of iron and steel materials purchased	4	Manufacture of pulp, paper and cardboard	56
Preparation and spinning of textile fibers and yarns manufacturing	0	Manufacture of paints, coatings and adhesives	54
AVERAGE	**214**	AVERAGE	**491**
STÁNDAR DESVIATIÓN	**522**	STÁNDAR DESVIATIÓN	**837**
COEFFICIENT OF VARIATION	**2.4**	COEFFICIENT OF VARIATION	**1.7**
Source: Compiled with data from INEGI, Economic Census 1999 and 2009.			

Table 2 one can see several aspects: the first is that the average productivity in manufacturing in the region increased from 1999 to 2009. However, like what is seen at the national level, the increasing standard deviation indicates that the heterogeneity degree increased. This is corroborated by the fact that in 1999 the sectors that recorded higher productivity than the average were 13/82, that is to say 16%, while in 2009, of the 76 manufacturing subsectors reported only 14 have a productivity above average, that is to say 18% of economic activities, which tells us of an absolute and relative concentration of the technologically modern sectors. The most recent data indicates that 62 manufacturing sectors in the region, that is to say 82%, are considered lagging economic activities by low productivity. The structural heterogeneity in the north central region is accentuated because of such indicators.

In the case of the auto industry showed in 1999 the presence of two of the four main branches of the activities with greater regional productivity: the terminal branch and the main provider. However in 2009, only the manufacturing of cars and trucks was among the

5 most productive areas of the central-north region. The manufacture of parts for motor vehicles and manufacture of bodies and trailers is among the manufacturing subsectors with low productivity, which puts them among the branches of the regional economy lagged. This is a first indication that in the auto industry there is a duality in which only vehicle assembly activities are technologically modern and highly productive, making suspect a tendency to form an enclave economy by the automotive sector in the region.

Figure 1. North Central Region: population employed in the automotive industry by industry, 2009.

13%   5%

82%

3361
3362
3363

Source: Authors' calculations based on data from INEGI, Economic Census, 2009.

Figure 2. North Central Region: Added Value in the Automotive Industry by industry, 2009.

50%   49%

1%

3361
3362
3363

Source: Authors' calculations based on data from INEGI, Economic Census, 2009.

Graphs 1 and 2 show that due to the high difference of productivity between auto branches, the assembly plants (3361) provided only with only 13% of employment in the sector produces almost half the value addition of the automotive industry in the Central-North region in 2009. The other two branches, Manufacture of trailers and bodies (3362) and the production of parts of motor vehicles (3363), with 87% of employment produce the other half of the regional automotive value added in the same year.

This is another element that corroborates the structural heterogeneity in productivity within the automotive industry in the study region. Now we need to see the correlation that hold the supplier branches, manufacture of trailers and bodies (3362), the manufacture of automotive arts (3363) and manufacture of other transport equipment parts (3369) with the leading branch is manufacturing trucks (3361). The analysis of each branch and its correlations were made with the total gross output variable, which accounts for intermediate consumption and value added.

TABLE 3. NORTH CENTRAL REGION: spatial correlation between the branches of the automotive industry, 2009.				
	3361	3362	3363	3369
3361	1	0.07869	0.59179	-0.00779
3362	0.07869	1	0.26519	0.00194
3363	0.59179	0.26519	1	0.67622
3369	-0.00779	0.00194	0.67622	1
Source: Compiled with data from INEGI, Economic Census, 2009.				

Table 3 shows the spatial correlation coefficients between the auto branches. The highest correlation that exists between the production of vehicle parts(3363) and manufacture of other transport equipment (3369), with a value of 0.68. It can be said that the presence of these branches in the region is highly correlated and that the presence of one this branches match in 68% of the other. However we must add that the percentage value of gross output of the industry 3369 represents less 0.05% of total regional automotive industry.

Another strong spatial correlation is the manufacture of vehicle parts (3363) and the manufacturer of trucks (3361), being this linkage the center of the activity and which together account for 95% of employment and just over 98% of value added in the region. In territorial sense it means the presence in the region of the assembly branch coincide by 59% with the presence of the manufacturer of parts for vehicles. This level of correlation is interesting because it implies that these activities share spatially neighborhood which could mean productive relationships or natural linkages (Map 1), however, as will be seen later this is not necessarily real.

MAP 1. Central-North Region: spatial location of the activities of the automotive industry by municipality, 2009.
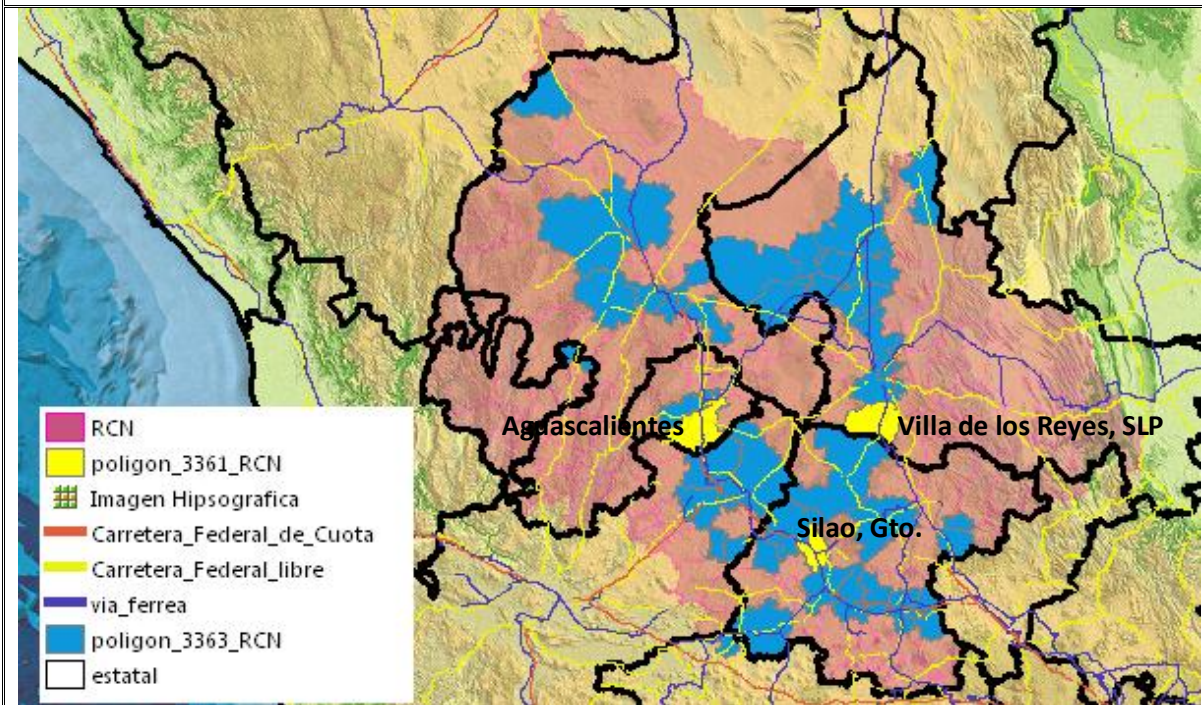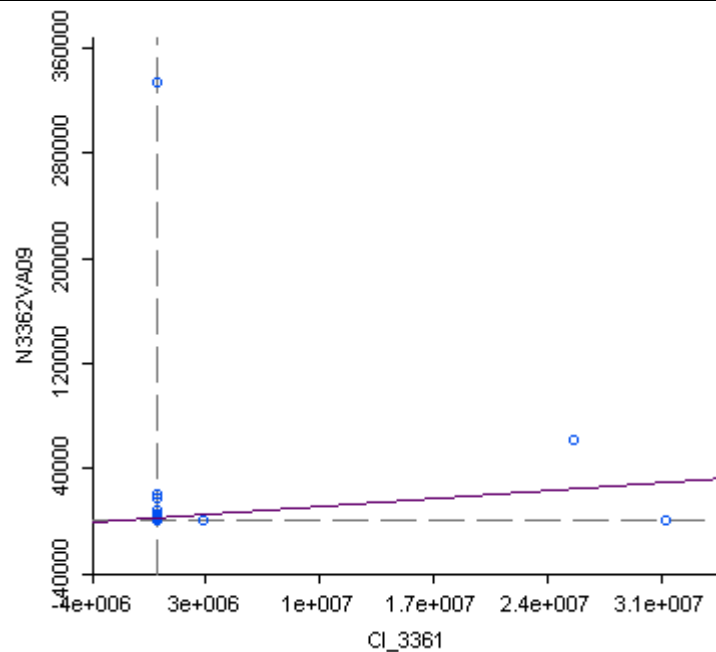
Source: Compiled with data from INEGI, Economic Census, 2009.

Another correlation observed is that of the manufacture of bodies and trailers (3362) with the manufacture of parts for cars (3363), which yields a correlation of less than 0.27; and the same happens with the branch 3369, the 3362 does not have a substantial weight in the automotive chain in terms of value added and regional employment.

As mentioned above, the neighborhood between the activities that make up the automotive industry does not mean that there are supply relationships, and to check this situation some models of simple spatial regression that purport to show the spatial dependence of the added value are presented for each one of the providers (3362, 3363 and 3369) depending on the consumption intermediate of the assembly branch (3361).

The first model presented shows the relationship of the value added of the local manufacture of bodies and trailers (3362) in the region in terms of intermediate consumption in the manufacture of trucks (3361).

Figure 3. Region Centre-North: Regression and dispersal of Added Value of the manufacture of bodies and trailers (3362VA) as a function of intermediate consumption of Manufacture of vehicles (CI-3361).
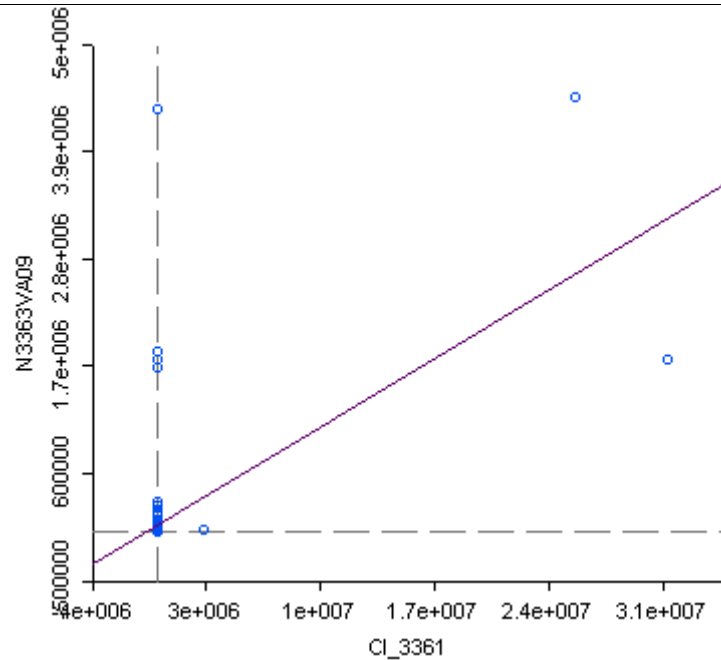
Variable	Coefficient	Std.Error	t-Statistic	Probability
CONSTANT	2349.565	1938.518	1.212042	0.2271391
CI_3361	0.0008873652	0.000635291	1.396785	0.1642570

Source: Compiled with data from INEGI, Economic Census, 2009.

As shown in Figure 3, the variation in the vehicle manufacturer branch positively affects to the manufacture of bodies and trailers, but with low elasticity because the Intermediate Consumption of assembly of vehicles (CI_3361) varies 0.008% added value of the manufacturing of bodies and trailers (N3362VA09). This despite the fact that there is a positive relationship between the two activities in space is not strong enough and is evidenced by the low slope resulting from the correlation between the two activities.

A second model presents the dependence between the manufacturers of parts for automotive industry (3363) according to the manufacturer vehicles branch (3361).

Figure 4. Region Central-North: Regression and dispersal of value added manufacturing car parts depending on the intermediate consumption of assembly of vehicles.
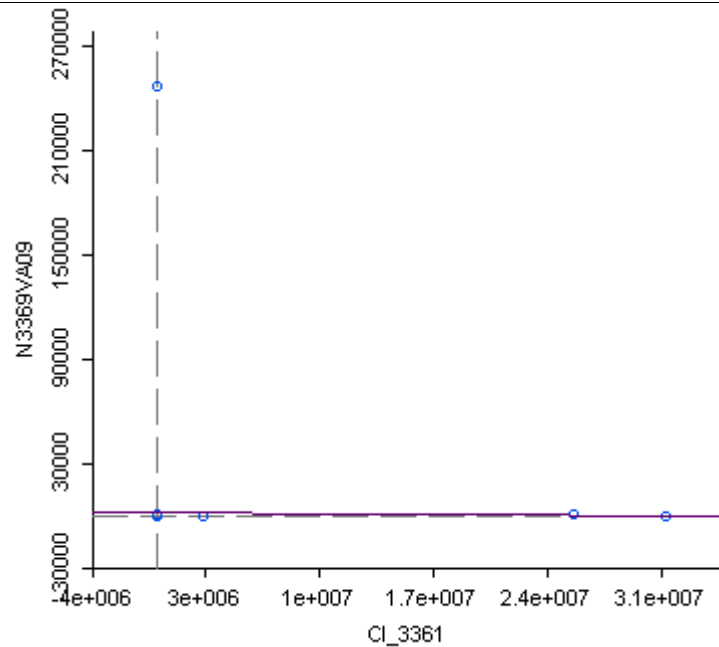
```
------------------------------------------------------------------------
   Variable    Coefficient     Std.Error     t-Statistic    Probability
------------------------------------------------------------------------
   CONSTANT       68446.57      33190.45        2.062237      0.0406716
   CI_3361      0.1008186     0.01087717        9.268821      0.0000000
------------------------------------------------------------------------
```

Source: Compiled with data from INEGI, Economic Census, 2009.

Graph 4 allows viewing a positive relations and a much steeper slope between these two branches manufacturers of transport equipment. However, the regression shows that for one dollar that varies intermediate consumption of vehicle manufacturing in the region, value added of the providers of parts of vehicles vary in only 10 cents. This result leads to the conclusion that, although there are positive relationships between these two branches of the regional automotive chain, are fairly limited and that the elasticity between both remains weak.

Finally, a third model that links the change in value added of manufacturing branch other parts of transportation equipment (3369) depending on the vehicles manufacturer Intermediate Consumption (3361) in the region.

Figure 5. Region Centre-North: Regression and dispersal of value added of manufacture of other transportation equipment in terms of intermediate consumption of assembly of cars and trucks.

Variable	Coefficient	Std.Error	t-Statistic	Probability
CONSTANT	1430.566	1415.606	1.010568	0.3136262
CI_3361	-4.828398e-005	0.0004639224	-0.1040777	0.9172426

Source: Compiled with data from INEGI, Economic Census, 2009.

Graph 5 shows a inverse relationship between the production of the manufacture of other parts of transport equipment and vehicle manufacturers, which means that the increase in intermediate consumption of assembly of vehicles provokes a reduction value added in manufacturing from other parts of transportation equipment.

We concluded from these three models that the functional relationship of activities inside regional auto industry is very low, meaning that despite having territorial neighborhood, productive relationship between them is scarce. The most significant case is the relation between branch 3361 car and truck manufacturer and the branch 3363 automobile parts manufacturer but still very weak, which may be related with a strong productivity differential between both activities. The branch 3361 manages very high standards of quality and the regional providers of branch 3363 are below average regional productivity.

Therefore, the structural heterogeneity that is evident in the region, and specifically in the branches that make up the regional automotive industry, explains the weak linkage of export activities to the regional economy as a whole. Productivity differentials between branches belonging to the same subsector emphasize the importance of technological cooperation and training of the workforce would allow productivity levels harmonize with the idea of generating higher links between transnational corporations that command manufacturing transport equipment and national companies that may be their suppliers.

For transnational corporations that drive productive activities export oriented, such as the automotive industry, is no problem the lack of regional providers because their supply needs are satisfied by a global supply chain that incorporate value added in other regions and countries to the regional production of vehicles for export. How important is the incorporation of value added in automotive production in the centre-north region? How much dependence of import has the auto industry in the region Centre-North? That question will be answered in the following section.

ii.   The Vertical specialization of the automotive industry in the region Centre-North of Mexico.

After two decades of presidential decrees in Mexico that led to the chain of automotive manufacturing under the strategy of import substitution industrialization, beginning in the 1980s a trend towards economic liberalization that allowed attracting significant amounts of foreign direct investment (FDI) reorient production towards export vehicles and spawned the spatial relocation of industry on regions such as the north, northeast and Midwest. Under the North American Free Trade Agreement (NAFTA) since 1994, production targets reflected the inclusion of several Mexican regions specialized in manufacturing activities to global value chains that command transnational corporations[15].

Therefore, economic openness and foreign direct investment has put the national export of auto in the global dynamics. This means that the regions that receiving foreign investment and who specialize in the manufacture of export vehicles are part of a global value chain, in which several regions of other countries are vertically aligned to the global production scheme, which is commanded by the intra-trade (transnational corporation), that moves parts of its production process to various regions of the world where they find advantages like lower production costs[16].

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[15] In fact, in Mexico regions as the regions from developing countries have increased their participation in global value chains of trade rising from 20% in 1990 to 30% in the 2000s and 40% in 2013 (UNCTAD, 2013), however, in the case of Mexico the share of domestic value added in the total value of exports has fallen from 72.1% in 1990 to 60.2% in 2011 (Minzer and Solis, 2014).
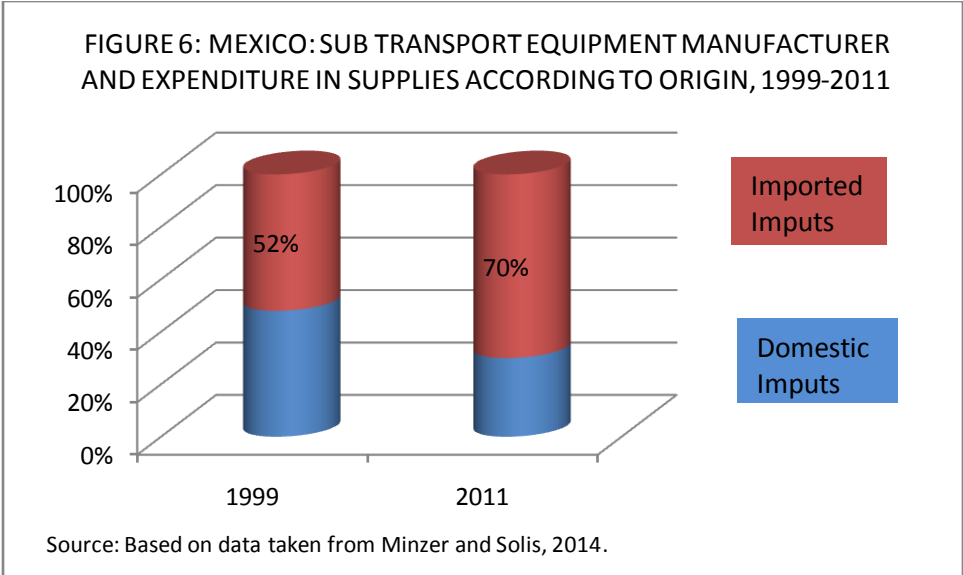
[16] Global value chains allow us to understand the new form of operation and organization of transnational networks representing 80% of world trade. Global Value Chain can also be considered as consecutive links of economic activities in different countries or regions that interact in a continuous dynamic. The participation of a country in these global chains reflects the portion of exports from that country as part of a commercial process in several stages and includes the added value added in exports of other countries. The countries located at the end of the Global Value Chain have a high foreign value added of its exports abroad.

According to UNCTAD (2013), the producers of transport equipment sector has increased its share of maquiladora employment and vertical specialization as part of the increase of the trade between Mexico and the United States which could be nearly half of all the exchange of goods between the two countries[17].

Nationwide studies have empirically shown that Mexico, along with other Latin American countries such as Brazil, are much more dependent imports from other countries. In the case of the manufacture of transport equipment, Mexico has not changed its position in the global value chain, specializing in the final stages of the production process from 1995-2011 (Rodriguez, 2014).
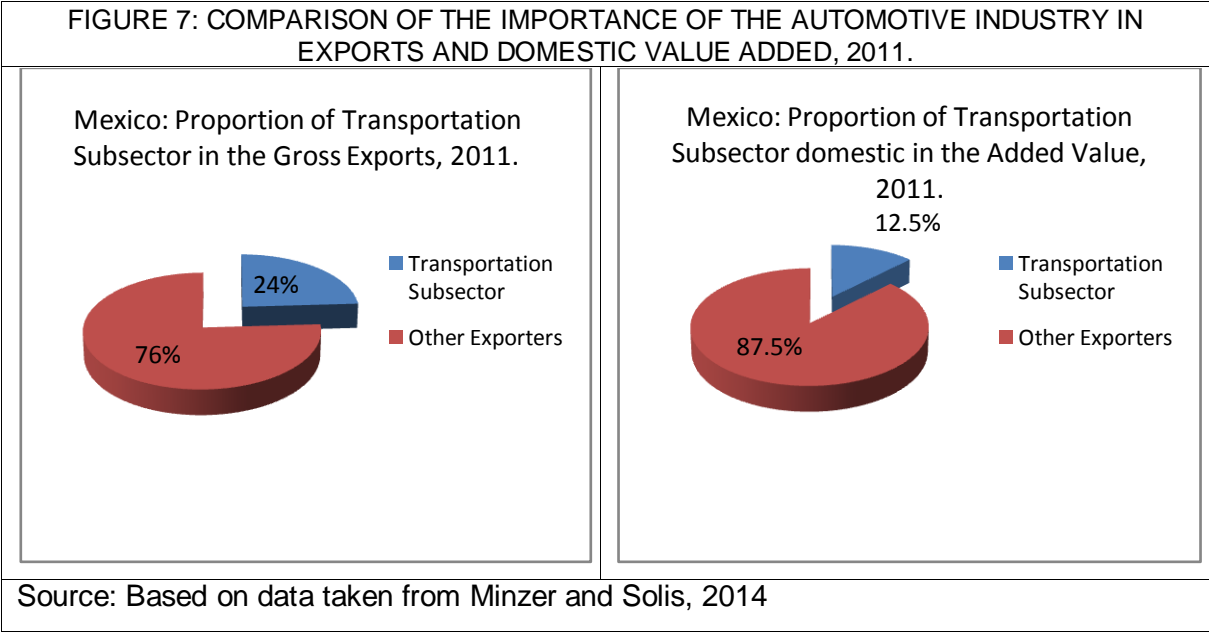
By the above, it is possible to understand the importance to measure the percentage of foreign value added (measured by imports) and evaluate the degree of integration for a country in world trade more if value-added incorporated in exports from that country grows constantly. However, for purposes of this article it is very interesting to analyze the amount of value added foreign to exports as an indicator of dependence of the productive structure of a country or region of the imports. This means that for a region or country that want to export one US dollars will need higher proportion of foreign inputs (value added foreign). If that region is inserted successfully in to the global value chain is possible to see a big local value added in to exports, which will impact in a higher growth and generation employment in the region or country analyzed.

Minzer and Solis (2014) note that in the case of Mexico, the manufacturing subsector of transport equipment, has increased national spending on foreign supplies of 1999-2011 from 52% to 70%.

FIGURE 6: MEXICO: SUB TRANSPORT EQUIPMENT MANUFACTURER AND EXPENDITURE IN SUPPLIES ACCORDING TO ORIGIN, 1999-2011

Source: Based on data taken from Minzer and Solis, 2014.

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[17] The erosion of tariff barriers and improved communication technologies and transportation have made that countries specialize in goods that can produce more efficiently (UNCTAD, 2013).

This means that the domestic value added in the automotive industry does not represent the same proportion to the activity in Mexican crude exports.

FIGURE 7: COMPARISON OF THE IMPORTANCE OF THE AUTOMOTIVE INDUSTRY IN EXPORTS AND DOMESTIC VALUE ADDED, 2011.

Mexico: Proportion of Transportation Subsector in the Gross Exports, 2011.

24%
76%
■ Transportation Subsector
■ Other Exporters

Mexico: Proportion of Transportation Subsector domestic in the Added Value, 2011.
12.5%
87.5%
■ Transportation Subsector
■ Other Exporters

Source: Based on data taken from Minzer and Solis, 2014

To check the degree of dependence on imports in the automotive industry nationally we calculated the vertical specialization using arrays of total transactions and import 2008.

The results of vertical specialization national corroborate a strong dependence on imports in the auto sector at the national level, although strong differences can be observed separately branches (Table4).

TABLE 4. Mexico: Vertical specialization in the automotive industry, 2008.			
BRANCH	AVEi /Te^{xi}	MEi / Te^{xi}	Total Check
3361	0.560308	0.439692	1
3362	0.505524	0.494476	1
3363	0.432615	0.567385	1
3369	0.569799	0.430201	1
Source: Estimate by the use of the computer program Mathematica V.9			

For example, the contribution of domestic value added is greater in the branch 3369 and 3361 with a 57% and 56% respectively. However, there is a reduced contribution in the

branch 3363, manufacturing parts of vehicles, whose contribution to value added is 43% and weight of imports in the gross value of exports of almost 57%.

In the case of northern and central Mexico, the vertical specialization will try to verify if there is a heavy dependence on imports as given at the national level. We use the matrices calculated for the Region Central-North[18] which collects information from 175 municipalities that make up said delimitation[19].

The results obtained for the central-north region in the vertical specialization is as follows:

TABLE 5. Region Central- North: Estimate of the Vertical Specialization, 2008.		
AVEi /Te^{xi}	MEi / Te^{xi}	Total check
0.856451	0.143549	1
Source: Estimate by the use of the computer program Mathematica V.9		

The region central-north incorporates their total exports 86% of value added versus 14% of total imports from other regions of the country or international.

As for the branches that make up the manufacturing subsector of transportation equipment results were:

Table 6. Region Central- North: Estimate of vertical specialization in the branches that make up the Auto Industry, 2008.			
BRANCH	AVEi /Te^{xi}	MEi / Te^{xi}	Total check
3361	0.785563	0.214437	1
3362	0.76229	0.23771	1
3363	0.714948	0.285052	1
3369	0.666858	0.333142	1
Source: Estimate by the use of the computer program Mathematica V.9			

The results for the branches of the automotive industry indicate that there is a major contribution to regional value-added exports and minor proportion of raw materials outside

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[18] The methodology for the development of an input-output matrix of the Central-North region was under estimation technique by adjustment coefficients location and intersectoral interactions of a national matrix for 2008, through Flegg Weber and Elliot (1995), followed by Quiñones (2015) and the team of the UNAM CEDRUS.

[19] The functional form of regionalization is by a method based on probabilistic flows, specifically the gravitational model Reyli.

the region in general. Inside you can see differences that point to what has been analyzed: there is structural heterogeneity in the subsector and that the regional reality is reproduced as in the national. For example, in the branch of vehicle assembly there is a less dependence on imported inputs, in fact, it is the smallest of the three main branches, with a higher proportion of local value added. However, for manufacturing vehicle parts industries (3363) and manufacturing of other transport equipment parts (3369) the level of dependence on imported inputs in the region is higher. In a competitive environment and with productivity differentials in the auto sector, entrepreneurs of the branch 3363 and 3369 have to import to ensure the quality that your customers demand in the branch assembly 3361.

At the national level and the regional level also, the shortage of providers of high quality in the auto parts has led a window of opportunity for international investment to arrive the regions specializing in the automotive industry and several foreign providers have become local suppliers but its origin is varied[20] (Development Secretariat of the State of San Luis Potosi, 2012).

A strong difference observed between the documented tendency of the national and regional industry of vehicles is that the last have less dependence on imports, however, there sources indicate that in areas automotive industry, such as San Luis Potosi, only 52% of inputs are sourced locally (Ibid), due among other things to the existence a small number of companies with certified systems of quality and strengthening the quality of imports from various countries, including Asians.

After analyzing the regional proportion of added value incorporated into the production process of the regional automotive industry and the dependence on imported intermediate consumption by vertical specialization, it is possible to incorporate other matrix analysis tool to see not only the dominance of the national auto industry and regionally, too its relative weight with and without imports. The aim will be to see the degree of connectivity external inputs give the automotive sector interactions with the local economy.

iii.   The linkages and economic interactions of the productive structure of the region and the effects of the automotive chain: An analysis of the determinant of the Central-North Regional Matrix.

Until now we have seen the importance of the automotive industry as a leading sector in the foreign trade, receiving in foreign direct investment, strong productivity generated in the assembly of the vehicle as a result of use intensive technology, among other relevant aspects. But as seen along the first section of this paper the existence of structural heterogeneity that makes economic branches coexist with high and low productivity, accuses a technological diversity and, as seen in the second part, there a trend toward dismantling its chain because in branches less productive such as vehicle parts and the manufacturing of other parts of transportation equipment, dependence on imports is

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[20] The origin of auto parts is 31% in Japan, 26% US, 23% in Germany and 20% other (Ministry of Development of the State of San Luis Potosi, 2012).

higher than in other branches, including the assembly of vehicles whose productivity is higher.

Now in this third section we will discuss the connectivity of automotive industry as a whole with respect to the national economy and with reference to regional economy north-central. This analysis will be done with and without imports in order to see the degree of connectivity that give purchases of external inputs. To this end, the calculation of the determinant of the matrices of total transactions (including import) and domestic will be done.

Before seeing the results, the following questions arise:

• What impact does the automotive industry nationally and in the region centre-north with respect to other important sectors such as construction and food?

• So how will contribute dynamism in imports in these sectors, focusing on the automotive industry in both spatial dimensions?

In this section we will see the situation first nationally and then immediately make emphasis on the regional level of the zone Centro-North of Mexico, being at this level of analysis, the aim of this work, where you see the real regional impact of the auto industry on economic activity and its contrast with and without imports.

As background to this analysis, Minzer and Solis (2014) have measured at the national level the very low level of backward linkages of subsector Transportation Equipment Manufacturing . The comparative results with other Latin American economies show an alarming disconnect between the production of this subsector to the national economy, much higher than in the countries compared[21].

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[21] The authors have managed to measure growth that have backward linkages from abroad. Between 1999 and 2011 the multiplier has gone from 0.28 to $ 0.42 per dollar produced in the Mexican economy.

Figure 8. Subsector transport equipment: Comparative backward linkages in several Latin American economies, 2011.
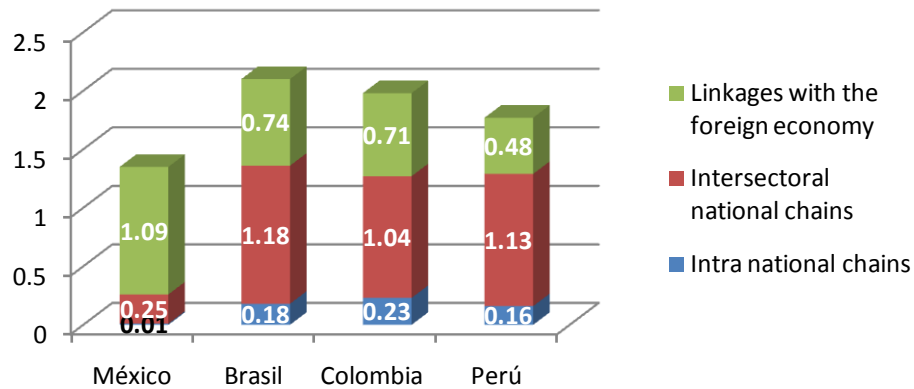
Source: Based on data from Minzer and Solis 2014.

In the case of Mexico, producing a dollar in the transportation equipment subsector has a multiplier effect of 1.35 dollars on its suppliers as total impact. However, nationally only generates 26 cents for every dollar of output, either by way of cross-sectoral relations (25 cents), that is to say for linkages with other national subsectors that not belong directly to the production of vehicles, or either by way of intra-relationships (one cent), that is to say by chains into branches that make up the block of auto.

Turning to the results of the calculation of the determinant of the matrix of the north central region, the 4 most important branches of subsectors such as construction, food and together with the most important of the Transportation Equipment Manufacturing are compared[22].

The national use of matrices total and domestic activity allows us to see the difference between economic activity with and without imports respectively. The results are shown in Chart 1:

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[22] The criterion for the selection of the four major branches of each subsector was the weight that these have in the added value. In the subsector of Construction take the next branches: non-residential building (2362), Residential Building (2361), Construction of facilities for water supply, oil, gas, electricity and telecommunications (2371), Construction of roads branches (2373). The branches that were taken make up 84% of the subsector. The Beverage Industry (3121), Manufacture of dairy products (3115), Manufacture of bakery and tortilla (3118) and Slaughter, meat packing and processing of livestock, poultry and other animals for food (3116), the branches were taken, which account for 70% of value creation in the Food subsector. While for the Manufacture of Transport Equipment the branches considered they are those already stated in previous analysis plus Manufacturing of other transport equipment (3369) with which it is agglomerated slightly more than 97% of value added in the subsector.

Chart 1. Mexico: subdeterminants By subsectors and their percentage change with imports, 2008				
Sector / Matrix	MIPD = 0.0017739	Percentage (%)	MIPT = 0.0001821	Percentage (%)
Construction	0.00190	1.07000	0.00020	1.07
Food	0.00214	1.20000	0.00022	1.2
Transport	0.00191	1.07000	0.00030	1.62
Source: Based on data of the MIP 2008, INEGI.				

MIPD is the Input-Output Matrix of domestic transactions, which is to say without imports, while MIPT is the matrix of total transactions, including imports. The results are interesting: the block of food activities have greater relevance in the total in comparison with the block of Transport and Construction, both sectors without imports. But with the influence of imports, their subdeterminants change, being the most important the block of transport, because it has greater subdeterminant, increasing its percentage from 1.07 to 1.62. The other branches have no such variation in relative weight. This shows the dynamism that the imports give to domestic auto industry.

Now it is necessary to corroborate the importance of the auto sector in the region centre-north in terms of the connectivity of imports in comparison with the same block of branches: Building and Food.
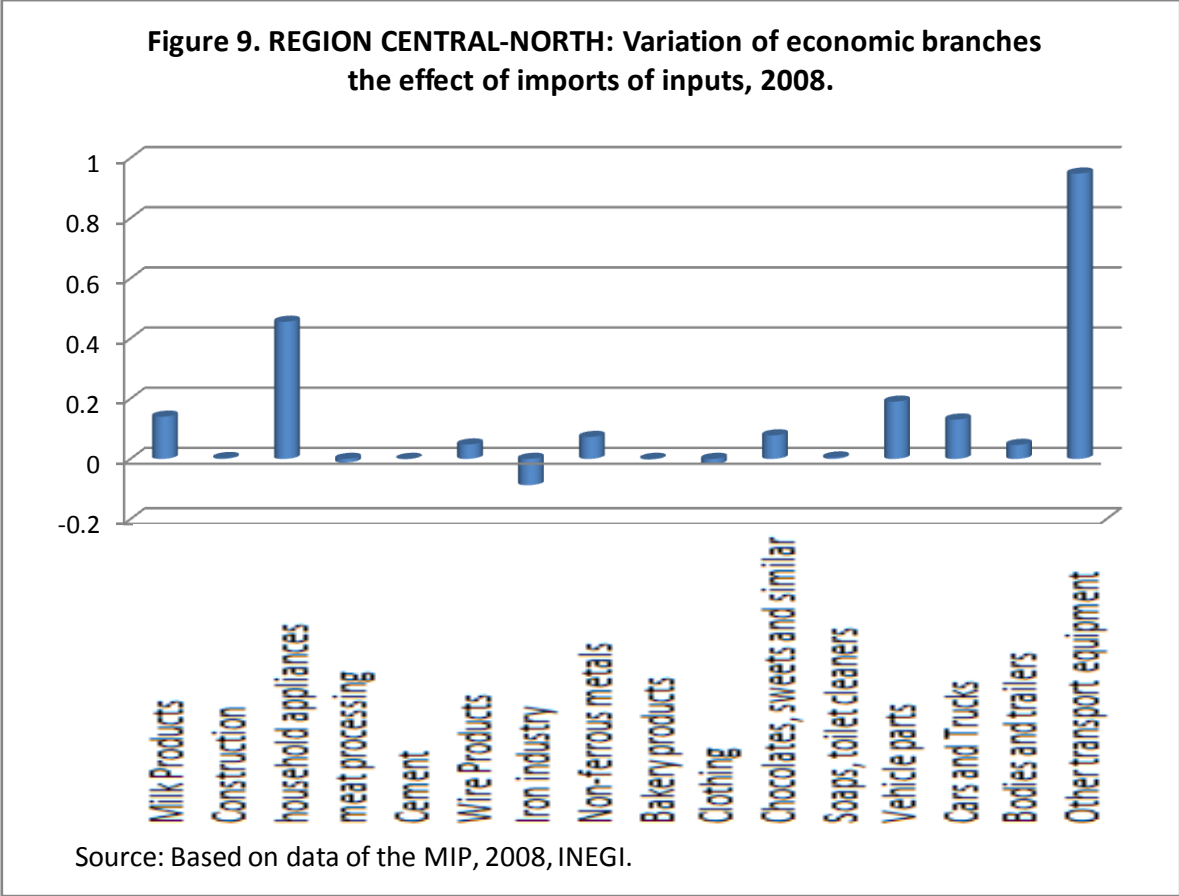
Chart 2. North Central Region: subdeterminants by subsectors and their percentage change with imports, 2008				
Sector / Matrix	MIPCNRD= 1.53×10^{-22}	Percentage (%)	MIPCNRT = 3.38×10^{-22}	Percentage (%)
Construction	2.49×10^{-20}	1.62	5.5×10^{-22}	1.62
Food	8.32×10^{-20}	5.41	1.88×10^{-21}	5.57
Transport	1.93×10^{-20}	1.25	1.11×10^{-21}	3.28
Source: Based on data of the MIP 2008, INEGI.				

As is evident, without the imports, the subsector of food in the north central region is the most important in comparison with the Construction and Transportation Equipment Manufacturing, same behavior to national level. However, this indicator shows the change compared with the activities when the matrix is observed with total transactions, including imports. In the block of the construction branches with imports, the connectivity stays unchanged, is to say, its percentage is not increased. The branches that make up Food sector its variation is small, going from 5.41 to 5.57 percent.

In the case of branches forming block of Transportation Equipment the significant variation occurs with the imports: the weight percentage in the regional economy going from 1.25 to 3.28%, indicating that external input purchases outside the region, whether national or international, increases the connectivity of the branches of the automotive industry.

Among the branches with greater weight in the central-northern region as their subdeterminants, there are two activities that are prevailing in the region related to the breeding and exploitation of animals (1152) and the Development of services of Dairy Products (3115) . Their weight in the region is very important for connectivity of it. Below are the most important branches in the region along with the branches of the automotive industry and its variation in connectivity as differences of subdeterminant of each branch between the determinant of the regional matrix with and without imports[23].

Figure 9. REGION CENTRAL-NORTH: Variation of economic branches the effect of imports of inputs, 2008.

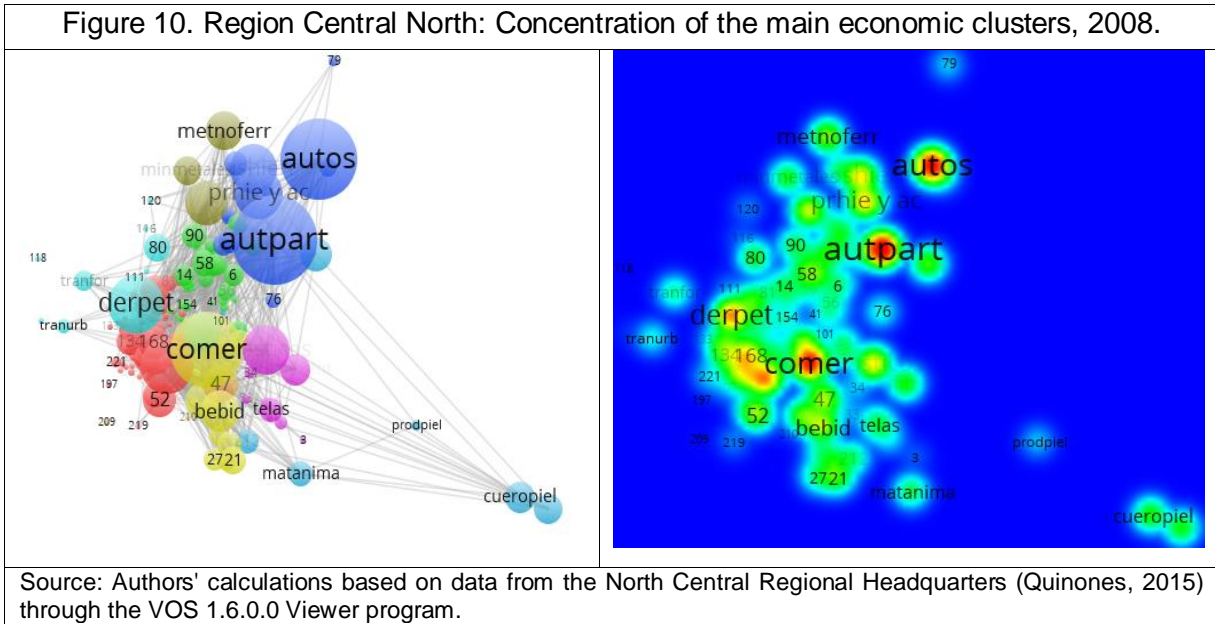Source: Based on data of the MIP, 2008, INEGI.

The figure above shows the variation they had in their connectivity key economic branches of the north central region as a result of imports. The activities with most connectivity as a result of imports were the branches of Manufacturing Other Transport Equipment (3369) Electric household (3352), Parts Manufacturing of vehicles (3363) Dairy Products (3115) and Manufacturing of cars & Trucks (3361).

As evidenced by the analysis of the determinants and subdeterminants of the regional matrices in domestic consumption and total transactions, the auto industry increases

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[23] For each input-output matrix, the total transactions and domestic consumption, a determinant is calculated with the subdeterminants of each branch. The relative weight of each branch is obtained by dividing the subdeterminant each branch between the general determinant of each matrix. Finally the difference between the relative size of each branch in the matrix of total transactions (through imports) and domestic transactions matrix is derived.

significantly its conectivity in the regional economy with imports. This indicates that the imported inputs are necessary for the production of transportation equipment.

Then, as a final way to illustrate the linkage that exists in the north central region of the automotive industry we make use of useful graphical methods to see economic groupings and their relationships across to appreciate the density of interactions.
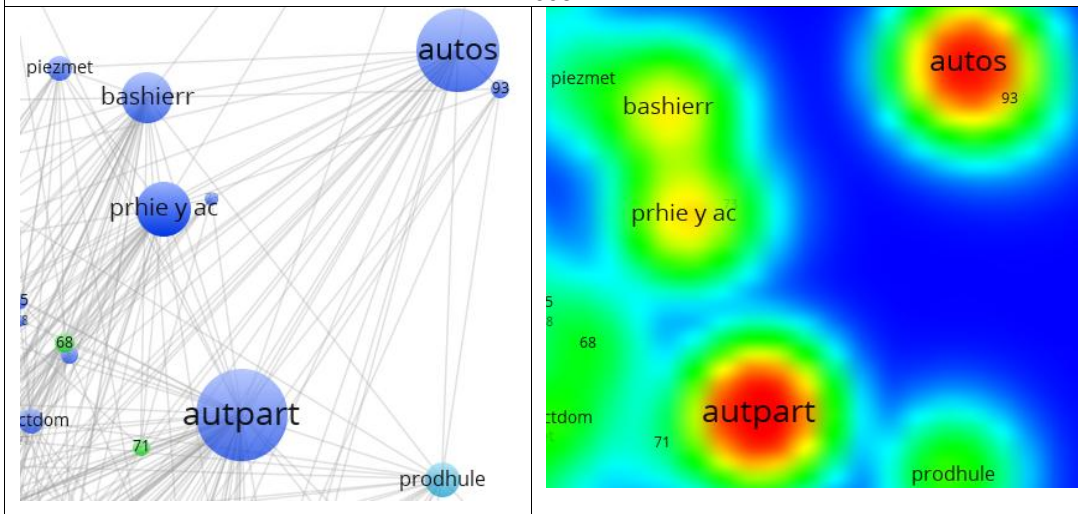
Figure 10. Region Central North: Concentration of the main economic clusters, 2008.

Source: Authors' calculations based on data from the North Central Regional Headquarters (Quinones, 2015) through the VOS 1.6.0.0 Viewer program.

By a group of economic activities in the central-northern region one can see that there are three important clusters There are those associated with the generation of electricity, trade and metalmechanic. In the latter, the most relevant branches of the region are assembly industry of vehicles (3361) and parts manufacturer of vehicles (3363). The size of the concentration (left panel of Figure 10) notices the economic importance of the main branches of the automotive industry symbolized by the bigger circles.

View the economy of the Region Central-North in terms of density (right side of Figure 10) you can identify several aspects: the first is to simply confirm that the terminal branch and manufacturer of auto parts have the highest economic densities even higher than the regional trade area. But a second aspect that can be noted is that both concentrations appear to have a close connection, but really both branches are separated each other in registering their spectrum of densities.

In a cluster approach, it is possible to observe the registration of relations between the assembler of vehicles and autoparts, however, these relationships are not dense enough for that the two activities come together. On the right side of the Figure 11 , the assembly activity (3361), appears next to the provider of trailers and bodies (3362), but both branches are separated of manufacturing of parts of vehicles (3363). It want to say that their productive relationships do not have the density inside of the vehicles chain neither to the regional economy. This image looks like an enclave economy.

FIGURE 11. REGION CENTRAL-NORTH: CONCENTRATION OF AUTOMOTIVE INDUSTRY, 2008.

Source: Authors' calculations based on data from the North Central Regional Headquarters (Quinones, 2015) and the Viewer 1.6.0.0 VOS program.

As one can conclude, it is clear that in an industry such as automotive, which is part of a global chain of value, the imported component is indispensable in specialized regions in final stages of the chain, as the case of the north central region, which hosts assembly plants of vehicles and a vast network of suppliers and to keep the regional linkage it is necessary get standards of quality based on high productivity. Consider that the wide margin that must import any of the branches forming the regional automotive industry speaks of links that are not self-sufficient and imports play that role "articulator" of regional production of vehicles and parts.

This articulation is nothing else that greater intra-regional connectivity is achieved through imported inputs that vehicle production in the north central region increases. This could be explained because the existing providers with low productivity and technological backwardness production would not have the quality standards required by a transnational assembly industry highly competitive vehicles therefore imports are given in greater amounts in the branches allow providers greater connectivity.

However, the relationships that exist between the terminal production of vehicles and its suppliers in the central-north region have a relative weight low as could be seen in the graphs of density, where a real low connectivity can be seen when viewed simply two activities with strong added value generation but with an economic radiation that do not connect to each other. Once referred to the results and usefulness of the determinants and graphs in the analysis of national and regional matrices, we offer the general and particular conclusions of this work.

V. CONCLUSIONS.

Many studies look to the automotive industry as a synonym for technological progress, competitiveness, productivity, qualified employment, exports and strong investment amounts, however, the success of this complex sector is strongly correlated to the degree of coordination with a global value chain allowing you to have a strong source of technological innovations that raise the quality requirement of inputs and production requirements. This highlights the lack of domestic suppliers able to be highly competitive and enter inside of this global network that can receive the benefits of trade liberalization. As discussed in this paper, there is the presence of economic sectors such as the manufacture of vehicles that have high productivity associated with the development and application of technological innovations that coexist with a network of suppliers with low productivity. This was corroborated both nationally and in the panorama of the central-north region.

The prevalence of this outlook has worsened in the period 1999-2009 to the extent that in the region central-north, some branches that the beginning of the period were above the regional average productivity, after 10 years only automotive assembly was preserved above and between the five highest productivity of all economic activities in the region. The dispersion was calculated for both periods and the results indicated an increase in the heterogeneity not only from the automotive industry, too in the regional economy as a whole.

The productivity gap that occurs between economic branches belonging to the same activity as in the case of the activities included in the automotive industry makes it less likely their linking. This is corroborated in the north central region when we see that there is little correlation between gross production of automotive branches in the region, but even more by the weak functional relationship between the value-added providers branches and the intermediate consumption of vehicle assembly. Here it is noteworthy that although there is a positive relationship between the production of parts for vehicle manufacturing and the assembly of autos, the variation of the second translates into an elasticity much lower, that is to say, that the variation in the manufacturing of cars provokes a low variation of regional raw materials.

The previous evidence is strongly related to the degree of regional economic integration in the value chain of global activity through the production of vehicles. That is, if there is a strong productive heterogeneity among branches that make up the industrial structure will have less local value added of the that potentially could provide if the disparity is reduced. Since such conditions have prevailed in the study region is to hope that the dependence on intermediate production to the imports will become most important in the future.

The analysis of vertical specialization that applies to the region shows that suppliers' branches just like making vehicle parts, bodies and trailers and manufacture of other transport equipment parts there is a ratio to import/export higher. The foregoing leads to the conclusion that to survive as a supplier due to low productivity and overall structural

heterogeneity of the region, it is necessary to incorporate a higher proportion of imported production inputs.

The results obtained from the estimate in the regional vertical specialization shed an average percentage incorporated of over 70% of regional value-added automotive exports, that is to say below the regional average, that is 85%. This shows that the weight of imports play an important role as part of the global value chain representing intra-firm trade in the auto industry.

It is very important to consider that studies using updated data to see if the dependence on imports is increasing. In this case we have to start to give suggestions regional industrial policy since the strategy of inviting foreign investment to detonate regional growth becomes meaningless if no technology transfer mechanisms and there is not productive relationships with local actors that reduce the productivity gap in the regional economy. Non-integration of the supply chain due to the presence of structural heterogeneity among auto companies in the same subsector provokes limited multipliers in employment and income, which not only reduces the expansionary effect of the investment on the regional economies, and then generates unemployment following the bankruptcy of companies that cannot compete increasing the formation of gaps in growth.

This problem that occurs in the region central-north is a reflection of what we live nationwide. The rapid performance of regional exports are not accompanied by a local solid productive chain that articulates export sectors with endogenous providers branches and generation of benefits is limited to low quality jobs, low incomes and less added value of our economy to global value chains, which speaks of a failed strategy of growth via exports with sectors such as the automotive industry as an engine of regional or national drag. This situation increases if the region specializes in end economic sectors of the global value chain of goods as the assembly of vehicles.

Productivity differentials between branches of the same subsector stress the importance of technological cooperation and training of the workforce that allows to harmonize productivity levels with the idea of generating higher linkers between transnational corporations that command the manufacture of transport equipment and national companies that may be their supplier.

The procedures followed in this work follow the line of other data that have documented the dependence to the imports is greater by the strong presence of transnational corporations in the field of auto providers. Therefore, there are suspicions that the productive dislocation occurs not between terminal industry and supplier industry directly, but happens within the provider branches. It is very important to note that at the national level is stronger this dependence on imports in the automotive industry. This requires precise estimates on the interactions that occur at the regional level with construction methods ascendents ("upstream") input-output matrix, ie from the standpoint of regional accounts. However, what has been achieved in terms of building of a regional input-output matrix has led to significant goals of analysis.

On the other hand, it is concluded that the results of the determinants for national and regional dimensions reveal that imports play an important role in the economic cohesion and increase the weight of the activity automotive industry economic due to that such purchases of foreign inputs fill the holes that for reasons of quality, technology, installed capacity or otherwise, do not fill domestic suppliers, so, in other words, the imports give greater connectivity, circularity and economic interaction in the region.

The comparison made between of the manufacturer of transportation equipment and the food industry and construction allowed to see exactly what was said in the previous paragraph: while in the latter two activities, the imports do not influence in the regional economic weight, in the automotive industry there was very noticeable variation. This suggests that in the study area the imports in the automotive chain if they play a strong factor of connectivity. In this analysis the change was more noticeable regionally, which points to the same logic to national level.

Finally, under techniques of graph analysis is possible to see the power held economic relations in the region of study but especially in the automotive industry. Their branches are the highest concentration of value economic but its link is sparse, this is a tendency from automotive assembly industry to become a pure enclave.

A general conclusion of this work is that in the globalization, regional economies are the spatial units that are set to articulate a transnational dynamic and the local actors, therefore, if there is for a much larger spill of the "benefits "generated by the insertion of the global value chains, undoubtedly technological innovations will allow them to increase the regional productivity and quality so that it can an opportunity toward development.

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