A comparative analysis for constructing regional input-output tables, for Sonora, Mexico, from the bottom-up approach, its methodology and advantages over the top-down approach.*

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Abstract

The main purpose of this essay is to apply a methodology for the construction of a regional input-output table from bottom to top and to compare it with the one made from top to down. Our main concern is oriented to stand out the regional productive structure and its spatial components on both approaches. We assume that regional matrix, built from the top approach, is insufficient for the comprehension of the economic behavior on space and its structural economic attributes, so it is not useful for the regional decision-making and territorial economic policy, due to its inability to capture the spatial heterogeneity of economic in space.

The findings of this research are briefly that the regional matrix built from top to down, be insufficient and inadequate for the comprehension of the regional economic structure and its spatial components. A key feature is the kind of regionalization by which is divided the region. The traditional method of taking into account political or geographical regions, are inadequate if we want to understand the regional economic behavior and the requirements of the economic policy for a more effective promotion of regional growth and development. Furthermore, the construction of the regional matrix from bottom to top is more realistic and efficient for the study of the economic structure of a region and its policy design. The information that the region provides, in spite of being scarce, can be solved by the use of a set of indexes and regional analysis, which as a whole provided the essentials of the regional behavior, upon which can be built regional matrix. The accuracy of the regional analysis from bottom to top, including the spatial component, exceed by far the results reached by the outcome of the top-down approach,

I. Introduction

Regional Input-Output tables are usually constructed from national Input-Output table, which is known as the top-down approach and is considered essential as an analytical tool for formulating growth policy and development of regions. However, their results are highly aggregated and generalize the behavior of the regional economy, taking as reference the country's economic performance. Even more, they do not identify the heterogeneity of intra-regional spatial structure and its fragmented and partial economic interactions. On the other hand, in the literature there is a lack of methodology and cases based on the bottom-up approach, which in essence build the tables from regional basis. Also it is outstanding that just few works have been done taking into account the spatial interactions that are inherent to the regional economic analysis. Furthermore, it is preferred to make a regional input out table from above, due to the lack of regional data and a sound methodology for built a regional input-output table from below. However we assume that it is required a spatial theoretical and methodological approach, in order to spell out the regional and territorial analysis from the bottom, under which should be built the regional input-output table, based on an economic spatial perspective.

Hence, this paper attempts to build a regional input-output table from bottom to top, pointing out its theoretical and methodology approach and to make a comparative analysis with a regional table built from top to down, mainly oriented to stand out the differences concerning regional productive structure and spatial components. We assume that regional input output table, built from the top is insufficient for the comprehension of the economic behavior in space and its structural economic space, so it is usefulness for decision-making regional and territorial economic policy, due to its inability to capture the spatial heterogeneity of intra-sub regional production and inter-sub regional structure. Besides its outcome, causes distorted effects of the estimated technical coefficients and on the economic linkages, due mainly for the lack of localization of sales and buys between places of origin and destination within region, because to its sectorial bias without location in space.

Then for this purpose, we use Sonora State of México as a case study that was selected only for analytical and methodological reasons, in order to make a comparative analysis between both approaches. In the case of the regional input-output table from below, we identified 10 functional economic sub regions, upon which we made their input-output transactions and its multi sub regional input-output table. On the other hand, we built a regional table from the top, through the use of two input-output tables for Sonora State. The first one was developed for the State Government in 2011, with data of the national

economic census of 2009[4]. This table was created by RAS method, based on National Input-output table 2010. The second regional input- output table was created by the definition of 6 sub regions with the main purpose of applied economic regional development policies for the Sonora's Economic Promotion Council[5], according with the economic promotion law of Sonora State government. It is worth to mention that the sub regions were identified based on municipalities and electoral districts. This table was developed through Flegg´s methodology, the main diagonal of the table and by RAS method or bi-proportional distribution, the economic transactions between sub regions.

Therefore the essay consists in three parts: 1. The built of the regional table from the bottom-up approach; 2. The built of the regional tables from the top- bottom approach; 3. The comparative analysis between the regional tables, taking into account economic linkages between sub regions in both analysis, in order to spell out sub regional differences in economic structure and linkages and their implications on economic behavior and on the effectives of the policy decision on the regional economic growth and development structure, due to the lack of spatial location between sales and buys among localities within and across the sub regions and on the region as a whole.

Finally, it is important to mention that the development of the methodology, required a huge amount of analysis and information; therefore we present the main findings of the methodology and of the comparative analysis, through the aggregate analysis of the economic linkages in the region, as well as in the sub regions, pointing out their differences and association with the spatial location of the economic activities within the region.

The analysis that had been made for the Bottom-up approach required the build of 10 input-output tables, one for each of the ten 10 sub regions with 20 by 20, economic sectors. Even more, in the build of the economic interactions matrix – inter-sub regional analysis-, we had built 90 input-output tables, each one of 20 by 20 economic subsectors. Moreover, it had required the construction of a multi-sub regional input-output table for the intra sub and inter-sub regional analysis. On the other hand, in the case of the Top-down approach, it had needed to build 6 sub-regional input-output tables for intra sub-regional interactions, each one of 20 by 20 economic subsectors and 30 tables for inter-sub regional interactions of 20 by 20 economic subsectors, and the multi-sub regional input-output tables.

4 Bracamonte Sierra Álvaro and Sánchez G. José Manuel "Matriz Insumo Producto para el Estado de Sonora, 2011: Actualización y Regionalización Estadística". Gobierno del Estado de Sonora, Secretaria de Economía, Hermosillo Sonora, Julio 2011.

5 Consejo para la Promoción Económica de Sonora (COPRESON).

II. Interpretation and Methodology

Accordingly with the theoretical and methodological approach of the economic concentration of the spatial dimension of the economy, a perspective that I have been developing, It is assumed that economic concentration in space causes the formation of economic spatial units, that determine and characterize the spatial structure and the behavior of the economy. In a generic way, these spatial units are defined as functional economic regions, result of the economic growth and development on space. So in order to identify and defining them in a geographic space, we defined them as functional geo-economic regions. (Asuad, 2001, 2007 and 2014)

We assume that economic growth in the national or international space, is not homogeneous or political bounded in or across States or municipalities; whereas spatial distribution of economic activity is highly concentrated in some areas which lead to the creation of economic and population nodes, which are characterized by their economic interaction through production, exchange and consumption.

An economic node or hub is defined as a site or place on economic space that is characterized by its economic dominance and connection between a set of economic sites that interact and compete among them. It is defined an economic site, as a place on space in which economic activity is highly concentrated and through it is exerted economic impulses for economic exchanges which guide economic behavior on space

Economic nodes are spatial economic units through regional or national space and are characterized by their highly economic and population density. They functionally behave as market areas that concentrate production and consumption as well as a set of economic activities on their influence areas, which interact economically through economic flows among them.

The economic importance of nodes depends on their economic interaction, which is an outcome of their type of connection and market relationships, such as economic functional complementarity or competence between them. Then if their economic interactions are important, they lead to structure sub economic spaces, which form the economic space that is a set of economic sites and their economic interactions in a given geographic space.

The existence of economic space depends on at least the existence of a pair of economic sites. Obviously, economic space does not match with political space, in spite of its influence due to its powers and political influence for decision-making process. Economy, market behavior and territorial development define the way in which the economy in space is structured.

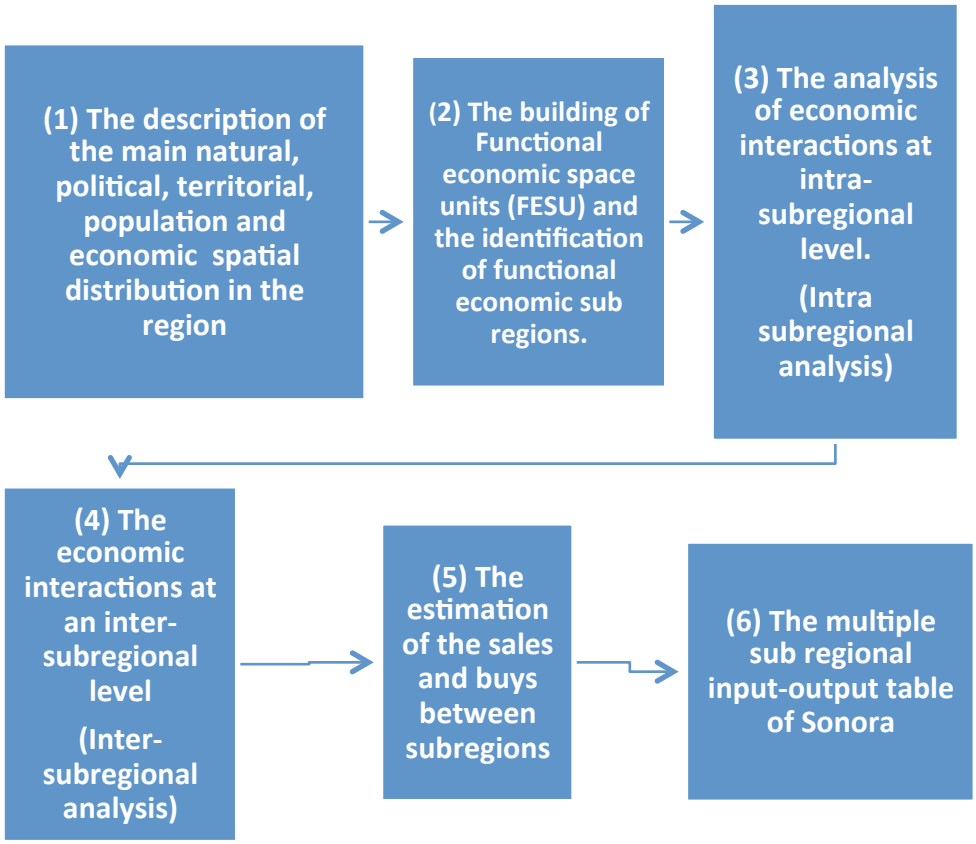
The main concept of the approach of the spatial dimension of the economy is economic space and its derivate economic concepts: territory and region.

Therefore we assume that economic interactions on space are an outcome of market transactions, characterized by sectorial economic behavior and their synergy with natural and territorial space in a given area, leading to the formation of economic space which leads to develop a system of cities and network of transport, that link them.

According with the methodology for build the regional input-output table from bottom-top the following diagram is presented.

Diagram 1

Methodology for build the regional input-output table from bottom-top



(1) The first step is done through the analysis of the political borders, natural and economic space. Firstly, it is described the geographic and political limits of Sonora, making emphasis on the differences of the natural space and the obvious advantages for population settlement and economic development, according to natural resources and main infrastructure capacities. Later on it was described the economic and population nodes, localizing them and sizing

their economic and population importance using a set of concentration economic and population index in the main nodes of the region, by an index of share, taking into account as variables: Population, employment and value added[6]. This analysis is complemented with the distribution of the net of transport road, pointed out the way in which the nodes are articulated by the net of roads. The outcome of this analysis is to characterize the spatial distribution of nodes and their physical contiguity through the net of transport within the region.

(2) This analysis, led us to follow the second step of the Methodology which is the building of the functional economic space units (FESUs) and the identification of the functional economic sub regions of Sonora (Economic Sub regions). This is the way by which it is identified the economic space, by precising the particularities of the concentration of the spatial distribution of the economic activity and their hierarchy. However, in a first stage is analyzed the economic structure aggregated of Sonora, and later is characterized the role and importance of economic and population, spatial distribution into nodes and their areas of influence, which let us to identify the functional economic spatial units within the region of Sonora. The identification of nodes and areas of influence is done by using as criteria of the analysis the concentration of economic activity and population, and the definition of influence areas. Therefore, according to the economic weight of the node within each municipality, it is disaggregated the main economic activities at a branch level, selecting the ones, from the highest value to the following considering their amount and share of total production as a criteria Pareto distribution which consist on a share of the 20% of the units weight 80% of the total economic activity. Later on, assuming that the pair of nodes which are spatially located near are in competition, we draw the borders between nodes, taking into account their size and distance by applying the Reilly index[7]. This let us to build the economic sub regions through the estimation of the Moran Index, in order to validate the spatial dependence of the economic activity within the sub regions.

(3) The third step of the methodology consists of the analysis of economic interactions at intra- sub regional level, which is done through several steps: 1.

[6] The information is provided by economic census of 2009, which is a data base at a locality and municipality level, disaggregated at sector of economic activity: Manufacture, Commerce and Services. Furthermore in case that there is not information at a locality level is possible to make estimation following the index of estimation of PIB per municipality and locality. (Annex I)

[7] The Reilly Index le us to settle the inverse relationship between size and distance between a pair of sites, denote as: $BP = \frac{Pa+Pb}{\sqrt[2]{Da+Db}}$, BP = Border point, Pa = Population site a, Pb = Population site b, Da = Distance to the site, and Db = Distance to the site b.

The identification of the dominant economic sectors by economic sub region, applying the Pareto distribution criteria; 2. The estimation of the economic specialization index by economic sub region[8]; 3. The built of the sub regional input-output tables, which is done firstly through an adjustment to the Flegg´s methodology, firstly by taking into account the economic specialization coefficient of the sub regions, secondly by estimating lambda λ, as a definition of the economic size of the sub region compare to regional and national production by applying the following index:

$$\lambda_r^{\delta} = \log_2\left(\frac{1+Y_{sri}}{Y_r}\right)\left(\frac{1+Y_r}{Y_n}\right)^{\delta} \quad \text{.....(1)}$$

$\delta = 0.3$

Y_r = TGP Regional

Y_{sri} = *TGP Subregional*

Y_n = TGP National

Later on, it is estimated the input-output table by economic sub region, that is calculated, through multiply the economic specialization coefficient by economic sub region, with the technical coefficient of state production and the Gross production of the economic sub region, which is specified as:

$$FLQ_{ij} = \left(CILQ_{ij}\right)\left(\lambda_r^{\delta}\right)\left(a_{ij}\right) \text{.....(2)}$$

(4) The economic interactions at an inter- sub regional level - Inter-sub regional Analysis- is done, by the assessment of the economic interactions between sub regions by the application of an economic interaction index, which consist of a cross correlation index weighted of the dominant economic sectors among sub regions (Annex II).

(5) The estimation of the sales and buys between sub regions is made by the application of index economic interactions. Then we applied the RAS method to the economic sub regions, through the referred index by the share of the gross production of each sub region and sector, in order to identify the technical coefficients of sales and buys between economic subsectors of the sub regions.

[8] See Annex

(6) The multiple sub regional of Sonora, created by the distribution of the gross production value, with the aim to build the multiple input-output sub regional table, that include the coefficients of the sub regions by the adjustment to Flegg´s methodology (4) and also the ones that come about from the application of the RAS method to the values of the economic interactions index among sub regions (5).

III. Built of the Regional Matrix from Below

The construction of the regional matrix from below was done by the following stages: 1. The Analysis of the natural, political and economic, spaces. 2. The Identification of the nodes of spatial economic concentration and their hierarchy. 3. The Identification and delineation of functional economic space units. 4. The Analysis of the economic interactions and the building of the sub regional matrices, and, 5.The construction of the sub regional matrix of Sonora from below.

3.1 Political and Natural Space

Sonora is the second-largest state of México, with 9.2% of the national territory, however it participates with only 2.1% of the population. It is located in the Northwest corner of the country, bordered on the north by the United States, mostly with the State of Arizona, 568 kilometers long and only 20 km with New Mexico.

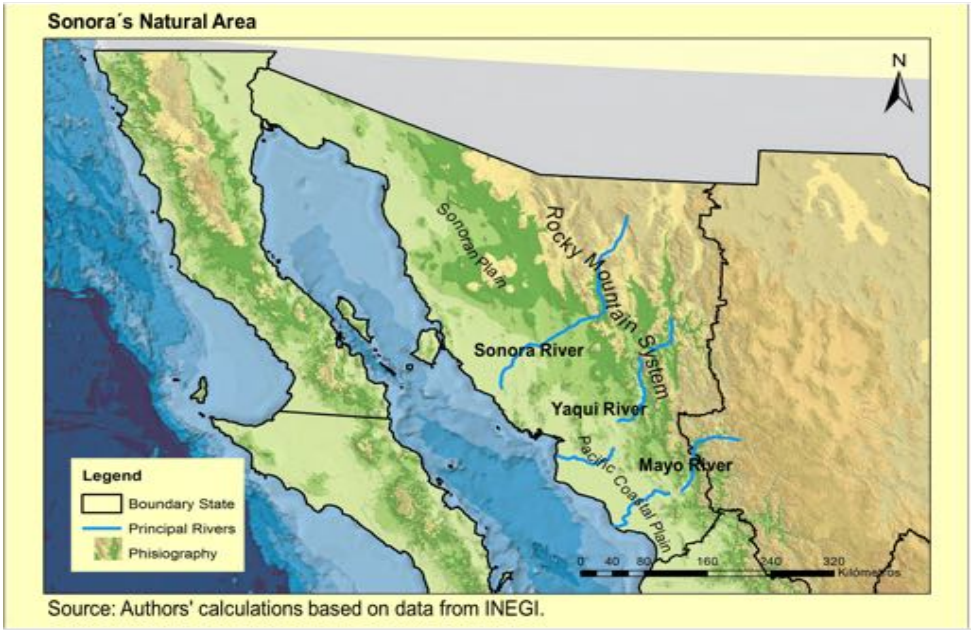
Their borders are Chihuahua to the East, Sinaloa to the south and Baja California and Gulf of California to the West. The Sonoran territory is divided into two major physiographic zones: 1. The eastern mountain range that belongs to the Sierra Madre Occidental which is the extension of the USA Rocky System, that occupies 49% of Sonora; and 2. The plain located in the east part, 51% of Sonora region with a direction to the Southwest towards the Gulf of California. However, most of the land is desert 48% and dry 46%, only a very small part is warm and moist.

Therefore, water in Sonora is one of the main problems; so it has been built a set of dams and irrigation districts along the main hydrographic basins. In the region highlights three basins: Sonora, Yaqui and Mayo, drained by those rivers, which run from North to South with origin in the mountains towards to the Gulf of California. Nevertheless, the main catchment is in the extreme southwest of the State based on Yaqui and Mayo Rivers, with 42%, mainly around Obregon and Navojoa Cities. Hermosillo City accounts 18% in his

surroundings. The other 40% of the State is distributed in the North Part of the Sonora River and in the Concepcion River in Caborca and in the Colorado River in the border.

However it is worth to mention that the dam system of Yaqui River accounts for 50% of the Sonora´s cultivated land which is the most productive agriculture of the Nation, followed by the Mayo River irrigation system in the South of the Yaqui Valley. ***(Map No. 1)***

Map No. 1
Sonora State, Physiography and Principal Rivers



Source: Authors' calculations based on data from INEGI.

Hence, it is clear that Sonora region has remarkable differences concerning sub regional natural and infrastructure facilities, highlighting mainly the advantages of the extreme southwest y central part of the Region, which are an indication of the advantages offered by these geographical areas for human settlements and for the development of economic activity in the region.

3.2 Economic Space

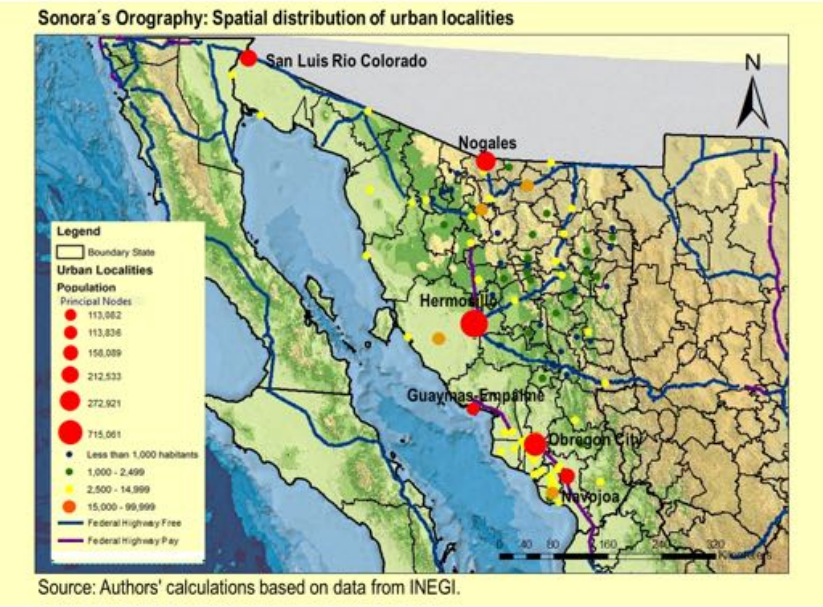
The regional territorial development is characterized by the spatial structure of the urban areas and the transport network that links them, as a very uneven spatial distribution, which results in the formation of a hierarchical system of cities in which 6 cities concentrate most of the population, 60% of the total, highlighting in order of importance the city of Hermosillo with 30% of the total, followed in importance Ciudad Obregón

12.8%, Navojoa 4.9%, Guaymas-Empalme 6.7%, Nogales 9.1 % and San Luis Río Colorado 6.8%. Furthermore, it is obvious the coincidence between the natural and infrastructure advantages of these areas, mentioned above and their relationships with the population settlement on these areas. Besides the main population settlement are in the central and Southwest of the region which accounts 57.4% meanwhile the border account 15.8 .

The territorial spatial distribution is characterized on one side by a system of prominent cities in the plain of the Center-South of the state, which concentrated most of the urban population of the region and a few cities in the US border. On the other hand a pattern of huge spatial dispersion is found, mainly in the mountainous area of the state. The network of cities forms two main corridors: 1. The end corridor south-central state that connects Ciudad Obregon Hermosillo-Guaymas and Navojoa- and the border corridor established by the system of cities from east to west: Agua Prieta-Nogales-Sonoita and San Luis Rio Colorado. ***(Map No. 2)***

Map No. 2

Sonora State, Urban localities by distribution of the population



Source: Authors' calculations based on data from INEGI.

3.3 Functional Economic Space Units (FESU)

The identification and delimitation of the economic operation of the spatial economic system within the region, requires specifying the importance and economic specialization within the region and its spatialization, by précising the particularities of their location and economic importance. This is done, firstly through the identification of nodes and areas of influence, using as criteria of the analysis the concentration of economic activity and population, and the definition of influence areas, assuming that the pair of nodes which

are spatially located near are in competition, taking into account their size and distance by applying the Reilly index. However, in the first stage is analyzed the economic structure of Sonora, and later is characterized the role and importance of economic and population nodes and their areas of influence, which let us to identify the functional economic spatial units within the region of Sonora.

3.4 Economic structure of Sonora, Nodes, Areas of influence and Sub regions

The economic structure of Sonora as a whole shows a predominance of industrial activity with 67% of production, highlighting the importance of the manufacturing sector with 43%, mining 12%, electricity 7% and construction 4%. The sector next in economic importance is the tertiary that accounts for 31% of total production, contrasting to the primary sector, which contributes only 2%. ***(Annex I)***

However, it is noteworthy that Sonora highlights nationally for its economic specialization in the primary sector, mainly in production and animal breeding and fisheries, while industry just stands in the primary metals industry and in computing manufactures as well as recreational services. ***(Annex II)***

However, the spatial distribution of economic activity is very uneven distributed because just 9 nodes of Sonoran territory[9], had accounted to the higher value added of the region 94.6%, 81.2% of the total employment and 79.4% of the regional population. ***(Table No.1)***

Table No. 1

Economically dominant nodes, 2008 (%)

Node (locality)	Total Population	Employment	Value Added
Hermosillo	30.7	32.5	52.1
Obregón City	12.8	13.3	12.0
Nogales	9.1	9.3	10.0
Guaymas-Empalme	6.7	6.6	8.2
Caborca	2.6	2.6	3.4

[9] It is worth to comment that the identification of economic nodes within Sonora was performed by analyzing at a local level, the weight and importance of the sector's value added, as well as its share of value added, employment and population. Moreover, the nodes that we are consider accounts for the 79% of total population, 81% of employment and about 95% of value added. Furthermore, it is necessary to clarify that economic participation was obtained from the data differences between locality and municipality to whom it belongs. The results shows the important share of locality, which values fluctuate around the 98.5% of municipal value added, 92.7% in employment municipality and 92.3% in population density of the municipality. (Annex III)

Navojoa	4.9	4.7	3.0
San Luis Río Colorado	6.8	6.6	2.7
Agua Prieta	3.3	3.3	1.7
Puerto Peñasco	2.4	2.4	1.4
Total Nodes	**79.4**	**81.2**	**94.6**

Source: Authors' calculations based on data from INEGI.

The economic importance of the nodes is complemented by their specialization and economic diversification, considering the economically dominant sectors in the economy of Sonora and those of the 9 nodes, where economic and population concentration is done. The economic specialization within Sonora in each of the nodes, shown a very different spatial pattern if we compare with the region as a whole. In spite of the important share of Sonora in breeding and production animals at national level, the only node that specializes in this activity is Ciudad Obregón, while on Fisheries do Guaymas-empalme, Puerto Penasco and San Luis Rio Colorado. The same applies to agricultural production since only highlights Caborca and Ciudad Obregon.

In the case of the industrial sector, which stands out as the most important sector of the economic production of Sonora, an important manufacturing differentiation per node can be observed , while Hermosillo is the main industrial center with five industrial activities, followed in importance by Ciudad Obregon with 4 manufacture industries, both differ in their industrial basis . Hermosillo specializes in basic industry, basic metal industry, metal products and non-metallic minerals while Obregon it does in food, beverages and Tobacco, as well as in the basic metal products and its manufacturing. On the other hand, Navojoa and Guaymas -empalme are specialized in assembly industry as wells as in Food , Beverages and Tobacco industries. On servicer's specialization, highlights the poor development of Hermosillo, contrasting with Obregon City. ***(Table No.2)***

Meanwhile, the border cities, Nogales, Agua Prieta and San Luís Río Colorado are specialized in the assembly industry, mainly manufacture of computer, communication and measurement equipment and other electronic equipment components and appliances manufactures. These cities also stand out in services mainly recreative.

Table No.2
Dominant economic nodes and economic specialization

Sector	Agua Prieta	Caborca	Obregón City	Guaymas-Empalme	Hermosillo	Navojoa	Nogales	Puerto Peñasco	San Luis Rio Colorado
Animal breeding and production	0.00	0.07	**3.31**	0.10	0.99	0.01	0.00	0.05	0.00

Fishing, hunting and trapping	0.00	0.50	0.11	**8.18**	0.08	0.01	0.00	**10.96**	**4.20**
Services related to agricultural and forestry activities	0.00	**9.75**	**5.90**	-0.07	-0.39	0.55	0.00	0.00	0.00
Basic Industry	0.39	**2.80**	0.76	0.23	**1.24**	0.85	0.11	0.70	0.37
Transportation equipment manufacturing	**1.65**	0.00	0.29	**2.56**	**1.25**	0.22	0.39	0.01	0.28
Basic metal industry	0.00	0.06	**2.76**	0.06	**1.13**	0.00	0.00	0.00	0.00
Food industry	0.18	0.47	**2.38**	**1.22**	0.78	**1.85**	0.06	0.49	0.95
Beverage and tobacco industries	0.14	**3.65**	**1.40**	0.04	0.59	**6.18**	0.14	0.10	0.08
Manufacturing of computer, communications, and measuring equipment, and other electronic equipment, components and appliances manufacturing	**1.32**	0.00	0.00	0.48	0.29	0.63	**7.25**	0.00	**4.57**
Metal products manufacturing	0.12	0.03	**1.25**	0.27	**1.10**	0.06	**2.28**	0.09	0.09
Nonmetallic mineral products manufacturing	0.54	0.08	0.30	0.35	**1.53**	0.48	0.22	0.94	0.66
Other manufacturing industries	**2.96**	0.02	0.08	**2.86**	0.05	0.31	**7.82**	0.10	0.23
Wholesale trade	**1.14**	0.96	0.93	**1.17**	**1.03**	**1.29**	0.65	0.71	**1.02**
Retail trade	**1.78**	**1.23**	**1.33**	0.93	0.73	**1.30**	**1.00**	**3.22**	**2.38**
Transportation, postal services and warehousing	0.61	0.54	**1.75**	0.65	0.90	0.80	**1.52**	0.18	0.47
Mass media information	**1.14**	0.24	0.30	0.25	**1.56**	0.23	0.17	0.50	0.57
Financial and insurance services	**3.99**	0.66	**1.87**	0.61	0.66	**1.01**	0.82	**3.24**	**2.72**
Urban Services	0.70	0.20	**1.08**	0.38	0.94	0.93	**2.22**	**1.62**	0.91
Social Services	**1.30**	0.58	**1.07**	0.72	**1.05**	0.67	0.95	0.60	**1.95**
Cultural and recreative services	**1.85**	0.37	**1.84**	0.83	0.65	0.98	**1.07**	**4.65**	**2.51**
Other services (except government activities)	**1.27**	0.66	**2.15**	0.44	0.81	0.73	0.82	**1.41**	**1.97**

*The index was calculated on the Value Added Total of Sonora. If the index is ≥ 1 so there is economic specialization.
Source: Authors' calculations based on data from INEGI.

The influence areas of the nodes are their complement, therefore considering the location and economic and population importance of the nodes, it is defined their areas of influence, which enhanced the whole region into 10 FESU. These were done in the case of the 9 nodes, through Reilly index, that let us to define the border between nodes. Besides, it was identified another FEUS, which is characterized by its extreme dispersion of localities and rural dominance, in order to integrated the whole economic areas that forms the region.

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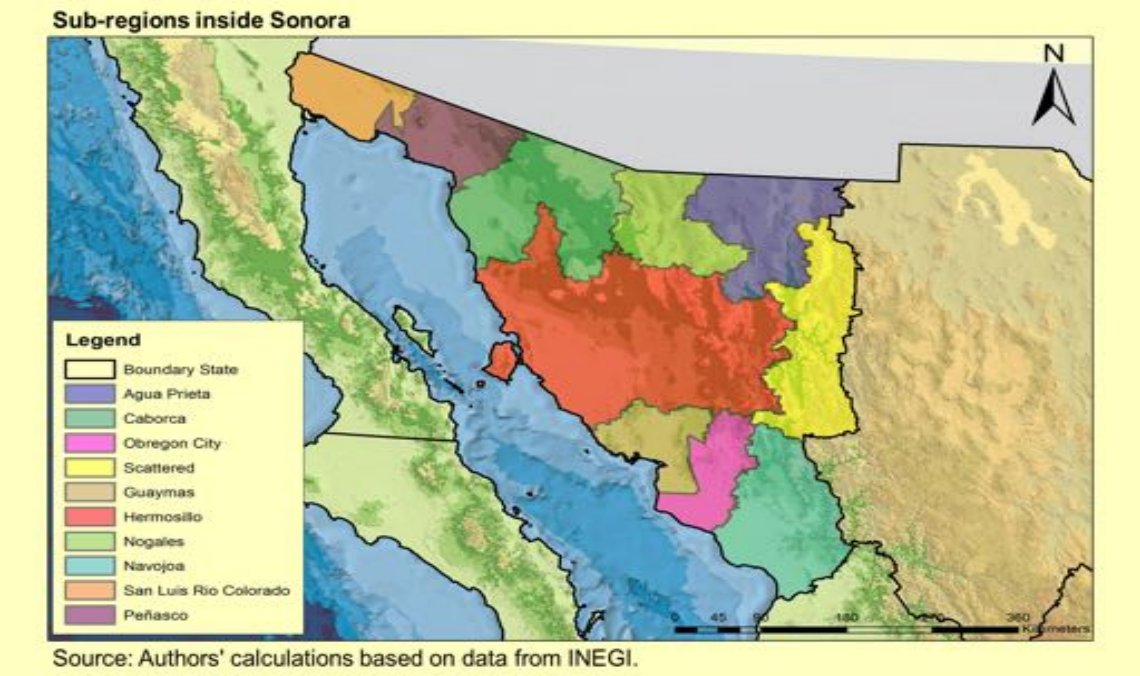
Reilly index, that let us to define the border between nodes. It was also identified another FEUS, which is characterized by its extreme spatial dispersion of localities and rural dominance, in order to take into account all the economic areas that forms the region.

However, we have validated the FESU as economic sub regions due to spatial economic interdependence that exists between them, through spatial econometrics by applying the Moran index. ***(Map No.3)***

Map.No 3

FESU as economic sub regions of the Sonora state



Source: Authors' calculations based on data from INEGI.

The economic importance of the sub regions is also associated with the population hierarchy, stand out for their economic and population share the economic sub regions of Hermosillo, Agua Prieta, Obregon and Nogales, which account for 83% of the regional production, 80% of total value added, 72% of total regional employment and 65% of total population of the region. ***(Table No.3)***

Table No. 3
Economic Information by sub-region, 2008 (%)

Sub-region	Employment	Total Output Gross	Value Added	Total Population
Hermosillo	35.65	49.82	43.31	31.89
Agua Prieta	4.93	16.13	16.14	5.65
Obregon City	17.18	10.76	10.88	16.95

Nogales	14.22	6.05	8.91	10.58
Guaymas	7.91	4.52	6.67	7.67
Navojoa	8.80	6.51	6.18	13.46
Caborca	2.98	2.23	3.26	3.63
San Luis Rio Colorado	5.13	2.19	2.27	6.64
Sonoita-Peñasco	2.89	1.16	1.41	2.60
Scattered*	0.29	0.63	0.97	0.93
Total	**100.00**	**100.00**	**100.00**	**100.00**

*Scattered is referred to localities, which does not have economic concentration pattern.

Source: Authors' calculations based on data from INEGI.

IV. Comparative analysis of the regional input-output tables from both approaches

The comparative analysis between both approaches is done by chains and links[10] examination. As well as the spatial implications for understanding the spatial economic structure of the region of Sonora and its possible implications for the formulation of the economic and regional development policy, remarking the linkages of the chains that come about, when the spatial locations of economic activities within sub regions, has taken into account or not.

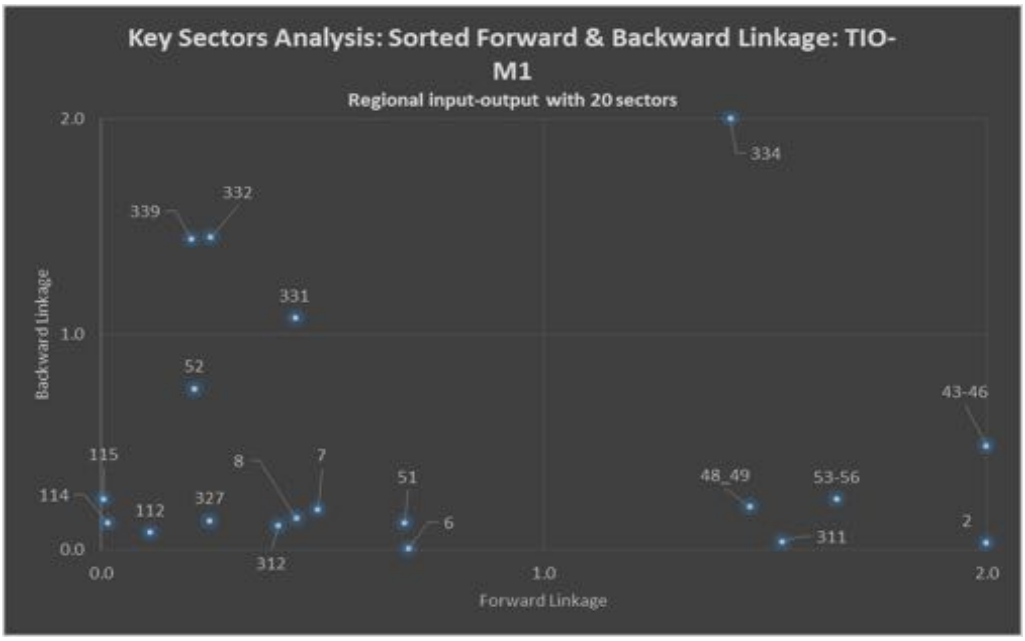
Therefore, under this approach are analyzed three input-output tables: 1.The regional input-output table of the Government of Sonora, from top-bottom approach, without sub regional divisions, denominated as MI; 2. The COPRESON regional input-output table, from top-down approach with 6 sub regional divisions, denominated as M2; and 3. The regional input-output table of Sonora from bottom-up approach, with 10 regional divisions, denominated as M3.

4.1 The Chains of the Regional TIO M1

The main findings of the chains of this matrix, are characterized by the predominance of independent sectors, a little over half, 11 sectors are characterized by high dispersion and lack of enchainment and only 9 are chained, as you can see in the Chart No 1.

[10] The determination of the impacts generated by the sectorial and spatial interactions of an economy, it is crucial for economic analysis and for the implementation of an effective public policy tool. The chains of production activities and their backward and forward links reflect economic relationships and productive dependence in a regional structure, where these chains are based on specialized sectors. The backward link of the chains reflects dependence of economic activity, of inputs that could have been provided by other region whereas the forward link of the chains reflects the specialized supply of inputs from one sector of a region to other economic activities of another region. To evaluate these chains, the rate of direct linkages was used back and forth, where the type of chain determines the role of the sectors in the economy, this may be specified:

Chart No.1



Next in importance are the subsectors characterized by forward enchaiment -based sectors[11],-, such as the 48-49 sectors (Transportation, Postal services and warehousing), 53-56 (Urban Services), 2 (Basic Industry) 311 (Food industry) and 43-46 (Commerce).

In the case of backward linkages [12], which are characterized by strong sectors, just stand out 3 subsectors: 339 (Other manufacturing industries), 332 (Metal products manufacturing) and 331 (Basic metal industry).

En el caso de los encadenamientos hacia atrás que se caracterizan por ser sectores de fuerte arrastre, destacan tan sólo 3 subsectores: 339 (Other manufacturing industries), 332 (Metal products manufacturing) y 331 (Basic metal industry).

Finally, the only key sector of the state identified in this matrix was 334 (Manufacturing of computer, communications, and measurement equipment, and other electronic equipment, appliances and components manufacturing), as it has backward and forward linkages .

[11] Direct linkages "forward" (Di) measures the proportion of the gross value of production of a branch of economic activity bound for regional intermediate demand. $D_i = \frac{\sum_{j=1}^{n} x_{ij}}{X_i} = \sum_{j=1}^{n} r_{ij}$; Where xij = Value of regional intermediate sales activity i to j; Xj = gross value of production of a branch of economic activity

[12] Direct linkages "backwards" (Dj) records the initial requirement of regional inputs for a sector to increase by one the gross value of production $D_j = \frac{\sum_{i=1}^{n} x_{ij}}{X_j} = \sum_{i=1}^{n} r_{ij}$. Where: xij = Value of regional intermediate sales activity i to j Xj = Gross value of required by a branch of economic activity inputs.

It is also worth mentioning that this matrix has only sectorial linkages, without any location on sub economic regions, leaving outside, the location and relationship between sellers and buyers, which makes impossible the identification of spatial economic structures and hence the understanding of the performance of the regional economy and its territorial characteristics. Accordingly, to this analysis, the regional economy of Sonora is distinguished by their dispersion and lack of sectorial, regional and territorial integration flows. The subsector 334 stands out as the unique economic subsector that it has characterized by their forward and backward enchainment and belongs to the assembly industry, specifically to the production of computers and electronic equipment and components.

Moreover, it is noteworthy that the food industry does not have backward linkages, despite national specialization of agriculture, cattle and fisheries of Sonora. Furthermore, this conclusion contradicts the location of these economic activities, as it was revealed in the distribution of the economic activities in the economic sub regions and nodes, according to our analysis of the spatial distribution of economic activities within the region. The same applies in the case of services, since they appear without forward integration in the sub regions, which are characterized by the development of cities.

4.2 *The Chains of the Regional TIO M2*

The regional input-output table of the State of Sonora, is divided in 6 regions, for the management and administration of regional economic development policy of the Government of the State of Sonora,(COPRESON) (Map No. 3).

It is noted that this regionalization is not based on the spatial distribution of economic activity, their specialization and territorial location. This shortcoming does not lead to identify the location of activities and subsectors of economic activity in each of the sub regions and nodes, where takes place; so it is not possible to identify the characterization of places for buying and selling, in spite that is through them that economic interactions and chains of sub-sectors are done.

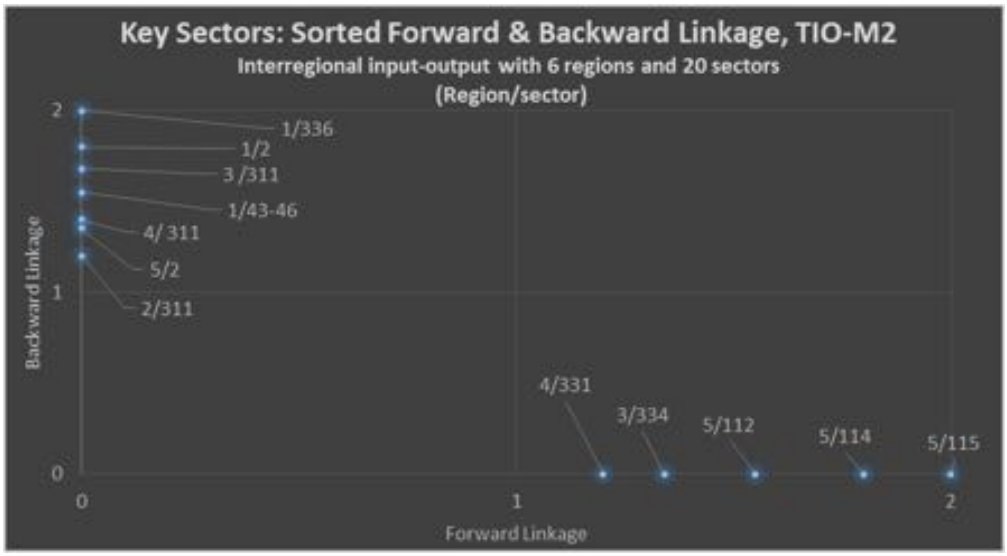
Map No. 3
COPRESON- Subregions

This table is build from top to bottom using the Flegg´s methodology, taking into account the 20 dominant sectors of the economy of Sonora.

According to the result of this analysis, 60% of key economic sectors are characterized by the existence of economic links, however, were not found, key sectors, which are characterized by their functional economic integration, with its linkages to forward and backward.

Therefore, it is possible to infer that according to this information, the interaction of the economy of the region is characterized by the lack of economic integration through the sub-regions, which should have been developed as nuclear articulators of the economy of Sonora. Consequently, only five economic subsectors, has a forward linkage performance, in addition to its very limited presence at the subregional level. They are found only in three sub regions, standing out the Northwest, -Caborca-San Luis Rio Colorado, due to the concentration of three sub sectors: 5/112 (Animal breeding and production), 5/114 (Fishing, hunting and trapping) and 5/115 (Services related to agricultural and forestry activities, whereas, the region 4 North- Agua Prieta, counts due to sub sector 331 and the región 3 Center-Hermosillo- , does with sector 334. See Chart No.2

Chart No. 2



The lack of integration is also observed, considering the sectors that are backward link, because despite they are being demanding of inputs, they have not forward linkages, which implying a disintegration of the productive structure, complemented by its spatial dislocation. In addition despite having presence in 5 sub regions, the sectors are highly fragmented and specialized, what is suggesting that it is an economy totally disjointed, either at a sectorial and regional level, characterized by its sectorial isolation, even in those sub-regions, which account for greater number of sectors.

Consequently, the subregion 1 Central Coast -Guaymas / Empalme- sectors characterized by 336 (Transportation equipment manufacturing), 2 (Basic Industry) and 43-46 (Commerce), while in the 3 center -Hermosillo, what sectors ago - 331 (Basic metal industry); in the sub region 4 North -Cananea / Agua Prieta in the 311 (/ Food industry); at the 5 Northwest -Caborca-San Luis Rio Colorado-in subsector 5/2 (Basic Industry) and finally, in the subregion 2 Sur B - Huatabampo- Navojoa, in the Sub region in the Central Coast 311 / Food industry.

The analysis of this regional matrix, presented Sonora, as an economy characterized by the lack of linkages between sub regions, which in principle indicates its characterization by almost autarchic closed sub regions, specialized in certain sectors, no interactions with other sub regions and sectors and therefore no linkage and complementarity of space and

land activities, including in the services sector is reflected in the economy of Sonora with a very uneven pattern and concentrate on a few urban localities[13].

4.3 *The Chains of the Regional TIO M3*

The construction of the regional matrix of Sonora under the bottom-up approach, is developed from the location and the regional and territorial structure of economic activity and population. Allowing to identify and delineate 10 economic subregions. The main results shown, stand out in terms of chains of economic activity by sub regions of Sonora. Notable is the diversification and integration of production presented by sectors of economic activity within subregions and economic interaction.

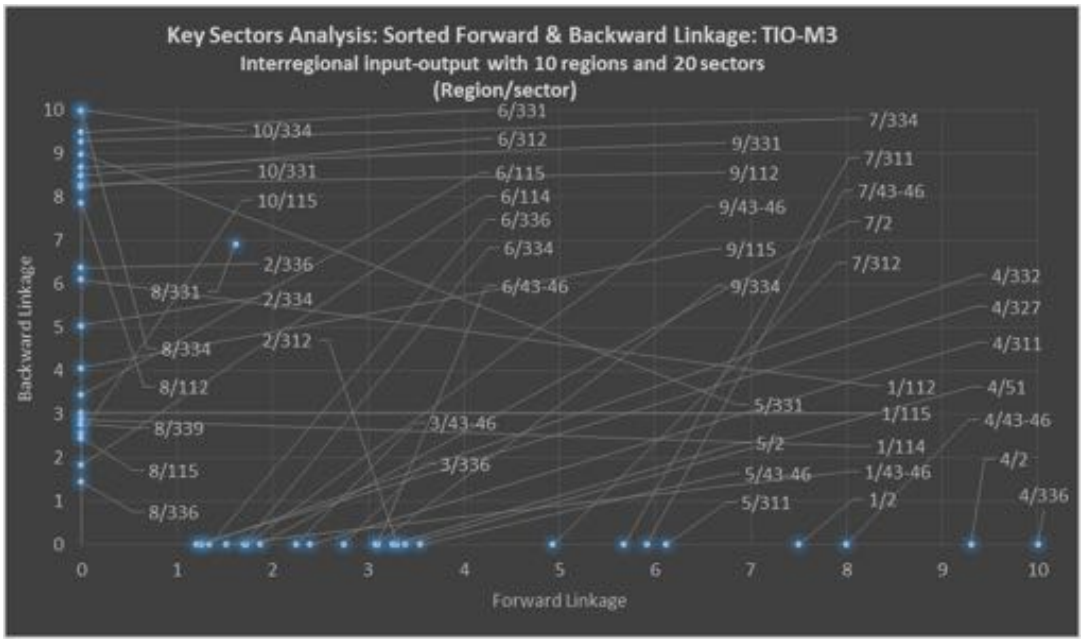
In a first approximation it shows that 14 of the 20 sectors of economic activity have some chain and 6 are independent sectors: Government, Recreational, urban and social services, financial services and postal services. Indicating that economic activity for the most part, has a degree of integration that shows the economic complementarity between sectors of economic activity in the region. Furthermore, the fact that these chains are observed in the 10 economic subregions considered, is indicative of the spatial economic interaction that describe the sectors in all subregions of Sonora. However, it is remarkable the case of business, which has only forward linkages and has no presence in the sub regions of Caborca, Sonoyta and Puerto Peñasco and the sub region scattered locations, it can be inferred that because of its location, near the border with the United States and Baja California, the trade is linked to these areas.

Moreover, it is noted the concentration and importance of economic linkages by subregion, as they show an association between the subregions that have higher chain and which have greater weight in output and employment in the region of Sonora.

Hermosillo, distinguished by its first place in the regional economic performance and the importance of their sectors and specialization, as it has 7 sectors chained forward, indicating its import function from other sub regions of inputs and various materials, as well as its function of providing trading services, food production, information and mass media financing and insurance. (See Chart No. 3)

[13] It is worth to mention, that in previous researches, these characteristics and behavioral findings of regional economic activity, was raised in previous studies on the state of Sonora, taking the Economic Census 2003 (Sanchez, 2005)

Chart No. 3



Moreover, we can see that the Hermosillo region also stands out for its interactions with other subregions, Nogales and Ciudad Obregon. In the case of Ciudad Obregon, the interactions are carried out forward with the following subsectors 311, 43-46, 2 ,312, and backwards with (334), whereas with Nogales are forward linkages 336, 43-46,334, and backwards 331, 312, 115 and 114. (See Map No. 4)

Therefore, this behavior evidence and territorial sub regional structure, given by chains and interactions of these productive sectors and regions most importants of Sonora: Hermosillo, Obregon and Nogales. Likewise, they carry out sub regional inter and intra interactions, which gives evidence of a structured regional and territorial economy from these sub economically dominant regions.

By the number of chains, also it highlights the sub region of Nogales, which is similar to Hermosillo, however, it has forward link on 3 sectors, which are trade, manufacture of computer equipment and communications and transportation equipment manufacturing. It is assumed that the inputs for these sectors come from abroad. On the other hand, they include rearward links on 4 sectors: 332, metal manufactures, 327, nonmetallic minerals and manufactured products, 311 food industry and mass media information, which is indicative of the drag that encourage their suppliers local inputs.

Map. No. 4

V. Conclusions

1. This regional matrix TIO-M1, has only sectorial linkages, which prevents sub regional analysis, where economic activities and their space, can not be separated, needless to say about the possibility of identifying a location precisely between sellers and buyers, which makes the identification of spatial economic structures and thus the understanding of the performance of the regional economy, where it is interpreted only by a sectorial approach, where there are no space considerations and the subsectors of economic activity are distinguished by their sectorial dispersion and their regional and territorial integration absence.

In the case of the Sonora region matrix, the food industry has no backward linkages, which seems inconsistent with the evidence of agricultural and fishing specialization of Sonora, identified in testing statistical distribution and association of productive sub sectors analyzed values per node and region spatial economic activity in the region of Sonora.

Something Similar happens in the case of services, when they appear without integration forward or backward, this also contradicts the spatial specialization and the economic

indivisibilities, which actually exists in reality, including cities and regions, as they were analyzed their relationships through Moran index in the Sonora region.

The analysis of the matrix without sub regions seems to contradict the economic spatial specialization and partnership that exist between economic sectors, according to the spatial distribution of economic activities and the development of economic sub regions and territories. Furthermore, the chain linkages that come about from this methodology make a distorted interpretation of the regional economy, due to the sectorial bias and aggregated of the region, accordingly to the national economy without taking into account the regional and territorial particularities. Therefore, the way in which regional input-output table was build from top to bottom approach, without space and sub regions are insufficient for the comprehension of the economic structure and for the policy decision making either for economic growth and development.

2. The regional matrix TIO-M2, created from top to bottom, in spite of define 6 regions, they were created by political and administrative criteria's, leaving aside the way in which the economy behave in space. Consequently the location and the distribution of the economic activity on space and the development of spatial economic units: Regions and cities, there were not taken into account. Accordingly, they do not consider the spatial distribution and the location of the economic activity, their specialization and territorial location, which is expressed by the territorial system: Cities and Rural localities.

This shortcoming does not allow the identification of activities and subsectors of economic activity in each of the sub regions considered for analysis; besides not allow characterization of places for buying and selling, which come from economic interactions and chains of sub-sectors considered in the analysis. In this regional matrix while sub-regional chains backward or forward were identified, there are not linkages between sub regions, in key sectors, such as agriculture, industry and services, which in fact in the descriptive analysis of the regional and territorial economy were observed. According to the results of this matrix, the regional economy of Sonora, is characterized by autarchic sub regions, specialized in certain sectors, where there is not interactions with other sub regions, neither links or complementarity with spatial and territorial activities. It is evident the link between services and urban development, nationally, as it is the case of Sonora region.

Consequently, the way in which regional input-output table was build from top to bottom approach, in spite to take into account the definition of regions, they are inadequate due to the political and administrative criteria's, upon which the definition of regions was done. Furthermore, it leaves out the location of the economic activity in regions and cities and their economic interactions. Hence this situation combined with the assumption that the economic region behaves as the nation does, causes a distorted comprehension of the

economic performance and an inefficient economic policy for regional economic growth and its development.

3. The proposed methodology of the creation of the regional input-output table from bottom-up approach, compare to those created by the opposite approach, offer a more realistic and rich information, regarding the behavior of the sectors analyzed within sub regions and cities, not only by the number of chains that were observed, but also for their precise location in space, either in regions or in nodes and also in minor localities. This led us to identify the spatial economic structure and its economic sites and interactions, which provoke regional and urban development. The identification and definition of economic sub regions under functional economic criteria is a precondition to understand the way and performance of the economy in space and their interactions, and also for the policy making decision to improve regional development and the diminishing of regional and urban disparities. When considering these linkages and the origin and destination of the regional sectors chained through the balance between purchases and sales regarded as the difference between the rates of interaction between sub regions by subsector, it is possible to describe the impacts on one sector caused by variations in economic activity in a specific sector and in the sub region of origin.

The construction of the regional input-output from bottom to top approach, is based on a theoretical and methodological approach, firstly by the concentration of the economic activity under the spatial dimension of the economy, which technically, rely mainly on the identification and definition of the Functional economic space units (FUSA). This implies the construction of several indexes and the application of the spatial econometrics and of the economic interaction index. This index is also combined with the input-output technics that are use frequently in the construction of the input-output table. Nevertheless, the essential of the regional matrix, built from below is rooted on their regional basis and disposable data, which is possible to collect and make the required estimations, in order to fulfill the information which is required for the built of the regional input-output table.

This work not only has demonstrated the importance of considering the spatial economic characteristics of the economic sectors, which is required in order to the proper construction of regional matrix, it has also been shown that they can build from below, even with the lack of data, is possible to build the matrix with indirect methods, as we do it in this research.

On the other hand, it is worth mentioning that this work is part of a line of research developed by the CEDRUS, since a long time and now is applied to the input-output field, opening for us new research proposals from applied technical studies for technology transfer and for development of models and experimental economics studies.

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Annexes

Activity		%
Primary sector		**2.20**
112	Animal breeding and production	1.5
114	Fishing, hunting and trapping	0.7
115	Services related to agricultural and forestry activities	0
Secondary sector		**64.70**
21-23	Basic Industry	25.9
311	Food industry	6
312	Beverage and tobacco industries	3.1
327	Nonmetallic mineral products manufacturing	2.2
331	Basic metal industry	6.6
332	Metal products manufacturing	2.7
334	Manufacturing of computer, communications, and measuring equipment, and other electronic equipment, components and appliances manufacturing	3.1
336	Transportation equipment manufacturing	13.2
339	Other manufacturing industries	1.9
Tertiary sector		**33.00**
43	Wholesale trade	6.8
46	Retail trade	8.2
48-49	Transportation, postal services and warehousing	1.9
51	Mass media information	3.6
52	Financial and insurance services	0.3
53-56	Urban Services	4.9
61-62	Social Services	2.3
71-72	Cultural and recreative services	3.3
81	Other services (except government activities)	1.7
Total activity in Sonora		**100.00**

Table X. Economic Specialization in Sonora, 2008

Sector	Activity	Index
112	Animal breeding and production	23.20
114	Fishing, hunting and trapping	4.63
331	Basic metal industry	2.57

336	Transportation equipment manufacturing	2.55
339	Other manufacturing industries	2.48
334	Manufacturing of computer, communications, and measuring equipment, and other electronic equipment, components and appliances manufacturing	2.20
332	Metal products manufacturing	1.75
327	Nonmetallic mineral products manufacturing	1.30
312	Beverage and tobacco industries	1.20
311	Food industry	1.15
71-72	Cultural and recreative services	1.08
46	Retail trade	1.04
81	Other services (except government activities)	1.03
43	Wholesale trade	1.02

Table X. Proportionality between economic node (locality) and its corresponding municipality, 2010 (%)

Node	Added Value	Employment	Population
Hermosillo	99.5	95.1	94.7
Obregon City	92.5	80.2	78.9
Nogales	100.0	98.3	98.6
Guaymas	97.3	88.4	87.8
Empalme	100.0	100.0	100.0
Caborca	99.7	94.0	94.1
Navojoa	99.9	98.6	97.8
San Luis Rio Colorado	95.9	93.9	94.3
Agua Prieta	100.0	100.0	100.0
Puerto Peñasco	100.0	100.0	100.0
Total Nodos	98.5	92.7	92.3

Source: Authors' calculations based on data from INEGI.

The information is provided by economic census of 2009, which is a data base at a locality and municipality level, disaggregated at sector of economic activity: Manufacture, Commerce and Services.

Identifying FEUS is done in two stages; first the nodes with the mere participation rate and economic specialization are identified. Then they characterize economic and population level to define the area of influence, considering the transportation network connecting the nodes and Relly index for identifying areas of influence of the nodes is applied[14].

To calculate the correlation table, it is considered that each pair of sites has a correlation coefficient. Cross immediately weighting table, showing the effect of the shares between sites (Normand et al. 2008) was developed.

This weight matrix is obtained; first calculate the shares by site within each economic activity, that is, the percentage involved each and every one of the activities, obtaining many entries per activity as the number of sites is calculated. Then it is generated by a score (score) by site participations obtained by adding the units per site. As a third step, a new entry per site is calculated from the scores, so that each share represents an overall weight (which includes the effect of all previous economic activities) per site (Normand, et al. 2008).

Finally cross weighting matrix, which is the result of multiplying the score or score participation site i for participation site score or score j is obtained. a weight or cross weighting is then obtained, i.e. the weight involving sites i, j. So this weight or cross-weighting ranks i, j of the new array of cross weights.

Then the correlation matrix is multiplied by the cross weights[15], this operation high interactions resulting from high real interaction sites, such as is reflected, while the high correlations, but result of two sites similarly low values reflect low and would not high as with simple correlation coefficients (Normand et al. 2008).

In the case of probabilistic index of economic interactions between sites it is determined by obtaining the statistical association between a pair of sites. It is calculated using the statistical correlation coefficient for a series of subsequently calculating weights cross type, transforming the correlation coefficient interaction indexed according to the following formulation.
S is the vector of economic sites S = (s_1, s_2, ..., s_n) with n as the number of these in a given economic region.
Now let A = (a_{kl}) matrix of economic activities with k = 1, ..., m sectors of economic activity and with l = 1, ..., n + 1, m> n for all k.
Now let R = (r_{ij}) a matrix of n x n.

---

[14] The index Reilly, which establishes the inverse relationship between scale and distance, is. $BP = \frac{Pa+Pb}{\sqrt[2]{Da+Db}}$, BP = Boundary Point, Pa= Population site, Pb = Population of site b, Da= distance to the site and the site Db= Distance b

[15] Multiplication is element by element, with the intention that each element weigh according to their weight calculated on the pair of corresponding sites. This is y_{ij}= ABS (x ij * ij) (Normand et al. 2008).

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 activity 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 estimated by OLS (OLS) coefficients. According to the definition of partial Pearson correlation you must $r_{ij} = r_{ji}$ 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 $r_{ij} = 1$ for all i.
Now let A '= (a'_{kl}) matrix' scores' scores or arising from A, containing such shares for each site in each akl s_j activity that is:

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

It is then $a'_{m+1l} = \frac{\sum_{k=1}^{m} a'_{kl}}{m}$ for all l, a'_{m+1l} Sea now $a'_{m+1l} = pond_l$ this is defined as the total weight for each site s_j.
Then have P = (p_{ij}) is an nxn matrix, called the P matrix cross weights and is defined as follows:
$P_{ij} = pond_i * pond_j$ for all i and for all j
That is, 'cross' total weights sites if and sj resulting cross weighting p_{ij}. Clearly $p_{ji} = p_{ij}$ = P is a symmetric matrix.
So there has to be economic interaction between a pair of sites i, j for all i, j given by the economic relation between the different sj.
It now has:

$$eij = rij * pij$$

That is to say:

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

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

E = (*e* * *ij*), where

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

So $e^{*}j$ [0,1], it is called index economic interaction between the two sites i, j. Here it is worth noting that E is also a symmetric matrix.