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Economic interaction, productive chains and formation of manufacturing clusters in the functional economic North Central region of Mexico: a case of regional input-output from the bottom-up approach.

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Working Paper

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Abstract

Economic and social reality in Mexico reflects wide inequialities. This situation urge to undertake regional analisis, to account for economic heterogeneity and its spatial components in order to correctly understand and analize economic fenomena, enabling the development of appropriate policies regarding territorially located problems. Currently, most of the studies that address regional disparities have focused on general macro analysis, with special emphasis on time dimension and favoring the use of federal entities or states, which are administrative spatial units, for their analysis. However, it is required an integral approach that takes into consideration space through a functional economic perspective, highlighting the importance of the spatial structure of economic activity and the economic spatial units to which it gives rise, as a fundamental element to explain regional disparities.

This paper provides a study case on the economic interaction, identification of productive chains and formation of manufacturing clusters in the functional economic North Central Region of Mexico, starting with the construction of a regional input-output matrix from the bottom-up approach as a key methodological element of analysis. Regional accounts and analysis of economic interactions are needed for the construction of regional input-output matrix. To do this, the functional region is presented and the main economic subregions are identified, validating its economic interaction with spatial dependence, measured by Moran and Lisa indexes, then there are constructed economic accounts by subregion, focusing on key sectors. Subsequently, using the built matrix, manufacturing regional interactions will be identified, remarking performance of subregional spatial units. Finally the results will be linked to the identification of productive chains in the region and with the formation of manufacturing clusters, using in this stage, clustering techniques from network theory, for subsequent georeference based on interaction and economic specialization.

Thus, this research aims to identify the formation of manufacturing clusters in the region studied, in use of methods that consider the importance of space as an explanatory element. So, the research question of this paper is the following: What are the major manufacturing clusters in the North Central Region of Mexico and how their interaction occurs spatially through economic functional units?

Data for the construction of the regional matrix will be taken from the economic censuses 2014, as well as information available from statewide surveys and official sources (INEGI). Also, from the regional matrix built, manufacturing productive chains and clusters will be identified, using GIS (Geographic Information System) as tool.

The importance of this work lies in the novelty of the methodology, since for the Mexican case has dominated the construction of regional input-output tables from the top-down approach without considering the dominant regional economic structure and thus the economic heterogeneity that prevails in the country; so this research is a contribution on how the economy of a region works spatially therefore represents a valuable tool for decision making. In addition, adressing the formation of manufacting clusters from a economic and spatial perspective.

Key Words: manufacturing cluster, regional input-output matrix, spatial dimension of economy, economic interaction, production linkahges.

Introduction

This work is a breakthrough on the development of a methodology and analysis considering a spatial approach of input product for the construction of regional matrices from the bottom-up approach using hybrid methods as a fundamental element for the identification of manufacturing chains as well as for the identification of the formation of industrial clusters at regional level and the spatialization of operation.

From the theoretical and methodological perspective of spatial dimension of the economy,wich allow to analyze comprehensively the structure and economic performance of a region through the identification of economic interactions that define it which makes possible to have an analysis account of their specificities. This perspective assumes space as, as important as temporal dimension, in explaining the economic process dimension and its territorial deployment expressed in patterns of economic concentration that characterize the prevailing spatial heterogeneity in our country and reflect disparities in regions that conform it.

Concentration patterns as manifestations in the space of economic activity respond to certain spatial and geographical elements, such as physical and natural environment of a particular region (type of relief, climate, use of natural soil, etc.) features, because these attributes generate different conditions for the establishment of human settlements and economic activity in a given region. However, the geographical feature does not operate as a single element in the location of population and economic activity, since they operate on par with economic forces of agglomeration with make it possible, in presence of economies of scale the location of specific activities at certain points of the territory. In fact this operation logic is essential on identifying regions.

It is very important to note that the proposal interpretation in this paper seeks to understand the functioning of economic activity in space through the identification of functional economic regions, going beyond administrative policies delimitations, considering that most of the studies in the country are about prevailing this added space notion, obtaining results that skew the understanding of how the economy actually operates in the regions, which is far from the national performance and even state.

The case study developed in this work, from the perspective of the spatial dimension of the economy as an integral proposal and alternative, is the delimitation of functional economic region of north central Mexico[2] and incorporates as an outstanding tool analysis input output , from the construction of regional input matrix product based on hybrid methods, i.e., they consider obtaining information directly from observed data and indirectly through estimates.

In fact, the construction of regional matrix has been a widely debated and controversial topic in the regional literature, which is why the construction of the input-output matrix of the north central region is undertaken, from the bottom-up approach combining direct methods and indirect obtaining information, thus constituting a case of using hybrid methods, same in the literature, are recognized as the most suitable option to the high costs of obtaining information via direct methods or survey (Sergeant, 2013), and with greater analytical range compared with estimates derived from the

[2] Functional economic regionalization proposal made by CEDRUS.

nacional input matrix product, widely handiest given the limited availability of information at regional level.

Thus, the construction of a regional matrix from the bottom-up approach is an elemental for identifying manufacturing clusters input, as well as linkages in the region as a starting point for the planning and design of policies aimed at strengthening industry of study area.

The finding on the major manufacturing clusters in the region and spatialized operation are discussed in sections. The first presents the methodological and interpretive proposal, both from the primary stage of functional regionalization to the construction of the input matrix product manufacturing and techniques used to identify linkages and manufacturing clusters. The second section is a section that collects empirical characterization and socio-economic performance of the studied region, to make way for the identification and analysis of the results in terms of chains and industrial clusters. Finally in the last section are presented the findings, scope and checkpoints for future developments.

1. Methodological and Interpretation Approach

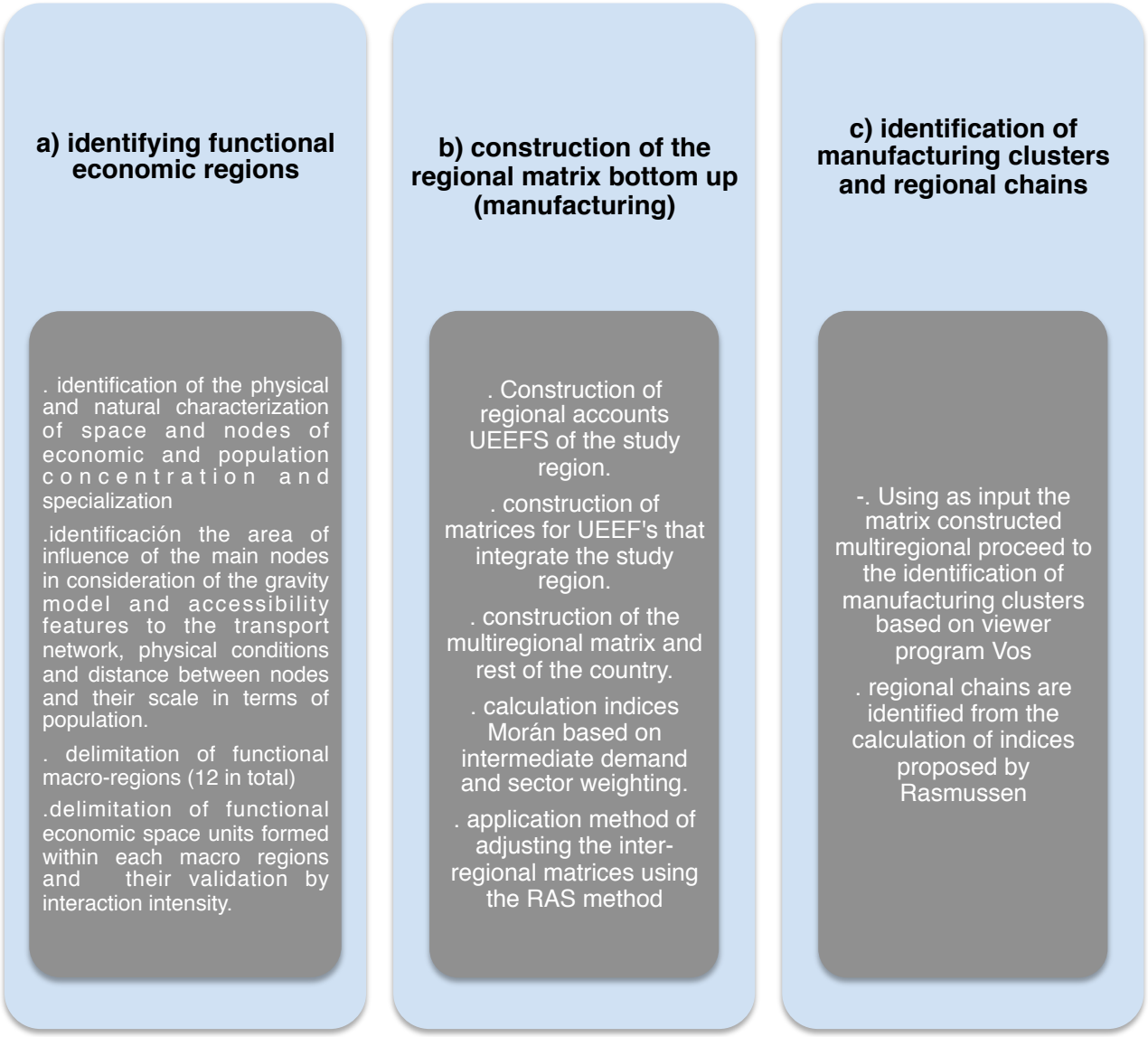
The methodological and interpretation focus on the spatial dimension of the economy[3] from which is incorporated into space from a broad concept in economic analysis, in consideration of the importance and influence it has on the distribution of economic activity , highlighting the main phenomenon of spatial economic concentration.

In consideration of the above, it is presented in this first section the methodological approach to firstly identify functional regions in the country, being the starting point by taking the case of functional economic region of north central Mexico and functional economic space units that shape it. Subsequently, the methodology used for the construction of regional accounts and on this basis the matrix of the study region and UEEF's that integrate it. Finally, the identifying methodology for manufacturing clusters and identifying regional chains is presented.

The general methodological framework that is used in this work is shown below.

[3]Asuad. (2001, 2007, 2013)

Table 1. Methodology of regional analysis using input-output



Fuente: Elaboración propia.

a. *Methodology to identify economic and functional regions*

The identification and delimitation of functional economic regions is performed by two steps, first nodes are identified by simple participation rates and economic specialization, characterizing them by their economic and demographic figures, delimiting its area of influence through the transport network linking nodes and applying the Reilly index to delineate areas of influence between nodes.

For the probabilistic index of economic interactions between sites it is determined by statistical association between a couple of sites. It is calculated using the statistical correlation coefficient for a series, subsequently calculating cross weights matrices, transforming the correlation coefficient into an interaction index according to the following formulation.

S is a vector economic sites S= ($s_1, s_2, \ldots, s_n$) with n as total in a given region.

A= (a_{kl}) is the economic activities matrix with k=1,…, m sectors of economic activity and *l* =1,…, n+1, with m>n and being $a_{kn+1} = \sum_{l=1}^{n} a_{kl}$ for all k.

R= (r_{ij}) is *n x n* matrix

We define R as the partial correlation matrix between different sites *sj,* where the calculation of partial correlation coefficients of Pearson (*rij*) is performed through the matrix A as follows:

$$R = \left(\frac{\hat{\beta}_2 \sum a_{1p}a_{2p} + \hat{\beta}_3 \sum a_{1p}a_{3p} + \hat{\beta}_4 \sum a_{1p}a_{4p} + \cdots + \hat{\beta}_n \sum a_{1p}a_{np}}{\sum a_{1p}^2} \right)^{1/2}$$

Where α and β are coefficients estimated by OLS (Ordinary Least Squares). According to the definition of partial Pearson correlation rij = rji then R is a symmetric matrix as follows:

$$R = \begin{pmatrix} 1 & r_{12} & r_{13} & \cdots & r_{1n} \\ r_{21} & 1 & r_{23} & \cdots & r_{2n} \\ r_{31} & r_{32} & 1 & \cdots & r_{3n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ r_{n1} & r_{n2} & r_{n3} & \cdots & 1 \end{pmatrix}$$

And so it is clear that *rii* = 1 for all i.

Now let **A'** =(a'$_{kl}$) matrix' scores'or scores arising from A, containing such shares for each site s_j in each activity a_{kl} that is:

$$a'_{kl} = \frac{a_{kl}}{a_{kn+1}} \text{ for all k}$$

It is then $a'_{m+11} = \frac{\sum_{k=1}^{m} a'_{kl}}{m}$ for all *l*, with a'$_{m+1\,l}$Now let a'$_{m+1\,l}$= pond$_l$ this is, defined as the total weight for each site s_j.

P=(p_{ij}) is a n x n matrix, called matrix P of cross weight and is defined as follows:

*Pij = pondi*pondj for all i and for all j*

This is, there are 'cross' total weight of sites *si* y *sj* having as a result thedcross weightes *Pij*. It is clear that *pij = pji* $\Rightarrow$ P is a symmetric matrix

Then, there exist interaction between pair of sites *i,j* for all *i,j* given by the economic relation between different sites s_j.

We have now:

*eij=rij*pij*

It means:

$$\begin{pmatrix} e_{11} & \cdots & e_{1n} \\ \vdots & \ddots & \vdots \\ e_{n1} & \cdots & e_{nn} \end{pmatrix} = \begin{pmatrix} r_{11} * p_{11} & \cdots & r_{1n} * p_{1n} \\ \vdots & \ddots & \vdots \\ r_{n1} * p_{n1} & \cdots & r_{nn} * p_{nn} \end{pmatrix}$$

Therefore it is through multiplication element by element of R and P that e_{ij} is defined Finally, let E be a matrix of *nxn* called economic interaction index, defined below:

E=(e^*_{ij}), where:

$$e^*_{ij} = \begin{cases} \dfrac{e_{ij} - Mín(e_{ij})}{Max(e_{ij}) - Mín(e_{ij})} \text{ si } i \neq j \\ \\ 1 \text{ si } i = j \end{cases}$$

So e^{*}_{ij} [0,1] and is called economic interaction index between pair of sites *i,j*. Here it is worth noting that E is also a symmetric matrix

b. *Metodología para la regionalización de la matriz de insumo-producto*

Regionalizing the input-output matrx had as a main starting point the identification of north central the economic-functional region of Mexico, taking into account the principal nodes which determine regional economic structure.

Considering the great importance in relative and absolut terms of manufacture industry in the studied región, the matrix it was built for the manufacturin branches of economies (4 digit) considerind the North America Industrial Classification System (NAICS), from which the manufacturing branches of the región were 82.

So, using available information from oficial sources, it was such as economic census 2014, regional accounts were built, in this case ¡, for each functional economic spacial unit (FESU) and for total region. From this, it was generated an input.output manufacturing matrix for each FESU or sub-region, in total terms, 12 matrices were built; considering five phases as methological approach.

First phse of the methodology was the construciton of regional accounts, which was obtained consideing four main accounts: production, investment, savings and external, as can be observed in the next table.

Table 2. Scheme of regional accounts

I. Product Account	
Use	**Source**
	Consumption (Private y Gobernment) *[C]*
Product *[P]*	Local investment *[I]*
	(X-M) *[Xn]*

$$P = C + I + Xn \qquad I = I_I + I_E$$

II. Entry Account	
Use	**Source**
Consumption (Privado y Gobierno) [*C]*	Product *[P]*
Saving *[A]*	

$$P = Y = G$$

III. Saving & Investment Account	
Use	**Source**
Local Investment	Saving
Rest of the country Savings	

IV. External Account	
Exports	Imports

$$\boxed{A = I}$$

According to the latter scheme Final Demand is disgregated as shown:

$$\boxed{D_F = I_l + X - M + C}$$

The variable of local investment is taken from the economic census, while exports are estimated from state data. Total imports were also estimated considering the proportion from brach of activity in the nation. Finally the variable consumption was calculated through difference from the production account.

The second phase of the methodology is the construction of FESU or sub-regional matrices, which were conduce according the next spteps:

I. Relative location coefficient was estimated with respect to average value added in the sub-regon compared with regional totals, and the scale weighting factor λ

Where λ **:**

$$\lambda = 1 + \left(\frac{VA_{\text{isr}}}{VA_{sr}} \Big/ \frac{VA_{ir}}{VA_{mr}}\right)$$

VA isr = Value addes from sector i in the subregion

VA sr = Total Value added in the subregion

VA ir = Value added in sector i from the region

VA mr= Average Value Added in the region

II. There are obtained the cross-coefficients of λ for each branch of activity by multiplying each element from the rows by each element of the columns.

III. coefficient of crossed λ is multiplied by each branch of activity, substituing the diagonal of the matrix for those corresponding values of λ.

IV. The entire matrix is standardized with respect to the rank of the matrix.

V. Demand coefficients are multiplied for distribution by branch of economic activity.

VI. Technical coefficients are obtained through participation of all inputs of each subsector between total inputs purchased from other subsectors.

VII. Intersectoral transaction matrix is obtained by multiplying the technical coefficient for the variable observed intermediate consumption by industry.

VII. the value of gross output-side sales and purchases are estimated.

The third phase is completed in accordance with the points listed below:

I. Analysis of the global Moran spatial dependence between subregions to establish the spatial association between sectors of economic activity UEEF's.
II. Analysis of economic specialization pair UEEF's.
III. Identification of buyers and sellers UEEF's. The highest score criterion of economic specialization coefficient equal to seller.
IV. Development of distribution tables UEEF's two sectors of economic activity and analysis of their holdings.
V. Analysis of the spatial dependence to determine the interactions of buyers and sellers sectors of economic activity between UEEFS by applying local Moran index.
VI. Matrix multiplication of shares by the Moran index to determine the size and importance of purchases and sales between sectors of economic activity UEEF's analyzed.

The fourth phase is to estimate and balance of sales and purchases flows between UEEFS by the method of RAS.

Finally, the fifth phase is the estimate of the multi-UEEF or multi-sub-matrix.

Thus the obtained regional matrix, is used for the next part of the methodology.

c. *Methodology to identify manufacturing clusters*

As parto d identifying manufacturing clusters there are several metodologies treated in literature, among the most used there, accordinf to Feser and Bergman: a) Expert opnion, b) Location coefficients (LQ), c) Input-output analysis cosnidering trade d)Input-Output analyisis innovation based e)Network Analysis f) Survey. In addition, (Roelandt,2000) group thechniques used in four

groups: 1) Input-Output Analysis 2) Graph analysis 3) Correpondence Analysis y 4) Qualitative approach.[4]

Considering these aproaches it was selected the graph analysis, applied using the regional matriz constructed from the bottom-up aproach, using VOS viewer programm.

In theoric terms, the study of graphs refers to "the branch of mathematics that deals with networks. A network, is a vertex colections, also called nodes and links in computational science"[5]

In order to identify the sectorial cluster relations between UEEFs, the VOSviewer software was used, which has a specific technique to build bibliometric maps. This technique consists in three basic steps: the calculation of a similarity matrix, the construction of maps starting from this matrix and form the particular VOSviewer particular technique and transformation of this map to generate consistent results for its further analysis and that could be reproduced in further investigations. (Jan van Eck and Waltman 2009).

The first step, the calculation of similarity matrix as a basic input, is obtained from the normalization of a co-occurrence matrix; unlike popular procedures for similarity matrix, VOSviewer use neither cosine nor Jaccard index to do so, instead the association strength measure (also known as proximity index or probabilistic affinity index) is used. In this, similarity (s_{ij}) is calculated by the inverse relation between the number of co-occurrences of items i and j (c_{ij}) and the product of the total number of occurrences or co-occurrences of these items ($w_i \text{ and } w_j$), as seen in the formula below:

$$s_{ij} = \frac{c_{ij}}{w_i w_j}$$

The construction of bibliometric maps starting the similarity matrix is done through the VOS technique where a two-dimensional map is constructed, in which the distance that separates items reflects their similarity s_{ij}: items with high similarity should be located close to each other, while items that have a low similarity should be located far from each other. This is done parting form the idea of minimizing a weighted sum of the squared Eucliean distances between all pairs of items, this is done for all the pair of items which it's average distance is equal to 1. This is the mathematical expression of this construction:

$$V(x_1, \dots, x_n) = \sum_{i<j} s_{ij} \left\| x_i - x_j \right\|^2$$

where the vector $x_i = (x_{i1}, x_{i2})$ denotes de location of item i in a two-dimensional map and where ||°|| denotes the Euclidean norm. Minimization of the objective function is performed subject to the constraint:

$$\frac{2}{n(n-1)} \sum_{i<j} \left\| x_i - x_j \right\| = 1$$

The constrained optimization problem is solved by, first converting it into an unconstrained optimization problem, and second using a so-called majorization algorithm, in VOSviewer is used a variant of the SMACOF algorithm which should be run multiple times, each one using a different

[4] Ver Ki Young Yoo (2003)
[5] Newman, M (2010) p.109.

randomly generated initial solution to increase the likelihood of finding a global optimal solution. Nevertheless, this optimization problem doesn't have this kind of solution, which leads to step three.

The ultimate step transforms this solution in order to generate consistent results; to accomplish this VOSviewer applies the following transformations:

Translation. The solution is translated in such a way that it becomes centered at the origin.

Rotation (also known as principal component analysis): The solution is rotated in such a way that the variance on the horizontal dimension is maximized.

Reflection: If the median of $x_{11}, \dots, x_{n1}$ is larger than 0, the solution is reflected in the vertical axis. If the median of $x_{12}, \dots, x_{n2}$ is larger than 0, the solution is reflected in the horizontal axis.
Furthermore, a cluster density view was produced out of this tool. In this view, the item density of a point in a map is calculated separately for each cluster. This is done by:

$$D_p(x) = \sum_{i=1}^{n} I_p(i) w_i K\left(\left\|\frac{x - x_i}{(\bar{d}h)}\right\|\right)$$

Where the item density of a point x for a cluster p is denoted by $D_p(x)$, $I_p(i)$ denotes an indicator function that equals 1 if item i belong to cluster p and that equals 0 otherwise, w_i denotes the weight of item i (total number of occurrences or co-occurrences), $K: [0,\infty) \rightarrow [0,\infty)$ denotes a Gaussian kernel function ($K(t) = exp(-t^2)$ and $h > 0$ denotes the parameter kernel with, and $\bar{d}$ denotes density of a point.

The graphic representation of the cluster density is given in a two-step color determination, after each cluster is associated with a color. First a weighted average of the colors in calculated in which the color equals the item density for the corresponding cluster. Second, this color is mixed with the background (black or white) color of the cluster density view that depends on the total item density of a point. In this representation, the lower the total density of a point, the closer the color of the point is to the background color.

As for the identification of linkages, it will be addressed from the perspective of key sectors indetificación using the method of linkage proposed by Rasmussen.

Hirschman postulates the term "linkage" which requires assessing investment decisions, first, in consideration of its effect or immediate product contribution and secondly, by its links, that is, the likely additional stimuli such decisions exert on primary investments.

In this context, two types of linkage is distinguished: "back" and "forward". Backward, when the direction of the stimulus that promotes the expansion of investment flows from the finished product to or semi-processed raw materials used in the manufacture of the product. Forward, when a certain production (A), which acts as input for other production (B) operates as a stimulus for a third product (C), which can also serve as input for the product (A).

Power and sensitivity of dispersion

The author, based on multipliers proposes calculating two indices that detect the relative effects of "chain", backward or forward, independent of the size of this sector. But before entering the formal definition of such indices, it is appropriate to provide some conceptual clarification, note what we understand by the effects of "drag" or chain "back" and "forward" (Pulido and Fontela, 1993).

• The effect of drag back, is defined as the chain of effects that will occur towards suppliers due to higher needs of intermediate inputs.
• The effect of drag forward, is defined as the impact that higher yields are about the possibilities of buying customers sectors.

In this sense, those presented above, multipliers production, model of demand and supply of inputs, the model of supply, measured immediately respectively the "linkage bachward" and "forward linkage".
That is, allow the identification of key sectors of the economy, which, which are linked to a high multiplier effect on demand and / or supply, as representing a major impact through purchases made to other sectors and / or by influencing supplies to other sectors.

Dispersing power

According to Rasmussen, "the scattering power index describes the relative extent on an increase in final demand for the products of industry j is dispersed through the system industries." In other words, it is the extent or scope than an expansion of industry j causes on the system industries. Its mathematical expression is as follows:

$$PD_j = \frac{\frac{1}{n}}{\frac{1}{n^2}} \sum_i \sum_j \alpha_{ij}$$

where the numerator is the ratio of multiplier production industry (unweighted) and the denominator (average of sectoral averages) global average used to normalize the results and facilitate cross-sectoral comparisons. If DPJ> 1 means that the requirements of intermediate inputs generated by a unit increase in final demand of sector j-th are greater for this sector than for the average of the economy and, therefore, that it is a sector with a strong relative power of drag back on the production system. The production chain back is a measure of input use a sector does in other sectors of the economy. This is calculated from the demand for inputs from one sector and includes both direct and indirect and induced effects.

f PD> 1, we must conclude that we are facing a highly interconnected activity; so an increase in demand spreads to other activities, stimulating production and growth. Conversely, if PD <1 your chain will be weak and insignificant impact on the economy.

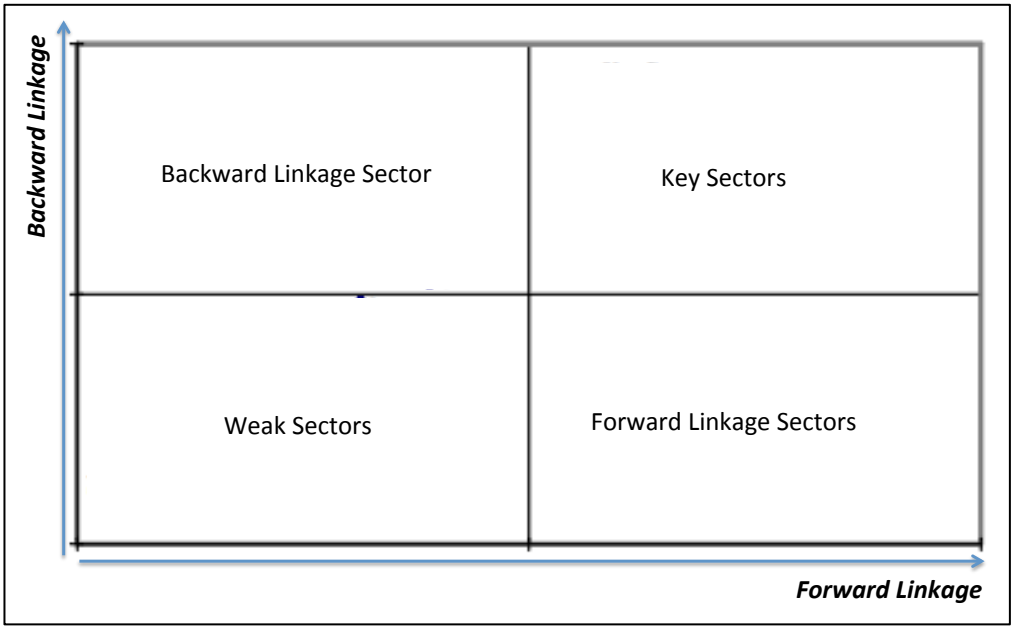
Sensitivity Dispersion

According to Rasmussen, "expresses the length or extent of the system burdens the industry industries i". In other words, it is the extent that i industry is affected by an expansion of the system industries. Its analytical expression is as follows:

$$SD_i = \frac{\frac{1}{n}\sum_j \alpha_{ij}}{\frac{1}{n^2}\sum_i \sum_j \alpha_{ij}}$$

where the numerator is the ratio multiplier uniform industry demand expansion (unweighted) and the denominator, the global average. If SDi> 1 indicates that the sector i-th expands its intermediate production at higher rates than the average of the production system when the final demand of all sectors increases by one, and, therefore, is a sector a strong effect of drag forward.

The value resulting from individual calculation of these indices for classifying sectors of the economy:



d. *Propuesta de interpretación*

According to the theoretical approach of economic concentration in the spatial dimension of the economy, it is considered that the economic concentration in space causes the formation of economic spatial units that determine and characterize the structure and functioning of the economy in space. Generically, these spatial units call them functional economic regions, a result of economic growth and economic and social development in space.

So that to identify and delimit in the national geographical space, we define as functional geo-economic regions.

The economic growth in the national space is not given way homogenous and limited administrative political entities, states or municipalities. On the contrary it is characterized by giving rise to the formation of nodes of economic activity in a few geographical areas within states and municipalities, economically interact with each other resulting in the production, exchange and consumption between them.

An economic node is defined as a place occupied by a dominant economic siege economic area, whose main characteristic is to link a series of economic sites that connect and compete with each other. By economic site the geographical place where economic activity is concentrated and carried out, in which economic actors, produce, exchange and consume goods and services is understood.

The nodes constitute spatial economic units within the national space, which is characterized by high economic and population density. They perform functionally as market areas, which concentrate while consumption and production, up to a set of economic activities in its area of influence, so that flows of economic activity between them are established.

The economic importance of the nodes depends on the economic interaction that take place between them, which in turn depends on their link and type of market relationship of complementarity, connection and / or competition.

Their interactions make, whether they are of national significance national economic sub spaces. Economic interactions between economic sites give rise to the formation of economic space, which consists of the set of economic sites and conducting interactions with each other in a given geographical area. The formation of an economic space requires as a condition of existence at least a couple of economic sites.

Obviously, the economic space that form does not match the political space consisting of states and municipalities. Moreover, the political space does not determine the economic area, even though it influences their behavior for their political powers and the allocation of resources and economic development, but do not direct the development process of national sub economies in the country, economic performance and how spatially market structure in space, it does.

The main category of the approach of the spatial dimension of the economy is the economic space and the derived categories are those of territory and economic region.

The interactions of sub-national economies of the country are the result of market transactions, characterized by sectoral economic performance and its synergy with the natural space in the various geographical areas of the country, resulting in the formation of economic space, which territorially it is set by its system of cities and transportation networks that articulate.

Derived from the methodological approaches presented above, the proposed interpretation in the present work is considered integrating the spatial conception in economic analysis, so it serves from the initial part to the identification of functional regions and the construction of the matrix regional, consistent with the objective of the research is to contribute to knowledge of manufacturing clusters and regional production chains that form through identification and analysis of its operation, considering the impact and importance of space through the UEEF's and territories in the north central region in its performance and features.

This proposal incorporates the traditional analysis of the identification and functioning of clusters their spatial aspects, to establish their links and relations with the composition of the economic structure of the region as well as local consumption and if applicable, national and international besides analyzing their strengths and weaknesses, identifying the potential that can have productive integration of links or related or complementary activities.

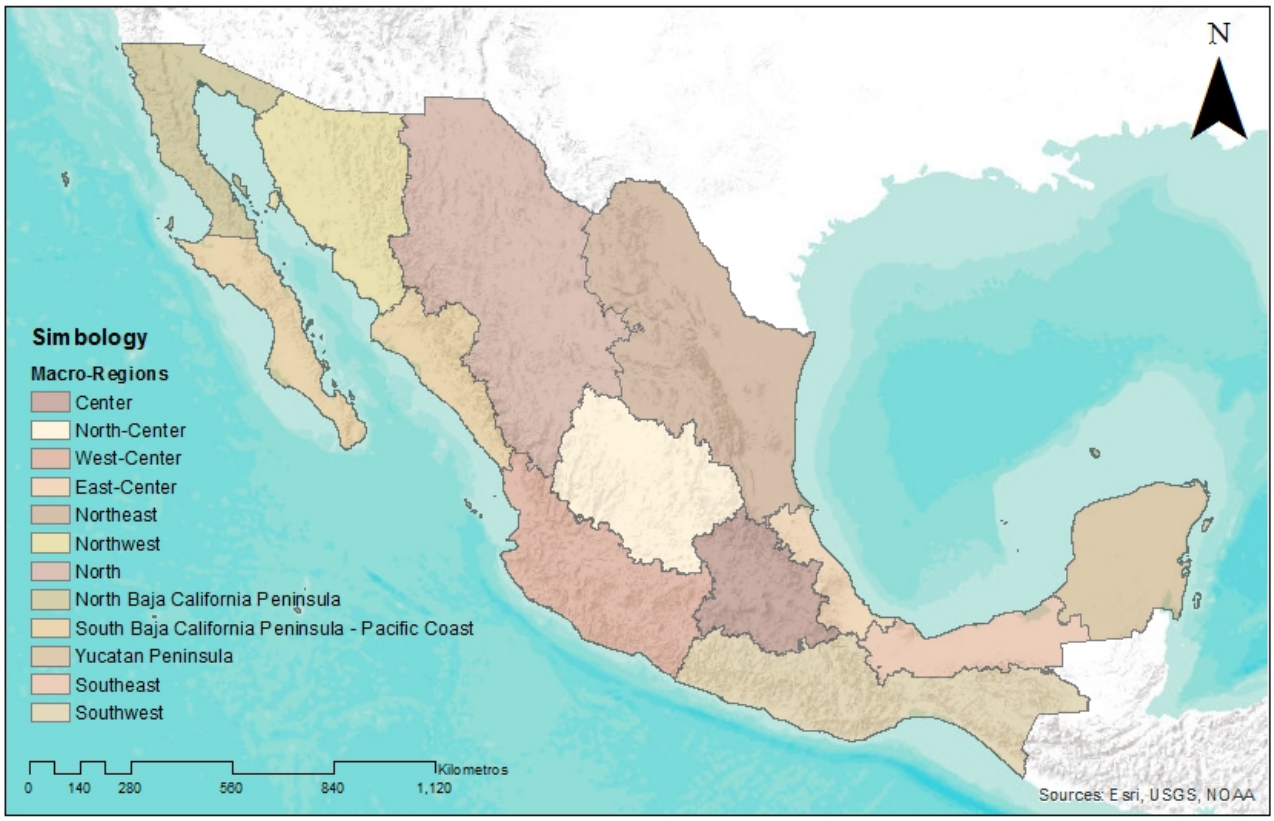
Finally, as part of the proposal it aims to identify general policy guidelines to consolidate its development in the regions, considering the needs and advantages of manufacturing clusters in the light of current development policy

II. Desempeño de la Región Centro Norte de México y su especialización manufacturera

a) National frame

Functional economic region of north central Mexico is one of 12 macro geo-economic regions of the country[6] with a privileged location in the country for its centrality and the road link via network with other regions.

Map 1. Macro Functional Geo-Regions in Mexico

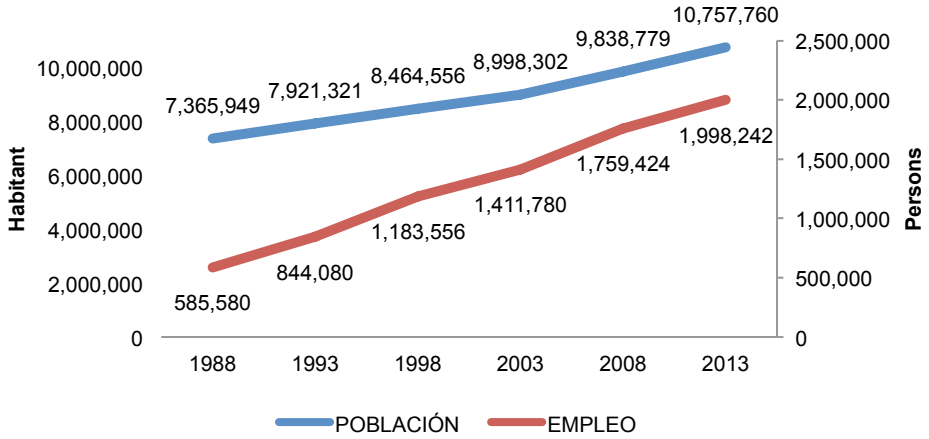


Fuente: Elaboración propia con ARCGIS 10.3

The region analysed, is a spatial unit of interesting analysis because of its strategic location, has positioned itself as an articulator economic region of national economic activity, linked to industrial activity mainly export, which has boosted the growth of its population and economic activity, increasing the population of 3.3 million people over a period of 25 years and employment in 1.4 million more people employed in 2013 compared to 1998; respectively representing 9% of the total population and national employment.

[6] See methodology section

Graph 1. North Central Region: Population & Employment. 1988-2014



Fuente: Elaboración propia con base en INEGI.

Nationally the north central region concentrated in 2014, 7% of gross value added census and 9% of total employment in the country. In this sense, despite its participation seems low, the region ranks fourth nationally, below the macro center, southeast and northeast region. It stresses even greater participation in added value that the framework presented by the Central West region, is fast becoming one of the last regions with traditional macro economic center in Guadalajara.

Economic share by Macro-Region 2013 (%)

Macro Region	Value Added	Employment
Center	39	36
Southeast	17	3
Northeast	14	12
North Central	7	9
West Central	6	11
North	4	6
Northwest	3	3
East Central	3	3
Península Baja California	2	4
Península Yucatán	2	4
Southwest	2	5
Península BCSouth-LP	2	3
Total	**100**	**100**

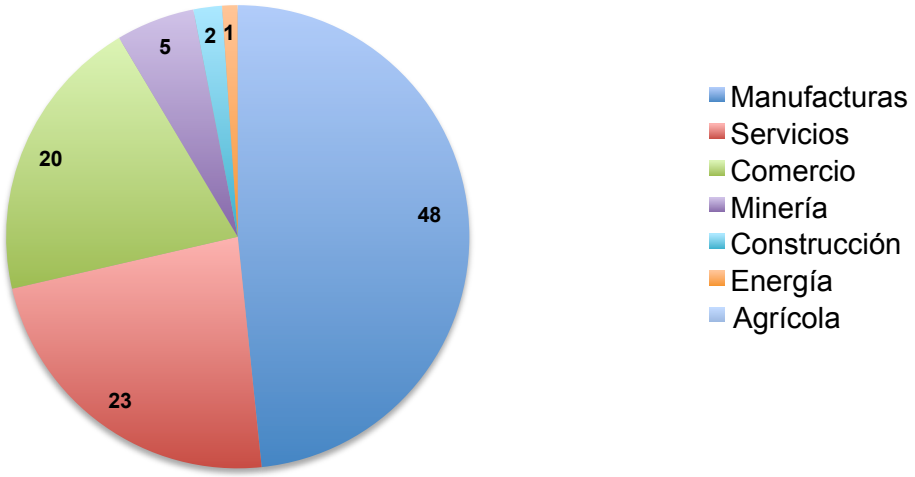
Fuente: Elaboración propia con base en INEGI.

It is for this reason that the North-Central Mexico, made up of an urban system led by ZM León region is today a dynamic and growing region that has gone through a process of economic reconfiguration inside, at par economic structural change in the country, which has led to the evolution and development of specialized industrial activities and has shown significant diversification in its main nodes, generating a process of industrial development.

It is worth noting some data on clear industrial vocation of the region, which in 1994 represented 6% of manufacturing value added at the national level and 9% of manufacturing employment indicators

increased according to data 2014 to 11% and 12% respectively. This participation at the national level has high relevance to observe the production structure of the region, which is dominated by manufacturing activity with a share of 48% of total value added generated in the region.

Graph. Share of value added u¡in north central region by activity (%). 2013.



Fuente: Elaboración propia con base en INEGI.

The emergence of the North Central region of the country has been accompanied from the structural change in the Mexican economy, specialization in key manufacturing sectors linked to the export activity, as in the case of the automotive industry. In fact, recent data suggest the dominance of the region at the national level in this important sector, accounting subsector Manufacture of transport equipment in 2013, 19% of the national total gross production in this area, 14% of value added and 14% of employment in such activity nationwide. While in terms of regional participation, susbsector Manufacturing of transportation equipment, linked to the automotive industry, represents 31% of the regional gross output, 27% of value added and 18% of employment in the region.

Considering the economic activity in the manufacture of transport equipment, the north central region ranks third nationally according to figures of 2013, positioning itself as a value-generating region and employment in that related to the automotive industry activity.

North central region. Economic Indicators. 2014
Subsector 336: Manufacturing of trasnport equipment

Macro Región*	PBT	Valor Agregado	EMPLEO
C	2,537.2	637.9	157,081
NE	2,264.2	551.1	237,801
CN	1,545.5	293.5	108,348
NO	866.4	243.2	41,885
N	457.1	196.8	167,589
PBCN	288.7	77.0	30,132
COC	139.5	38.4	15,431
PY	7.1	1.0	1,826
SO	5.8	1.0	6,186
COR	5.2	2.2	1,540
PBCS-LP	4.9	3.3	7,570

SE	0.4	0.1	213

Fuente: Elaboración propia con base en INEGI. * Propuesta de CEDRUS 2015
*VA y PBT en millones de pesos de 2003. Empleo en numero de personas ocupadas.

Notwithstanding the foregoing, it is important to note that although industrial activity is dominant and has been the rector of economic development, can not be neglected the role of services, as many are associated with industrial activity. Thus the services but do not generate most of the regional value added themselves are responsible for a third of regional, same proportion with employment engaged in trading activities in 2013. Altogether jobs, services and trade had a total of 1.2 million people employed in the region, abasrcando 62% of regional employment, while manufacturing employment accounts similar magnitude of the remaining 30% of employment in the north central region.

As indicative additional elements of the manufacturing vocation of the study region, the importance of activities in addition to the manufacture of transport equipment as the main activity in the region, the food industry, tanning and leather finishing and leather, chemical industry highlights , basic metal industries, industry Beverage laid and snuff, plastic and rubber industry, fabricated metal products and manufacture of accessories and electrical appliances; which together accounted for 84% of manufacturing value added generated in the north central region and 75% of manufacturing employment in 2013.

Main manufacturin branches in north central region 2013 (%)*

Activity	**Value added**	**Employment**
Fabricación de equipo de transporte	28	18
Industria alimentaria	16	17
Curtido y acabado de cuero y piel, y fabricación de productos de cuero, piel y materiales sucedáneos	7	18
Industria química	7	3
Industrias metálicas básicas	6	2
Industria de las bebidas y del tabaco	5	2
Industria del plástico y del hule	5	7
Fabricación de productos metálicos	5	6
Fabricación de accesorios, aparatos eléctricos y equipo de generación de energía eléctrica	5	3

Fuente: Elaboración propia con base en INEGI
*Participación sobre total manufacturero regional.

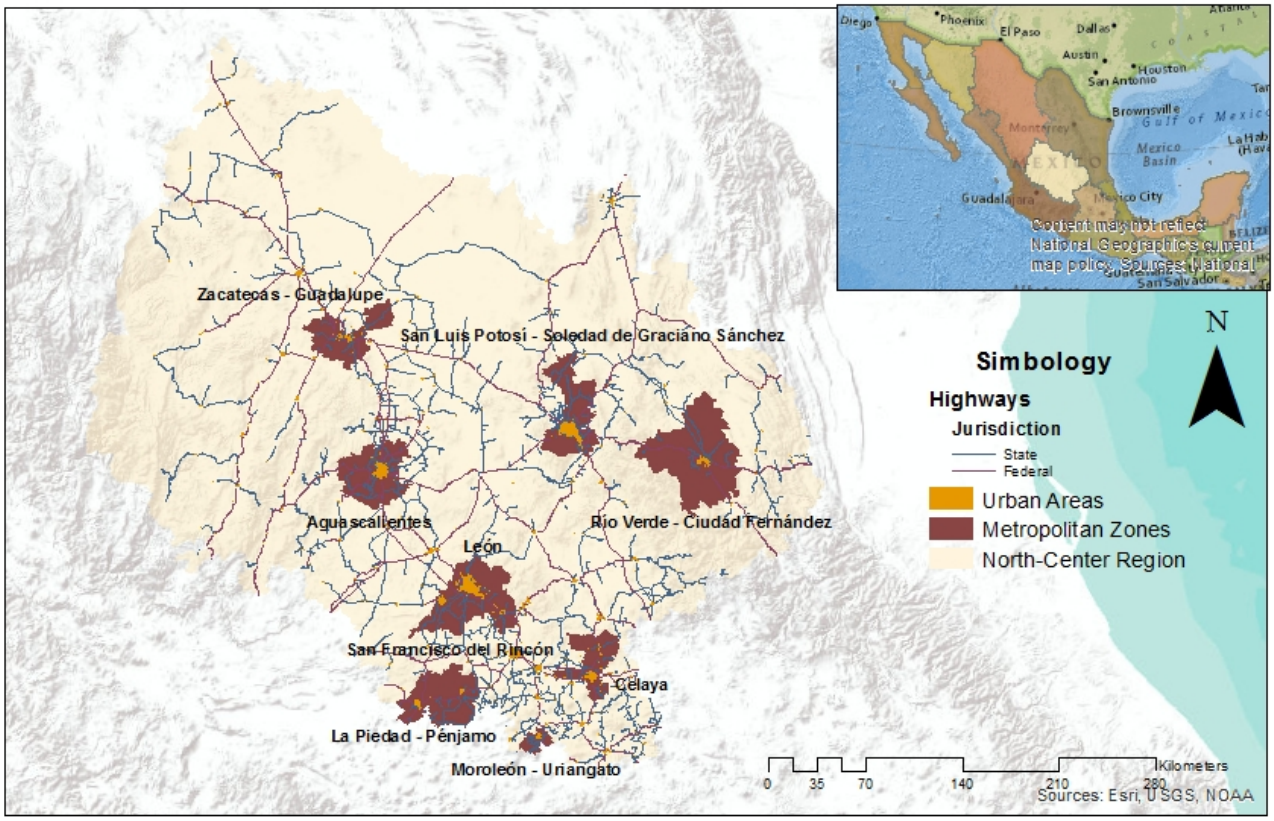
It should be mentioned that activities with more intensive use of labor are the food industry, tanning and finishing of leather and fur, in contrast to target a capital intensive and less labor and industry activities . It is thus that the structure of employment and added value generated in the manufacturing sector in the region indicate the diversity of industrial activities present, and their characteristics.

Having outlined briefly the emergence and economic structure of the study region and its importance to clearly focused on industrial activity nationwide deepens then the characterization of the study area in terms of its spatial economic structure, with emphasis on industrial activity.

b) Regional frame

The northern economic region functional center is made up of 175 municipalities in the states of Aguascalientes, San Luis Potosi, Guanajuato and Jalisco, located in the central area of Mexico. According to the analysis of economic and population concentration, regional urban system is made up of 15 key nodes which together pelleted 84% of value added, 78% of employment and 63% of the population according to 2008 data . in this system highlighting the ZM cities of Leon, San Luis Potosi ZM ZM Aguascalientes and its hierarchy.

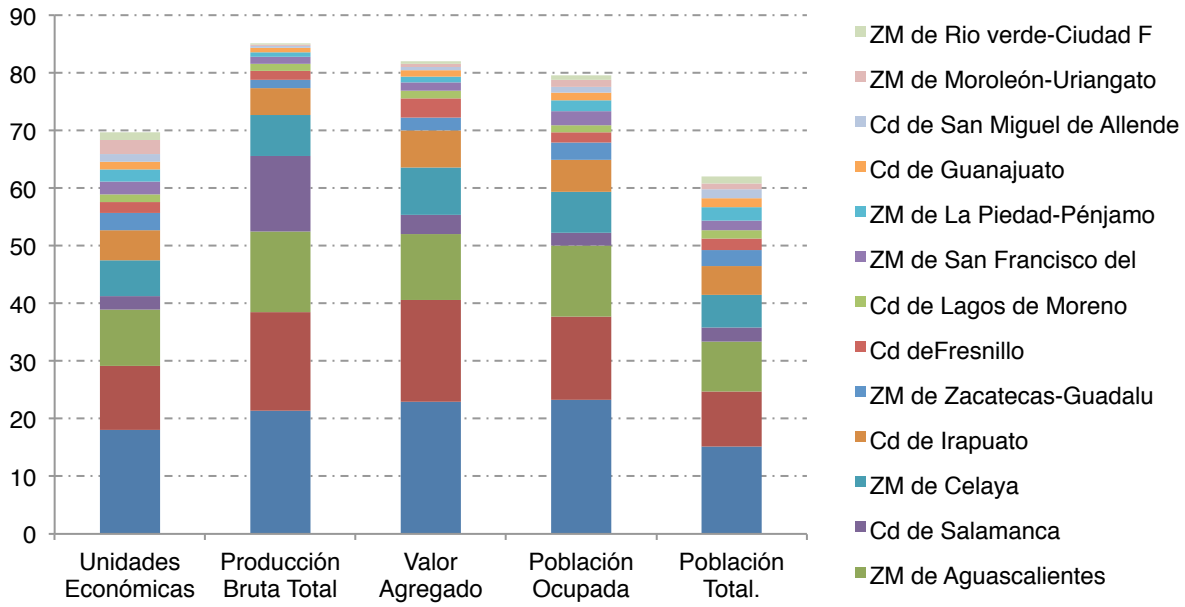
Map 2. North Central Region. Economic Nodes and freeways.



Source: Own elaboration with ARCGIS 10.3

15 economic nodes are distinguished by concentrating 70% of economic units, 85% of Gross Production Total, 82% of added value, 80% of the employed population and 62% of the total population within the macro North Central Region. Prominent among them, three metropolitan areas: the ZM de Leon, the ZM of San Luis Potosi and the ZM of Aguascalientes, same as concentrated respectively 23%, 18% and 11% of the regional value added in 2013, over half of economic activity in the region: 52% of value added and 50% of employment.

Graph. North central region. Concentration indicators (% with respect total region)

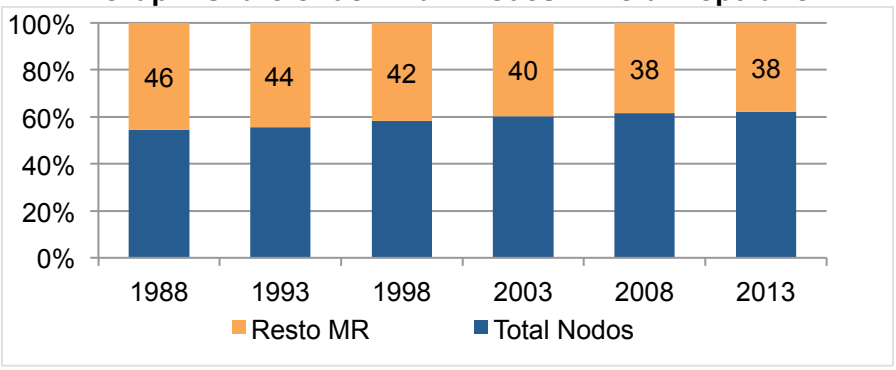


Fuente: Elaboración propia con datos de INEGI

The dominant economic nodes that make up the Macro North Central Region, comprising the Urban Regional (SUR) system, 8 are metropolitan areas, while the rest are cities of over 100,000 inhabitants.

From 1988 to 2013, the regional urban system has agglomerated over 50 percent of the total population in the region, indicating a trend towards concentration of the population only in cities or dominant nodes in the region, while the rest the region has experienced a loss of market share.

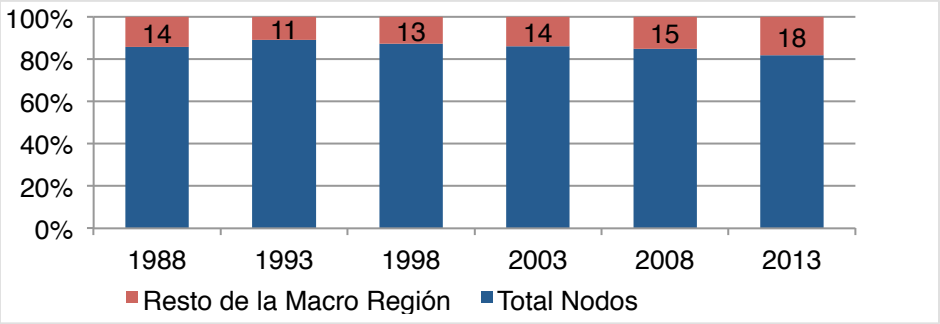
Graph. Share of dominant nodes in Total Population



Fuente: Elaborado por CEDRUS con datos de INEGI.

With respect to performance Added (VA) Value at key nodes in the macro region has been a downward trend for the period 1988 to 2013. The decline of the participation of the nodes within the VA of the Macro Region total, due to growth in the rest of the region, from having a stake of 15.02% in 2008 to 18.02% in 2013. the decrease in the participation of key nodes within the MR is mainly due to decreased VA in the cities of Guanajuato and Salamanca, which decreased from 2008 to 2013 for 66.87% and 22.58 Salamanca Guanajuato.

Graph. Share of economic nodes in total Value Added

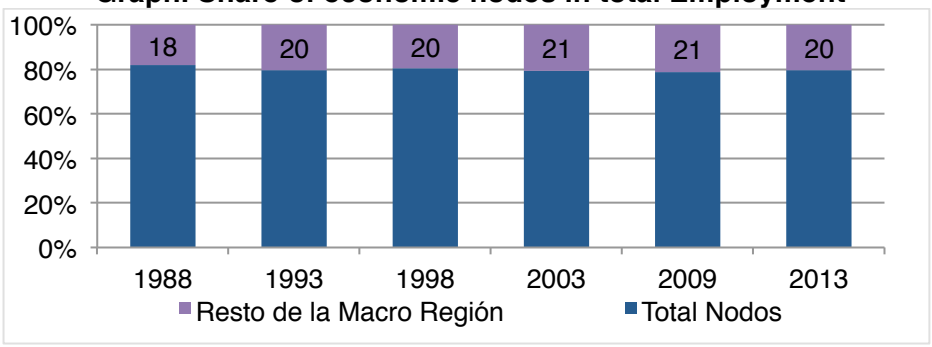


Fuente: Elaborado por CEDRUS con datos de INEGI.

In the case of the pattern of concentration of employment between dominant nodes that make up the urban system coincides with the presence of three major sites agglomeration during the period 1988 to 2013. Highlights include the cities of Leon, San Luis Potosi and Aguascalientes, for being the agglomerate more than 50% of the employed population in the total of the key nodes. San Francisco also highlight the corner, Fresnillo and Lagos de Moreno, being cities that had higher percentage increases during the period 1988 to 2013, and mainly in the period 1988 to 1993. Although these cities had large increases during the period , these cities are not the most representative in terms of the total employed population within the dominant nodes.

With regard to the concentration of employment in the region, in line with the pattern of concentration of population and value added, the urban system agglomerating an important part of the regional total. In this case, the set of cities concentrated in 2013, a 79.59 percent of the employed personnel. Notably, in 2008, the employed population had decreased, being of 78.87% in 2008, lower than the employed population 2003 with 79.44 and 2013 79.59.

Graph. Share of economic nodes in total Employment



Fuente: Elaborado por CEDRUS con datos de INEGI.

The economic base of the dominant nodes is analyzed from the calculation of specialization per node, which according to the table below is noticeable how the top three-population economic concentrations: Leon, San Luis Potosi and Aguascalientes, presented complementarity; as both San Luis Potosi and Aguascalientes have industrial specialization, while Leon, the main center of economic concentration, has specialization in trade and service sector, working as a supplier of advanced services such as financial and professional services, which requires industrial activity.

Additionally, it is possible to observe that the set of cities considered, presents a higher level of specialization in industry and trade; which in turn is consistent with a greater number of key nodes with specialization in such sectors.

Economic dominant nodes. Specialization economic index. 2013.

	Agropecuarias (11)	Comercio (43-46)	Comunicaciones y transportes (48-49)	Industria Básica (21-23)	Manufacturas (31-33)	Servicios (51-82)
ZM de León	0.01	1.00	1.93	0.41	0.88	1.37
ZM de San Luis Potosí	0.16	0.84	1.38	0.40	1.11	1.09
ZM de Aguascalientes	0.00	1.08	0.97	0.48	1.12	0.86
ZM de Celaya	2.30	0.75	0.87	0.25	1.25	0.99
Irapuato	1.07	1.35	0.21	0.26	1.11	0.86
Fresnillo	0.30	0.71	0.07	8.55	0.13	0.33
Salamanca	0.02	0.82	0.35	0.52	1.39	0.56
ZM de Zacatecas-Guadalupe	0.00	1.64	0.84	2.63	0.35	1.30
ZM de San Francisco del	0.94	0.91	0.09	0.36	1.21	1.05
Lagos de Moreno	0.35	0.91	0.14	0.08	1.51	0.39
Guanajuato	0.30	1.06	1.34	4.27	0.21	1.40
ZM de La Piedad-Pénjamo	0.88	1.70	0.60	0.26	0.59	1.72
San Migue de Allende	6.72	2.14	0.10	0.47	0.30	2.00
ZM de Moroleón-Uriangato	0.00	2.46	0.14	0.48	0.45	1.29
ZM de Rioverde-Ciudad F	4.94	3.02	0.34	0.44	0.11	1.53
Total Ciudades	0.48	1.01	1.15	0.83	0.99	1.07

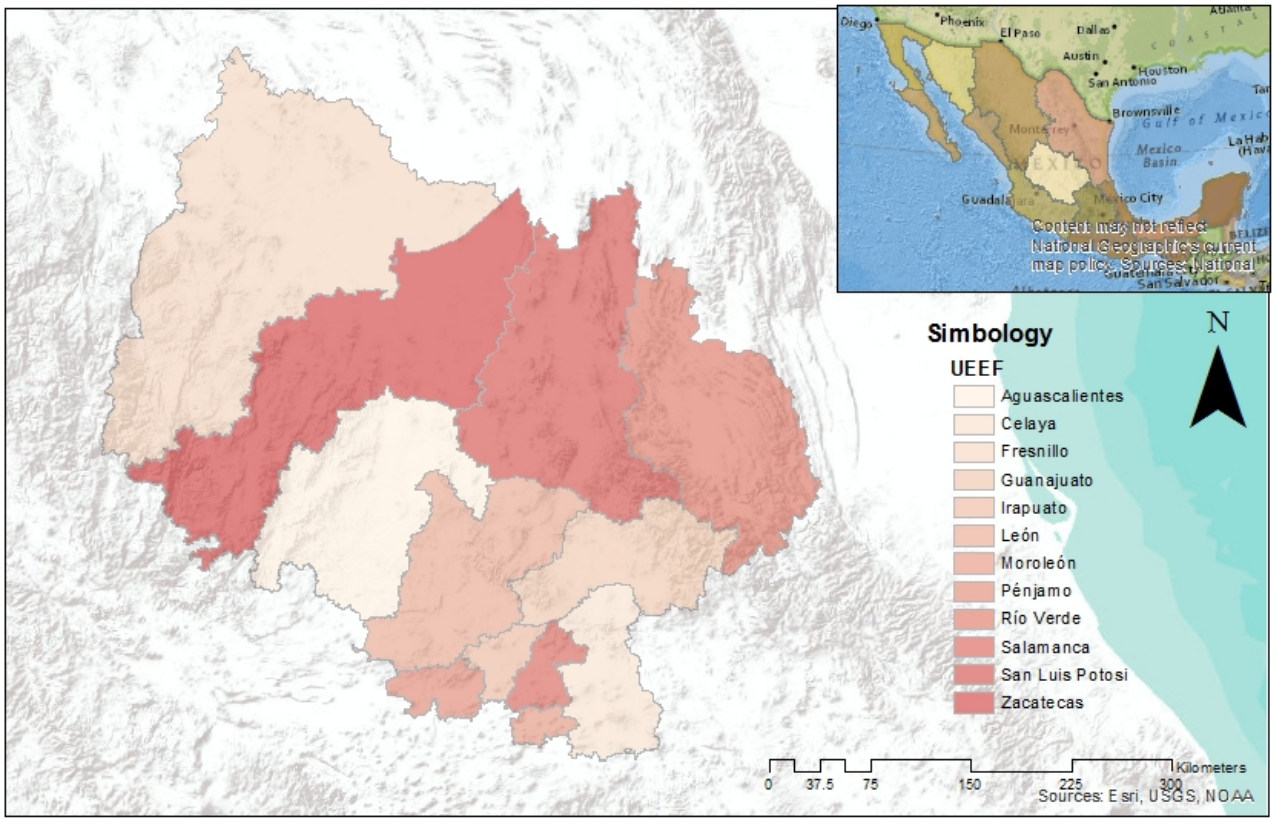
*En azul índices mayores o iguales a 1 = especialización; en negro índices menores o iguales a la unidad = no especialización. Fuente: Elaboración propia con base en INEGI

In fact looking at the pattern of economic concentration in the period 1998-2008, highlighted by the consolidation in terms of manufacturing, commercial economic hierarchy and service of the three key nodes: Leon, San Luis Potosi and Aguascalientes, even though the fall in participation occurred in the period; highlighting the increased counterpart nodes lower economic range as Celaya, Irapuato and Salamanca, same as for its location and specialization have managed to become subcentres concentration mainly linked to the industrial corridor connecting Celaya to Leon.

So according to the pattern of economic concentration at the regional level, considering the levels of spatial agglomeration dominant economic sites of value added and employment and areas bounded

influence among them, from the index Reilly 12 units were identified and delineated economic space functional outcome of stroke market areas, which constitute the functional economic regions of the north central region, as shown below.

Map 1. North Central Region Demilimitation of Functional Economic Spatial Units (FESU).

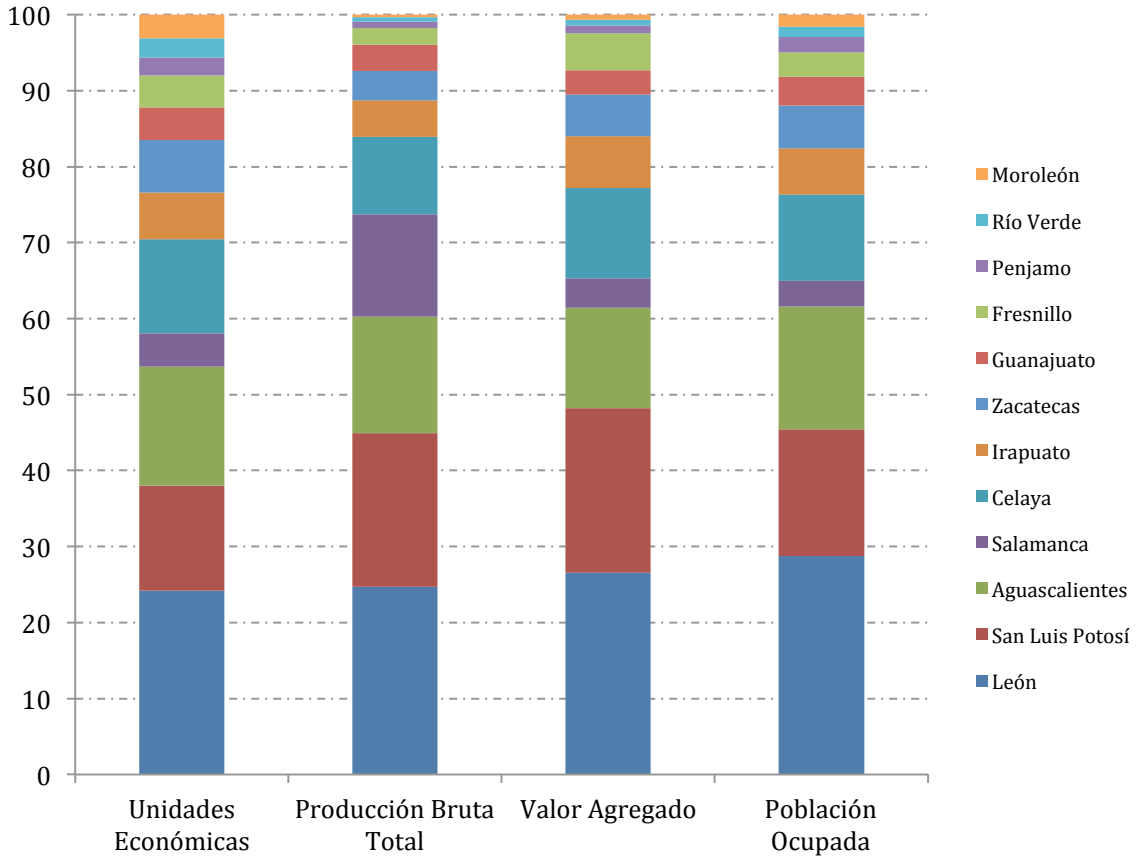


Source: Own elaboration with ARCGIS 10.3

In this regard it is noteworthy that the formation of the 12 economic-functional spatial units was the result of incorporating the ZM of San Francisco del Rincón as part of the area of influence of the ZM de León, given the economic hierarchy population of the latter; while in the case of San Miguel de Allende, it was incorporated as part of the area of influence of Celaya. Thus, although we started from the identification of 15 nodes of concentration, the end result was the delimitation 12 UEEF.

The UEEF that make up the macro north central region are characterized by showing a different pattern of concentration. There are seven UEEF that represent around 80% of economic activity and population in 2013, as seen in the chart below.

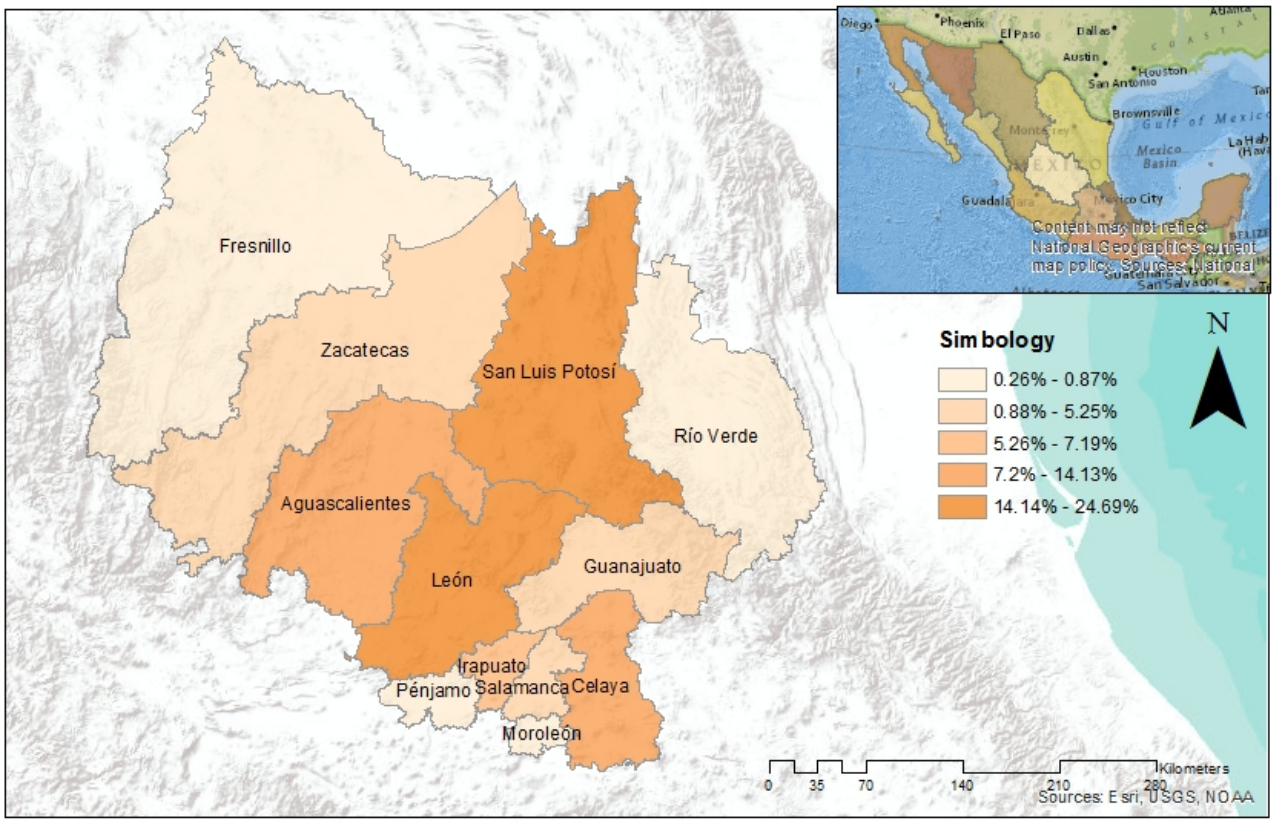
Graph.. Concentration indicatoris (% of regional total)



Source: Own elaboration with information from iNEGI

Subsequently, according to economic specialization and the presence of specialized sub-sectors, namely manufacturing, distribution and characteristics of industrial activity in the region was analyzed. The region are characterized by its important industrial activity with a share above 50% in generating regional added value in the period 1998 to 2008. In this regard, taking the functional economic regionalization of north central Mexico, they were identified in this case four functional economic space units with a high concentration of manufacturing value added, as shown in the map below.

Map 4. North Central Region. Concentration of manufacturing value added 2013. (%)



Fuente: Elaborado por CEDRUS con ARCGIS

Table 11. Specialization index by FESU. 2013

FESU	Agropecuarias (11)	Comerce(43-46)	Comunication & transport (48-49)	Basic Industry (21-23)	Manufacture (31-33)	Services (51-82)
León	0.12	1.01	1.68	0.38	0.93	1.30
San Luis Potosí	0.14	0.77	1.15	0.90	1.13	0.92
Aguascalientes	1.29	1.16	1.02	0.57	1.05	0.89
Celaya	2.47	0.91	0.71	0.25	1.19	1.01
Irapuato	1.02	1.38	0.23	0.26	1.07	0.94
Zacatecas	2.53	1.02	0.39	2.05	0.95	0.75
Fresnillo	0.55	0.77	0.20	7.94	0.18	0.38
Salamanca	0.47	1.03	0.34	0.49	1.23	0.77
Guanajuato	0.27	0.89	0.47	1.66	1.00	0.92
Pénjamo	0.85	1.72	0.58	0.29	0.59	1.69
Río Verde	7.93	2.22	0.58	0.29	0.60	1.14
Moroleón	22.46	2.31	0.12	0.50	0.42	1.50
Total UEEF	1.00	1.00	1.00	1.00	1.00	1.00

*In blue index > 1, meaning specialization.

Source: Own elaboration with information from INEGI.

General concept of clusters

Clusters represent a very important framework of reference for understanding regional economies, as from its study can identify and exploit the advantages and challenges of proximity and connections between economic actors and institutions of a specific region, managing to see ways to support the development of economic regions, based on the specificities of the region.

Define what is a cluster in an unique way is a complex task since most research on this issue try to deliver a unique and complete definition of what a cluster is, however these definitions are focused theoretically and not analytical-practical , so they end up being too general and imprecise to describe specifically the cluster phenomenon which is pretended to be described and analyzed.

As mentions Cortright, "researchers should accept that clusters are an « umbrella » concept not a precise term, and that clusters vary from place to place and across various industries" (Cortright 2006, iv).

Among the multiplicity of definitions found in the literature, there are common general factors that identify clusters: spatial geographic proximity, cooperation between enterprises and other types of institutions and specialization and economic complementarity.

Conceptualizing Cluster Comparison Chart

Definition	Source
Sectoral and geographical concentration of companies that produce and sell related or complementary products; They give rise to external economies (such as the emergence of specialized suppliers of raw materials and components or the generation of specific skills for a sector) and promote the creation of specialized services in technical, administritivos and financial aspects. Its main axis to the chain established in a given region and must be supported by other institutions (universities, research centers, etc.)	ONUDI (2004 P.22)
Are geographic concentration of interconnected companies and institutions in a particular fiel. Cluster encompass an array of linked industries and other entities important to competition. Also often extended downstream to channels and customers and laterally to manufactures of complementary products and to companies in industries related by skills, technologies or common inputs . Finally clusters include government and other institutions(such as universities, think thanks , etc).	Porter Michael (1988, p78)
The typical concept understands the regions and localities as territorially defined nodes, as they operate as closed, welded, homogeneous and invigorated by the inter-local cooperation structures, and in which the sectorally specialized production clusters obtained a territorial collective efficiency that could not be obtained through individual action. (SCHMITZ1995))	------ Satto and Ignacio Fernandez Ramiro Virgil Greco (2007, 862
There are three related definitions of clusters to address empirical identifications: 1) (regional cluster) 2) the sectors or groups of sectors (sectoral cluster) ·) the chain value on production (cluster of chains or networks). Spatially concentrated industries These definitions of clusters are based on two main approaches: based on simlitud and / or interdependence.	2) Jacobs and Deman ------ - (1995)
A spatially limited critical mass (that is sufficient to attract specialized services, resources and suppliers) of companies that have some systemic relationships to one another based on complementarities or similarities.	Rosenfeld (2002, p.10)

Networks of interdependent firms, knowledge -producing institutions, bridging institutions and customers linked in a value-added creating production chain.	OECD(1998,43)
Firms an related economic actors and institutions that draw productive advantage from their mutual proximity and connections	Cortright (2006, p.2)
A local concentrations of horizontally or vertically linked companies with specialist in related lines of business together with supporting organizations . ————————	Support to Cluster Development in Croatia : Cluster Development Handbook (2012)

A key to understanding the factor clusters are the various dimensions that comprise these (which also vary according to the authors): geographic, distance, technology and production flows. Feser considers three main dimensions: Life cycle of chains and geographical.

Matrix Input-Output is a interindustrial model to identify groups of economic activities that have linkages, where it is possible to identify industrial clusters by observing cases where greater interactions between buyers and sellers exist, so it is a way of analyzing clusters with the method "Top-Bottom" from concentration and dispersion measures (such as the location coefficient and the Gini index), since in theory, these measures indicate those industries specialized suppliers; However one of the problems of this method is that the data inputs and outputs of the MIP are in a nationally-aggregate level, which prevents the visibility of variations that may exist in very specific industries or regions.

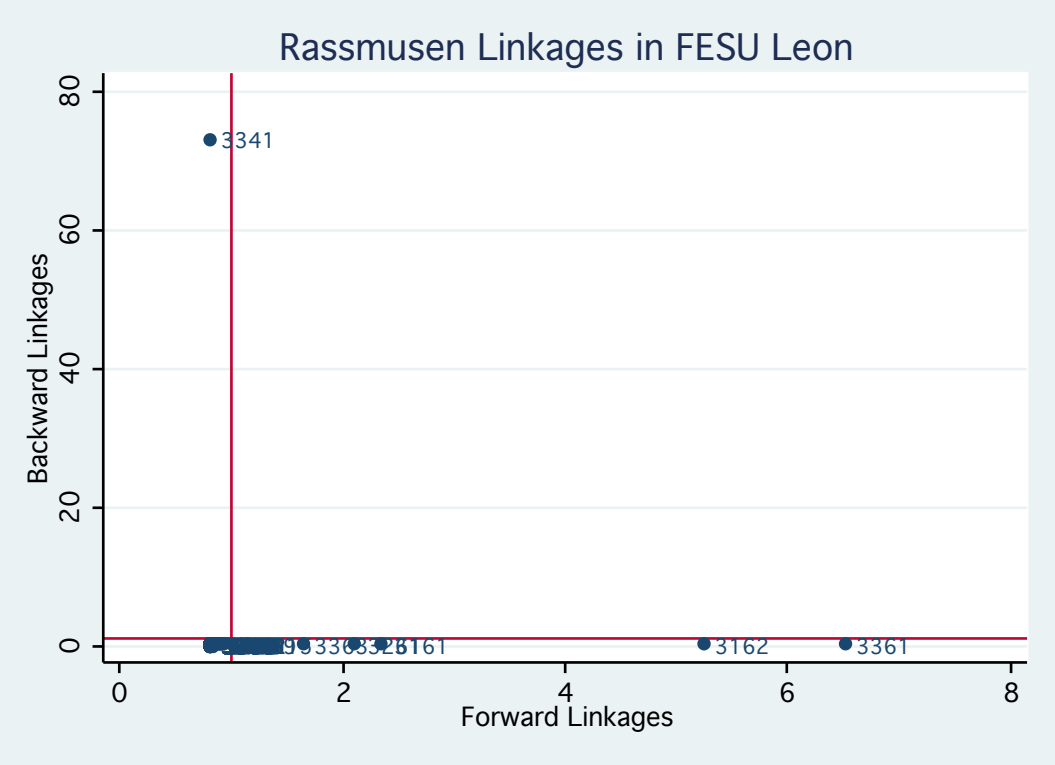
According to the results of identifying manufacturing clusters using Vos Viewer emphasizes the formation of 3 main clusters as a resulting advance for the FESU of León:

- Automotive Cluster
- Food Cluster
- Chemical Cluster

Some of the methods used for identifying chains are the approximations of Chenery and Watanabe (1958), or identifying key sectors from the approximation of Rasmussen-Hirschman (1956). These methods aim to "evaluate the ability of economic sectors to boost other activities or receive impulses from other sectors[7]. »

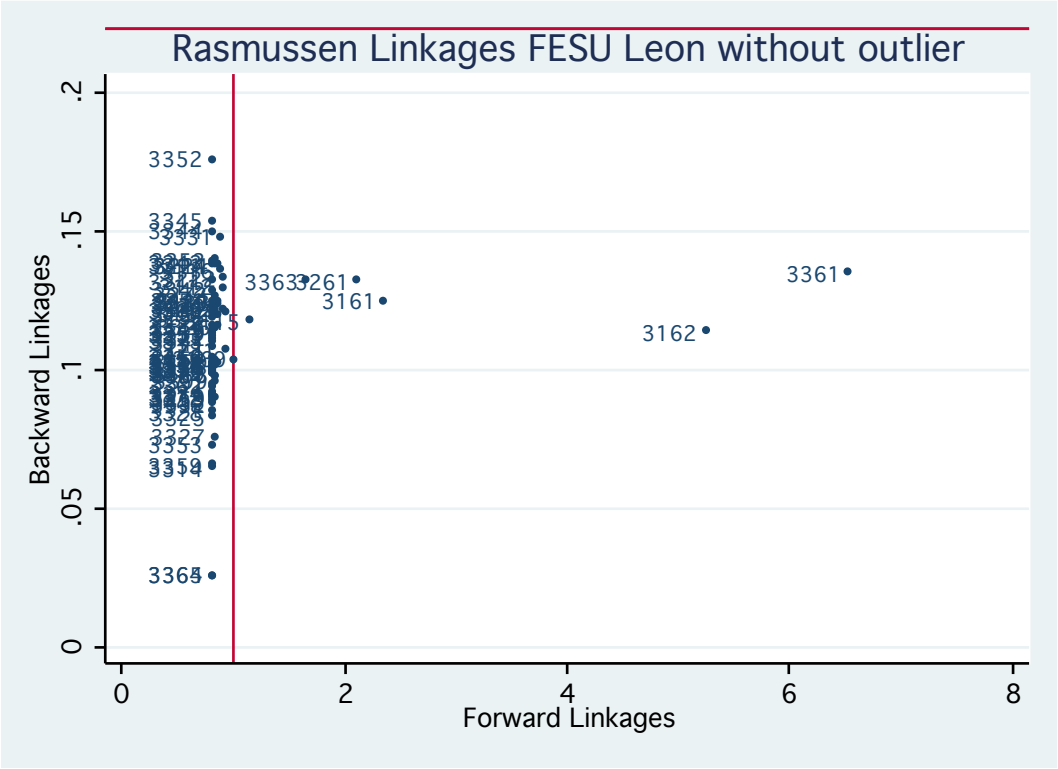
[7] According to Araizoz, B (2006), in recent years, have proposed other methods such as those advocating analyze the effect it would have on production the hypothetical elimination of a particular sector (Cella, 1984; Clements, 1990; Sonis et al., 1995; Dietzenbacher and van der Linden, 1997), or raised quantify these relationships across the full effect of a change in production and not in final demand (Cai and Leung, 2004) .

With that objective and in accordance with the results obtained by constructing manufacturing matrix for the study region, chains present are identified at the regional level using the proposal Rasmussen-Hirschman, having the next preliminary results for the FESU of LEON.



Source: Own elaboration with Stata

Considering these firts results it can be observed an outlier sector as a typical bacward linkage sector identified with computer manufacturing and pheriferal equipment. When we drop this outlier value we can observe how the rest of the linkages are revealed, with the higher forward linkages shown by vehicles and autoparts manufacturing, wich is interpreted havin low purchases among the region, situation according with real functioning of the automotive industry, as they obtain their main inputs from abroad and not from local market.



Source: Own elaboration with Stata

III. Conclusion

Some findings given the advance presented here center attention on methodological approaches, although empirical evidence and results given by the cluster analysis and rasmussen linkages have to be deepened.

In terms of methological advances, it is worth mentioning that the identificación of functional regions let us analyse the real performance of economic activity through territory. In this sesnse the constroction of the regional matrix is crucial for de identificación of clusters and linkages, uderstanding it's economic logic inside the region.

These results contrast with the agregate character and spatially homogeneity to be derived from having built the regional matrix from adjusting the national matrix, which would imply their lack of usefulness to understand how it is structured and how economy operates in the region and eventually for formulating policies for economic and social development.

However, it is considered that this approach should be deepened, in order to allow a discussion of the economic performance regions, which involves generating additional information, continuing estimating regional economic accounts and comparing them with national available information, and by expanding sub regional and inter-regional analysis.

IV. References

Asuad Sanen Normand Eduardo (2014) Pensamineto economico y espacio, Colección economía regional y urbana, Volumen Primero, Facultad de Economía de la UNAM.

Asuad Sanen Normand Eduardo (2007a) Un ensayo teórico y metodologico de sobre el proceso de concentración económica espacial y su evidencia empírica en la región económica megalopolitana de 1970 a 2003 y sus antecedentes.

Asuad Sanen Normand Eduardo (2007b) Una propuesta metodologica para la delimitación d eregiones economicas a traves de un indice de interacciones económicas, el caso de la región Noreste del país.

Asuad Sanen Normand Eduardo (2001) Economía regional y urbana . Introducción a las teorias, tecnicas y metodologias básicas. Benemerita Universidad Autonoma de Puebla, Colegio de Puebla, Asociación de Exalumnos de economia de la FE-UNAM.

Dávila, F. (2002). Matriz de insumo-producto de la economía de Coahuila e identificación de los flujos intersectoriales más importantes. Economía Mexicana. Nueva Época, Vol. XI, núm. 1.

González O. E. (2010). Identificación de Cadenas de Suministro Agrupadas en Clusters en México. México: Quinto Coloquio Interdisciplinario de Doctorado-Universidad Popular Autónoma del Estado de Puebla.

Hewings, Sonis, Jemien Guo (2000). New Image of Classical Key Sector Analysis: Minimum Information Decomposition of the Leontief Inverse. *Economic Systems Research, Vol. 12, No. 3, 2000.*

Iráizoz Apezteguía, B. (2006). ¿Es determinante el método en la identificación de los sectores clave de una economía?. Una aplicación al caso de las tablas Input-Output de Navarra. ESTADÍSTICA ESPAÑOLAVol. 48, Núm. 163, 2006, págs. 551 a 585.

Ki-Young Yoo. (2003). Method for Identifying Industry Clusters: Assessment of the State of the Art. Chapell hill

Fuentes, N. A. y Brugués A. (2001), "Modelos de insumo-producto regionales y procedimientos de Regionalización," Revista Comercio Exterior, Vol. 51 Núm. 3 págs. 33-54.

Fuentes A. (2003). Matrices de insumo-producto de los estados fronterizos del norte de México. México: Universidad Autónoma del Estado de Baja California.

Parra y Pino (2003). Obtención de una matriz de insumo producto a 20 sectores y análisis de los encadenamientos productivos en la región del Bio-Bio Base 2003. Horizontes Empresariales.

INEGI. Instituto Nacional de Geografía y Estadística. http://www.inegi.org.mx

VOSviewer http://www.vosviewer.com