**Fragmentation, vertical specialization, manufacturing exports and economic growth in Mexico**

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**Abstract**

There is a widespread belief that exports, especially manufacturing ones, contribute to accelerate economic growth. This approach was diffused in many countries due to the high dynamism of some economies of Asia. According to this proposition, this fact was derived from the encouragement given to manufacturing exports. These ideas were disseminated in Latin America since the eighties of the last century, which led to the economic opening of the region and the promotion of exports.

In the recent decades, one country that has shown a high growth of manufacturing exports, particularly of medium and high-technology, is Mexico. However, the country’s economic growth has been unsatisfactory.

The present work attempts to explain this paradox. With this aim, the relationship between exports and economic growth is focused on the multiplier effects of exports on intermediate goods-producing sector.

The empirical evidence of this paper is the 2003 Input-Output table for Mexico, which is studied using graph theory. This allows to:

* Know the intersectorial level of integration and direct influence (direct causality).
* Identify, quantify and analyze the paths of economic influence transmitted in the productive structure (indirect causality).
* Hierarchize sectors by levels so those belonging to higher levels are in a privilege position to pull economic sectors located at lower levels (strict causality).

These aspects allow to solve the limitations of input-product analysis and to contribute better understanding of the relationship between productive articulation, exports and economic growth. One corroborates the conclusions calculating the vertical specialization, outsourcing of Mexico and comparing them with countries of the OECD and Asia.

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**Introduction**

The relationship between exports and economic growth has been the object of many investigations, theoretical and empirical respectively. The theoretical approach argues that exports contribute to accelerate economic growth. The previous statement was the basis of the proposal that countries that follow an export-led growth model will tend to grow faster than those who do not. Other investigations have argued that manufacturing exports have a greater contribution to economic growth due to the dynamism of their global demand, the behavior of their prices and their possibilities of incorporating technical progress derived from the fact of having an important manufacturing export sector.

These approaches were diffused to many countries because of the great dynamism of some Asian economies that, according to some arguments, is the result of supporting manufacturing exports. This encourage has been seen as the main raison that pulled (dragged) the economic growth. The issue has gained importance in the current context of economic crisis that has affected almost everyone. In view of the present situation, many countries are trying to find a way out through the augmentation of their exports.

These ideas were spread to Latin America during the eighties, which led to the economic opening of the region and the encouragement of the export sector. In the recent decades, Mexico has shown high export dynamism and a noticeable change in the composition of exports in favor of manufacturing ones, especially those of medium and high technology. Nevertheless, the growth of long term of the economy has been clearly insufficient. The central objective of this work is to contribute to explain this apparent paradox.

This work is focused on the leverage effect of global demand which can come from the export expansion. It seeks to overcome the mainstream approach, which supports the export-led growth instead of the demand-lead growth (e. g., Eatwell, 1998: 737-738 since the beginning of the Century, there has been a controversy over the East Asian economies, recently diffused to China, which argues that that these economies need to move forward to a demand-led growth model. (Palley, 2002, and Razmi & Blecker, 2008). Moreover, there are authors that have written about the East Asian countries like Felipe (2003: vii) “in the end, it is about achieving a golden combination between export-led growth and domestic demand-led growth” or Felipe y Lim (2005: 4) “…the best periods seem to be those when domestic and net exports exhibit significant and continuous growth or improvements…”. According to us, they do not place enough emphasis in the complementarily relationship that can exist between export growth and internal market dynamism.

The hypothesis of this paper is different. We postulate that the virtuous circle between exports and economic growth reinforces if the export sector expansion pulls (drags) the internal market expansion. Even if the economic dynamics can be characterized by the export performance, we argue that the export expansion is not necessarily an alternative to a demand-led growth model. Instead, it is postulated that the export expansion can contribute simultaneously to expand the domestic demand, which allows that economic growth can be pulled by both external and internal demand. However, this possibility depends on the characteristics of the export sector. This paper, based on the Mexican economy, seeks to respond the queries about the characteristics of the export sector of the exporting sector that determine that it is transformed into a engine for the growth.

In summary, the investigation is centered in analyzing why the strong manufacturing exporting dynamism of medium and high technology weakly drags the economic growth of Mexico. The hypothesis that will be maintained is that the two conditions for the manufacturing exporting sector drag the growth of the Mexican economy are: 1) integration/disarticulation productive of the exporting sectors with the rest of the sectors of the economy, and 2) the participation in the global productive chain where to add more value added along a global production network. This article is dedicated to the first question. The first aspect will be analyzed from two theoretical-methodologic approaches that, although they are different, are complementary for the study of the productive fragmentation: graph theory and the vertical specialization. On the one hand, from the approach of the graph theory we will analyze productive integration/ disarticulation global of the Mexican economy: integration and influences direct, quantification of the footpaths of the economic influence transmitted in all the productive structure and the sectorial hierarchy by levels. This will allow us to establish the capacity of drag by means of identification, quantification and analysis of the “linkages” in the Mexican productive structure. On the other hand, from the approach of the vertical specialization we will analyze the associate productive fragmentation to the imported component of the exports.

The application of the graph theory is justified by the contributions that represent to overcome the limitations of the methods of traditional structural analysis and on that the approach of the vertical specialization is also based. The shortcomings of the methods of structural traditional inputp-output analysis are in the following aspects: 1) that is a species of “black box” since although they capture the global effects (direct influences and indirect of joint way) do not allow to detect, to quantify and to analyze the footpaths by where the flows of purchase and sale between the sectors in all productive structure circulate, 2) cannot explain the indirect influence between the different sectors when they are by intermediary by a third sector, 3) provides only the final effect of a change in the structure and it is not possible to disturb to the impact between the initial variation and the final effect, 4) does not take into account the number of interchanges, 5) nor the position of the sectors in the productive structure 6) far from it allow to establish a sectorial hierarchy by levels.

The structure of the work is the following one: in section I it is exposed, in brief form, the literature referred to the relation between exports and economic growth from the point of view of the channel through which the exports can contribute to the expansion of the internal demand and, therefore, to the growth of the economy. In section II one appears, in synthetic form, the transformations that the exporting sector of Mexico has undergone. The third part is consecrated to analyze the degree of disarticulation of the manufacturing exporting sectors of the rest sectors by means of a structural analysis based on the graph theory, that explain the fact that the exporting dynamism has been accompanied by a dissapointing economic growth. Section IV quantifies and compares the vertical specialization of Mexico with some economies of Asia and the OECD, like a phenomenon of the international fragmentation of the production. The paper finalizes with the condensate presentation of its conclusions.

**I. Exports, internal demand and growth.**

Adam Smith said that foreign trade contributes to increase production due to exports, which also enables increasing the division of labor. According to him, this is the key to augment the wealth of nations. He argued that through foreign trade the countries: En palabras de Smith, a través del comercio exterior los países “…remit abroad the surplus produce of their land and their work, lacking in internal demand, and get to bring in exchange of that surplus items that are requested in the country. Through trade, limiting the domestic market does not prevent the division of labor in a particular branch of the arts and manufactures, is carried to its highest perfection. Opening a wider market for any portion of the work product of the work exceeding the needs of domestic consumption, encouraging him to improve and promote the productive forces, so it reaches a considerable annual product development and, therefore, wealth and the actual income of the society (Smith, 393-394).

Exports contribute to greater global demand and output in two ways: firstly, as a component of global demand and the multiplier effect that the increase in exports has on other components of aggregate demand. On the other hand, because the increase in exports requires more inputs, which, if produced domestically, increase the production of the sectors that produce and generate a multiplier effect resulting from its expansion.

The conventional way in which estimates the contribution of exports to growth from the perspective of global demand is known:

Y = C + I + X – M (1)

gy = gc(C/Y) + gI(I/Y) + gx(X/Y) -gm (M/Y),

where:

gy: GDP growth rate

gi: growth rate of i component of aggregate demand

gx(X/Y) - gm(M/Y): percentage points of output growth explained by net exports.

However, this relationship does not consider two factors: firstly, the multiplier effect of exports on the product and, on the other hand, the fact that exports are not only intended to generate imports, but some of them go to consumption and investment, which underestimates the contribution of exports and overestimates the domestic demand growth in the economy (Kranendonk and Verbruggen, 2008 and Akyüz, 2010).

Regarding the first point, Harrod (1933) developed the concept of foreign trade multiplier, which functionally relates the expansion of exports to output growth considering the effects of export growth on the other components of aggregate demand. If the only component of autonomous spending increases are for exports, GDP growth rate is equal to:

$\frac{ΔY}{Y}=\frac{1}{k}ax\frac{ΔX}{X} $ (2)

 Where:

1/k: foreign trade multiplier

k = (1 – c) + i + m

c: marginal propensity to consume

i: marginal propensity to invest

m: marginal propensity to import

Δx: weight of exports in the product

Later, Hicks (1950) introduced the concept of super-multiplier effect by adding that exports have on the product through the foreign trade multiplier the fact that export growth allows them to expand other components of autonomous demand to the extent that the increase of imports is equal to the initial increase in exports.

In the short term, the absolute increase in product through the foreign trade multiplier equals

△Y = (1/k)△X (3)

Induced increase in imports arising from the increase in output is equal to

△M = m△Y (4)

△M = (m/k)△X

Since k> m, the growth of imports will be less than exports, rising trade surplus with the outside. However, in the long run, super - Hicks multiplier can increase the level of economic activity through other components of autonomous demand to balance foreign trade:

△Y/Y = (1/k) (ax△X/X + ag△G/G), (5)

Where:

G. other autonomous expenditure

ag: participation of other independent expenditures in the product

In the line of reasoning of Harrod on the role of exports as a driving force of growth from the point of view of demand, the development of Kaldor (1981) is as follows:

Y = (1/1-k)X (6)

 Si (1-k) = m

Y = (1/m)X

The dynamic of this expression leads to the known law Thirlwall (1979), in which the effect of exports on growth is mediated by increased imports:

 △Y/Y=(△X/X)/$π$, (7)

 $π: $ income elasticity of demand for imports

Kaldor expresses this idea as follows: "From the point of view of any particular region, the 'autonomous component of demand' is the demand that comes from outside the region, and the concept of super-multiplier’Hicks can be applied to express the idea of foreign trade multiplier in a dynamic context. Thus expressed, this view argues that the economic growth rate of a region is essentially governed by the rate of export growth "(Kaldor, 1970: 318). Further extends the same principle to developing countries: "the spread of industrialization in developing countries, to be successful, involves following an 'outward looking strategy' that leads to the development of export potential and not only import substitution "(Kaldor, 1981: 341).

The second channel on the effects of exports on economic growth on the demand side is derived from the investigations that have been undertaken in recent years on the domestic value added content of exports, which have been driven by fact that the import content of exports has tended to grow in recent years in many countries (Loschky and Ritter, 2006, Breda, Cappariello and Zizza, 2007, Chen et al, 2007; Breda and Cappariello, 2008, Koopman et al ., 2008; Kranendonk and Verbruggen, 2008, He and Zhang, 2010; Akyüz, 2010).

This work belongs to this second way, that is, in investigating the potential increase in aggregate demand "backwards" that is contained in the sectors that supply inputs to export activities. This potential increase in demand stimulates domestic activities to the extent that a greater proportion of inputs for the export sector are produced domestically. If this is so, the increase in exports means more imports, so that the potential effect of the economy boost demand from leaking into the exterior.

**II. Mexico. Dynamism and change in the composition of exports with show economic growth.**

Since the eighties of the past century, Mexico has attempted to follow a manufacturing export-led growth model. We will show that indeed, they have grown at a tremendous speed, but have not managed to become the country's growth engine.

**II.1. Total Exports**

The beginning of trade liberalization process in Mexico could be dated at 1987 the same year of Mexico’s accession to GATT. Between 1992 and 2008, Mexico’s total exports had a remarkable growth, from 46.2 to 291 billion dollars in a 16-year period. During 1989-2006 exports’ average annual growth rate was 9.6 %, between 1989 and 1993, 5.8% and during 1994-2008, 14.1. This led to an increase, between 1988 and 2008, in export coefficient from 13% to 27%. (Graphic 1)

**Graphic 1. Total exports and export coefficient**

Fuente: Banco de México

**II. 2. Change in export composition**

Exporting dynamism was simultaneous to the change in the structure of exported goods. In 2008, manufacturing exports amounted to 231 billion dollars, which represented 79% of total exports (Graphic 2).

**Graphic 2. Exports by type of merchandise (2008; percentages)**

Fuente: Banco de México (2009)

**II.3. Manufacturing exports by factor intensity**

Graphic 3 shows the composition of manufacturing exports by factor intensity. The’re classified by natural resource-intensive goods and technology-intensive goods, even if they’re low, medium or high. We can apreciate that the most important industrial goods are those of medium and high technology, that, since the early nineties, have represented 60% of total industrial exports. However, this data must be carefully analysed because they’re derived from a classification of export goods by technological level and it can be that there could be country that is specialized in a simple technological production stage of a good that is of high technology. This is important to consider for countries whose main part of manufacturing exports are generated under the international production sharing scheme. As we will show, Mexico actively participate in this model.

In the same way, , Myro et al. (2008: 38 y 40), classified the manufacturing exports of the OECD member countries in three groups –advanced, intermediates and traditionals- according to the demand dynamism and the technological intensity. In 2005, 41% of Mexico’s manufacturing exports are classified in the first group, 39% are intermediate, and 25% are traditional. For Germany, the classification is 21; 55 and 23 % respectively; for Japan is 32, 55 and 13. In summary, this can show that the international insertion of Mexico via manufacturing exports is higher in technological terms and demand dynamism in contrast to those developed countries. In addition to this, Mexico’s export sophistication (Hausmann et al. 2007) and the change in the international specialization pattern messured by the adaptability index suggested that this economy should grow faster because, according to this, it has the appropiate productive specialization.

Despite the extraordinary performance of the manufacturing export sector, Mexico’s economic growth has been unsufficient. During 1996-2008, the GDP’s average annual growth rate was 3.4%.

**Graphic 3: Industrial exports by technological content(2006; percentage of total industrial exports )**

Fuente: CEPAL (2008)

**III. Exports and intermediate demand. Productive disarticulation of the exporting manufacturing sector**

Enterprises generate demand directly or indirectly through three channels: input demand, consumption goods for workers and demand for capital goods. This demand can be satisfied by local enterprises or by imports. The demand intensity for local inputs of the exporting enterprises depends on the magnitude and the proportion that is satisfied by domestic production. Consumption goods demand depends on the wage level, the division between domestic and imported goods and the number of workers in the export sector. The demand for local capital goods is a function of the amount of investment of the exporting enterprises and the national component of capital goods. We will focus on the first component of the demand.

This paper is part of a focused research program to analyze the productive articulation, manufacturing exports and economic growth, in which the thesis is maintained of which the two conditions for the growth of the Mexican economy are: 1) integration of the exporting sectors with the rest of the sectors of the economy, 2) participation in the global productive chain where to add more value added along a global production network. This paper is dedicated to the first question.

In the paper a theoretical and methodologic approach is developed that emphasizes two fundamental questions: from the theoretical point of view the importance of the productive structure since all the sectors do not have the same capacity of drag on the rest the economy derived from their links and from the methodologic point of view from the graph theory realises three important contributions, that traditional consumption-product allows to surpass the limitations of the methods of structural analysis and to further on go in literature on the relation between the productive articulation and economic growth, besides tying to the dynamism of the external markets.

First of all, the relations of direct causality allow us to analyze the integration degree and influences direct when sector i sells to him directly (it buys) to j, which is important since we will know the degree of influence and dependency of a sector with the rest of the sectors of the economy, with a greater analytical and interpretative wealth by the greater grant of indicators than the indicators “black box” of the traditional structural analysis. Secondly, the relations of indirect causality allow to detect the footpaths us by where the economic influence in the Mexican productive structure is transmitted, as well as they quantify the economic importance by means of the valuation of his arcs. One of the implicancias of the applications of the graph theory is the research of the influence transmitted throughout a way anyone of the graph that by means of an arborescent decomposition, allows a quantitative, detailed vision, and graph of the footpaths of the influence inside the productive structure. Thirdly, the relations of strict causality will allow us to establish the sectorial hierarchy by levels and to quantify the magnitude of the influence transmitted by the footpaths in the productive structure. The sectorial hierarchial structuring by levels consists of the arrangement of the productive sectors in such a way that the sectors pertaining to levels superiors are in a privileged position to drag to the sectors of the economy located in levels inferiors to those. The importance of this type of analysis is in the identification, pursuit and quantification the economic influence transmitted in the productive structure from the sectors source (or emitters of influence) to the sectors well, by means of the relations of influence (direct and indirect) and of dominance.

The methodology of the graph theory applied in the investigation presents important contributions and advances in the study and literature of the relation between the economic development and the Mexican productive structure because it allows us to capture the following aspects simultaneously: 1) The number (density) of relations, 2) the direction of the economic influence in the productive structure, 3) the relevance or importance of the influence transmitted in the productive structure, 4) the “extension” of the footpaths of the economic influence, 5) the quantity of the transmitted economic influence in the all the productive structure, 6) the importance of the relative and hierarchic positions of the sectors in the productive framework determines its capacity to influence or to dominate. These aspects are fundamental in the determination, explanation and quantification of the capacity of drag the exporting sectors of the economic growth.

As it is well known, there are two ways to realize the input-output analysis. We`ve chosen the distribution matrix as the basis of our analysis and not only the technical coefficients. We understand that a possible way to study the sectorial interdependence is by using the relative influence graph, based on the distribution matrix, and not the absolute influence graph, which is based on the technical coefficients matrix. The relative influence graph weighted the intensity of the relationship between two sectors because of the relationship that exists between their productions. In the other hand, the absolute influence graph only takes into account the relationship between two sectors without any weight.

We make the empirical application by using the 2003 Input-Output (IO) table for Mexico aggregated to 40 sectors both total and domestic. The fundamental criterion of aggregation is to the separate the sectors under study and to lose as little information as possible. The 2003 Input-Output table for Mexico (MIPMX03) was made by Instituto Nacional de Estadística, Geografía e Informática (INEGI) and published in April 29, 2008.

It is possible to indicate that the MIP of 2003 incorporates two important methodologic innovations in their construction with respect to the previous ones. The first place, is the adoption of the System of Industrial Classification of North America replacing the System of National Accounts of Mexico based on the Industrial Classification the Unique International (INEGI, 2002). The second place, consists of the double meaning adopted between total economy (if it includes the maquilas) and internal economy (that exclude the maquilas), and total matrix, when it includes imports and domestic matrix when it does not include them. The main criterion of aggregation of the NAICS is the similarity of the production function. In this work the total and domestic matrix of the total economy with the aim of analyzing the impact of the imports is used on the Mexican productive structure, i.e. to show the strong degree of productive disarticulation of the manufacturing exporting sectors as a result of the component elevated of imports.

The enormous multitude of relations that exist between sectors practically makes an operative analysis nonviable of all of them. In this sense, one has classified the distribution coefficients by the intensity of his relations, having calculated four matrices associated to the graph (Boolean matrix, transitive closure, matrix of distances, etc.)[[1]](#footnote-2) corresponding each one of the same with the different levels from intensity of the relations, and their corresponding associate graphs (G, G1, G5, G10):

a) To and G: matrix of incidence and graph that pick up all the relations.

b) A1 and G1: matrix of incidence and graph that represent all the relations, except weakest. That is to say, those distribution coefficients will be taken superiors to 1%.

c) A5 and G5: matrix of incidence and graph that represent the average and strong relations. They will be taken, the coefficients superiors to 5%.

d) A10 and G10: matrix of incidence and graph that represent only the strong relations, taking the coefficients superiors to 10%.

For reasons of space, one only reports the results corresponding to the G graph and G10 emphasizing the strong degree of disarticulation reflected had not only to the increase of the filter (having left we with the most important relations[[2]](#footnote-3)) but to the fort contrasts between the total and domestic IO table, derived from the imports.

**III.1. The direct relations between the productive sectors of the Mexican economy: study of integration and direct interdependence**

The study of direct causality determines if a direct relation between two sectors i, j exists and if this relation is or non-symmetrical. That is to say, if i buys to him directly (or it sells to him) to j. These direct relations are collections in the boolean matrix of (A), and their elements aij are of the form:

• If a sector i sells to him directly to another j, the element aij of the matrix of incidences will be 1.

• If such direct relation did not exist, aij will be zero.

The matrix of incidence allows to determine the integration of the sectors by the “sales” and “purchases”, and the dependency or influences direct that each sector exerts on the rest of the economy.

These relations can be determined calculating the semidegrees of the sectors of the graph. The exterior semidegree of sector i d+ (xi) expresses the number of sectors to which i sells[[3]](#footnote-4) directly, giving a measurement of integration through the sales and is the result of the sum by rows of the elements of the matrix of incidence for each sector.

  (7) On the other hand, the inner semidegree of sector i d (XI) indicates the number of sectors to which i purchase of direct form, representing a measurement of integration by the purchases and is the result of the sum by columns of the elements of the matrix of incidences for each sector.

  (8)

Defined therefore the semidegrees, it interests to make the following interpretation of the same. Whichever major is the outer semidegree of sector i, to greater number of sectors him “sells” this sector. On the contrary, whichever major is the inner semidegree, to more sectors “buys to him”. It interests, therefore, to determine to us which are the sectors that present/display majors semidegrees, essentially the outer semidegree (interior), to realise one first approach to the most influential sectors (dependents).

From the semidegrees the integration index can be obtained (sum of both semidegrees) and an index of influence, defined as the quotient between the outer and inner semidegree of the productive branch, that indicates the relative capacity to influence to the others (high values) or to be influenced by the rest (low values of the index). Whichever major is east index, majors are the sales that the sector at issue in relation to the purchases realizes and, therefore, major is the influence.

Using as reference el average (μ) of relations of purchase and sale can be established the classification of the sectors according to its degree of integration. One says that a sector poorly integrated when the outer and inner semidegree is minors who their respective average, however very will be integrated when the outer and inner semidegree is majors that the average. A sector very will be integrated mainly by sales if its outer semidegree is major that the average and its inner semidegree smaller than the average. In the opposite case one will say that the sector will be integrated by purchases (Table 1).

**Table 1**

**Criteria for the classification of sectors according to their degree of integration**

|  |  |
| --- | --- |
| **Clasification** | **Conditions** |
|   |   |
| Poorly integrated | If d+(xi) <  and d-xi) <   |
| Integrated mainly by sales  | If d+(xi) >  and d-(xi) <   |
| Integrated mainly by purchases  | If d+(xi) <  and d-(xi) >   |
| Highly integrated | If d+(xi) >  and d-(xi) >   |

The normalization of the semidegrees allows to compare the centrality of economies of different sizes. In addition, given the interpretation of the outer semidegrees as indices of direct influence and the interiors like indicators of direct dependency, it is possible to introduce a vector of net direct influence (σ), quotient between the outer and inner semidegree, whose elements correspond to the expression (Huriot, 1974). Its normalization through number of sectors offers an expression limited between zero and one, like as it takes higher values will be appraised a greater net direct influence and, vice versa, when it comes near to zero.

The sum of the outer and inner semidegrees of all the sectors of the economy is of 1382, that represents the total number of sales relationships if you look at the rows and the total number of purchase if you look at the columns.. In the Nro picture. 2 appear the outer and inner semidegrees and the index of net influence for each one of the 40 aggregated sectors of the total IO table of Mexico. As to be observed in the table 2 the sectors that greater number of purchases and sales they establish with the rest are Manufacture of machinery and equipment (13) and Manufacture of electrical and electronic machinery (14) and Other manufacturing industries (17) with 76, 75 and 75, respectively, that is to say, are integrated. The other sectors with equal number of direct relations are: Electricity, gas and water (3), Construction (4), Printing and related industries (9), chemical Industry (10), Manufacture of furniture (16), Freight truck transportation (22).

On the other hand, the sectors that establish the smaller number of relations within the productive structure are the sector Sightseeing transportation (25) and Health care and social assistance services (36). Considering the indicated thing and that the level average of relations of purchase and sale is of 34.55 it presents the classification of the sectors according to his degree of integration of the Mexican economy in the table 2.

There is no sector that maintains relations direct of purchases yet (direct dependency) with the productive system, whereas if there is several sectors with direct relations of sales (it influences direct) with all the other sectors.

Of the index of net (σi) it is deduced the sectors Wholesale trade and Retail trade (18), Rail transportation (20), Transport by water (21), Pipeline transportation (24) and Warehousing services (28) that within its levels of integration, they own one better relation between possibilities of influencing and of being influenced. On the contrary, the sector Agriculture, Forestry, Fishing and Hunting (1) along with of Activities of the government and other international and extra-territorial organizations (40) owns a proportion of relations of sale-buys inferiors to the others very; that is to say, they are sectors very oriented to the purchases and with an index of net influence, by, consequently very low.

The sectors of the export industry that process much imported input (Manufacture of machinery and equipment (13), Manufacture of electrical and electronic machinery (14), Manufacture of transport equipment (15), Manufacture of furniture (16) and Other manufacturing industries (17)), in principle, they appear integrated very but when they are applied the different filters happen to be poorly integrated and even isolated as it is seen more ahead.

It agrees to emphasize that this type of studies, when considering equals all the existing relations independent of its numerical value, can lead, and in fact, thus happens, to erroneous conclusions. Already long time ago that Jilek (1971), among others, showed like an excessive countable fervor, filling up the squares of the table with numbers of irrelevant transactions in the set of the economy, it could enormously affect not only the qualitative studies, but, also, to the quantitative ones. In addition, it agrees to remember, from time to time, that one of the primary targets, if not first, in the analysis of a table of inter-sectoral relations is the one to describe the economic structure of a certain space geographic, differentiating the fundamental thing from the accessory or simply anecdotal (Morillas, 2004). Therefore be addressed in the analysis will focus on the contrast between the graph G and G10, from weak ties directly to the most relevant.

The elevation of the filters has shedded new lights and allowed an interesting analysis. The table 3 deepens the investigation, having itself reduced to only 27 when it is strong relations (superiors to 10%). You can see how the study of the relations means and strong lead to the formation of a large number of isolated sectors (d + (i) = d-(i) = 0), totaling 15 sectors, thereby uncovering the real skeleton of the Mexican production structure (Table 3).

They appear strongly as sectors highly integrated the Mining (2), Manufacture of electrical and electronic machinery (14), Financial and insurance services (30) and Professional services (33). These three last sectors stay like highly integrated from the graph G1 to the G10. But in relation to the sector Manufacture of electrical and electronic machinery, it has to have some repairs as it is indicated later when the domestic IO table is analyzed.

**Table 2** 

The sectors that remain as integrated by sales between the G5 and G10 are the Industry of the wood (7), connected Industry of the paper (8), Printing and related industries (9), metallic Industry (12), Machinery and equipment manufacturing (13), Postal services and Courier and messenger services (27), Warehousing services (28) and Rental services of tangible goods and nontangibles (32). The sells sectors of the Table 3 of the graph G10 are all vertices source (d+(i)>0 and d-(i) =0) and the buyers are vertices well (pozo: d+(i)=0 and d-(i) >0), whereas a transmitters sector when ((d+(i)= d-(i) =1), the one of the Mining and three sectors that act more like receivers than emitting of influence: Manufacture of electrical and electronic machinery (14), Financial and insurance services (30) and Professional Services (33).

Next an analysis on the basis of the domestic IO table will be realized, with the aim of showing the impact of the imports in the productive structure. Since there are no important changes between graph G the total and domestic and total IO tables G, obvious this.

The elevation of the filters has shed new light and allowed an interesting analysis. In the Table no. 4 was found to be reduced to only 19 strong relations formed a large number of isolated sectors (d+(i)=d-(i)=0), being 20 sectors, thereby uncovering the real skeleton Mexican production structure, ie. half of the sectors is disarticulated.

They appear strongly as sectors highly integrated the Mining (2), Financial and insurance services (30) and Professional services (33). Both last sectors stay like very integrated from the graph G1 to the G10. As the sector can be observed, when domestic servant works with the MIP, Manufacture of electrical machinery and electronic (14) it is not a sector highly integrated like were it in the total IO table, in fact, as we said is isolated like the other sectors of the export industry that processes much concerned input: Manufacture of machinery and equipment (13), Manufacture of transport equipment (15), Manufacture of furniture (16) and Other manufacturing industries (17) (Table 4). In the total IO table, between these sectors, only the one of Other manufacturing industries (17) appeared as isolated (Table 3).

**Table 3**

**Table 4**

The sells sectors of the table 4 of the graph G10 are all the vertices source (d+(i)>0 and d-(i) =0) and the buyers is vertices well (d+(i)=0 y d-(i) >0), whereas a transmitters sector exists ((d+(i)= d (i) =1), the one of the Mining (2) and two sectors that act more like receivers than emitting of influence: Financial and insurance services (30) and Professional services (33).

A brief comparative observation between the total and domestic IO table of G10, allows to emphasize three questions. First of all, that as much in the total and domestic IO tables the sectors Agriculture, Forestry, Fishing and Hunting (1), Industry of the wood (7), connected Paper industry (8), Printing and related industries (9), Nonmetallic mineral products manufacturing (11), Metal products manufacturing (12), Postal services and Courier and messenger services (27), Warehousing services (28), Rental services of tangible goods and nontangibles (32) and Waste management and remediation services (34), appear as integrated mainly by sales. Secondly, that as much in the total and domestic IO tables, the sectors Construction (4), Food industry, beverages and tobacco industries (5), chemical Industry (10), Wholesale trade and Retail trade (18), Real estate services (31), Health care and social assistance services (36) and Activities of the government and other international and extra-territorial organizations (40) appear as integrated mainly by purchases in the graph G10. Thirdly, the sectors Textile industry (6), Machinery and equipment manufacturing (13), Manufacture of electrical and electronic machinery (14), Transportation equipment manufacturing (15) and Manufacture of furniture (16) that appeared like integrated (or by sales, purchases or highly integrated) in the total IO table are indeed in the domestic IO table are isolated.

Also, it is possible to emphasize that these sectors of the export industry that process much imported input that appeared as highly integrated when eliminating itself the very weak relations happen to be integrated poorly or to be isolated, showing the strong degree of disarticulation which they are bringing about the imports of these sectors in the productive structure of Mexico.

**III.2. The indirect relations between the productive sectors of the Mexican economy: study of the footpaths of economic influence and the quantification of its importance**

The fact to take into account only the direct relations between the sectors and to determine most excellent with the implantation of different thresholds from meaning of the distribution coefficients could give an incomplete vision of the productive structure of an economy. The contribution of the graph theory by means of the matrix of ways and distances to the structural analysis of the model input-output, also allows the possibility of studying the causality relations - hint between the different sectors influences and to define the itineraries of propagation of this economic influence. [[4]](#footnote-5)

The indirect relations are analyzed by means of the matrix of ways and distances. A way between two poles is a succession of arcs and the distance between two vertices is the length of the way shorter it unites than them. Then, the matrices of ways and distances associated to the influence graph allow to detect the footpaths by where the influence is transmitted, at the same time as they quantify his economic importance by means of the valuation of his arcs.

The matrix of ways, where appropriate, gives information about the existence of, at least, a way between two vertices any. If this way exists between the vertices xi and xj, it will say that xj is accessible to xi. Of there, the use in British terminology of the first term of accessibility to define this matrix.

If we defined the set of all the descending vertices of xi, that is to say, what its transitive closure is called, and we denominated to him, we would have that . The matrix of ways, R (D), is a matrix of elements rij such that,

rij=1, yes and only yes, xj *xj*∈ (9)

rij=0, yes and only yes, xj *xj*∉ (10)

One assumes that each vertex is its own descendant, reason why the elements of the main diagonal are all equals to 1 (rii=1, for all value of i).

The matrix of distances is fundamental to study the properties of the structure of the relations in a graph. By means of the same we will obtain data about the distance that separates two vertices any. One is a squared matrix of order n (vertices of the graph), whose elements, eij, represents the distances (number of arcs) between the vertices xi and xj. The properties of this matrix, that we will call E(D), are the following:

1. Whatever xi, eii=e (xi , xj) =0. That is to say, the elements of the main diagonal of matrix E (D) are all null ones.

2. If rij=0, eij= ∞.Therefore, if does not exist walk (xi ,…., xj), the distance between those two vertices is considered like infinite.

3. The element eij is, indeed, the minimum power n to which the incidence matrix must rise, A(D), so that ; said of another form, the use of boolean algebra (existence or absence of a relation), so that the element (i, j) of the nth power of the incidence matrix is equal to 1.

Like can be observed in the matrix of walks associated graph G (Table 5) in the Mexican productive structure almost all the sectors are related to each other. Therefore, anyone of them is able to influence in all the other sectors, that is to say, that directly or indirectly, need goods and/or services of each one of the economic sectors to develop their productive process. In other words, the Mexican productive structure is, in principle, almost totally interdependent. As well, in the majority of the relations the ways have like principle of length 2 (Table 6). It means that the influence of a sector on another one can be transmitted almost always of direct form or through a single sector that serves as intermediary. In this sense the interdependence, from a qualitative point of view, seems evident and strong.

It is possible to indicate, that although we must like objective locate the footpaths by where the economic influence journeys, the enumeration of each and every one of the ways of graph G and the quantification of the influence that they transmit would be a tremendously laborious task not only by the dimensions of the matrices but not even the possibility exists of establishing an algorithm to determine the exact number of elementary walks or circuits. What it forces to select some to us of the walks.

As one affirms on the matter in literature the problem is to establish a criterion that helps us to choose those ways that later we will analyze with more detail. It would not have sense to select those that transmit major influences for two reasons: 1) Because this cannot be known a priori and it would force to construct all the existing ways, 2) since all the coefficients are smaller than the unit, at the most long it is a way, minor will be the influence that it transmits. And if we were based on this criterion, we would undo of the ways of greater length, than it is in opposition to our aims that are not other that those to make more emphasis in the footpath followed by the influence. Therefore, like general norm, we will study those walks that arrive at the remotest vertex of the graph, that is to say, those whose distance is the principle.

Once established the criterion of selection of the ways to investigate the question of the quantification of influence considers. The calculation of transported direct influences exists the possibility only of having a approximate but sufficient knowledge of the influence using[[5]](#footnote-6).

**Table 5**

**Matrix of walks associated to the graph G**

**(Total IO table)**



**Table 6**

**Matrix of distances associated to the graph G**

**(Total IO table)**



It is also possible to determine the total influence transmitted along a path λ by taking into account the effects generated by the presence of circuits between the vertices that constitute it.

Calling g to the circuit gain, ie, the influence transmitted along the same, the relationship between direct influence and the total influence transmitted along the path λ is given by

 iT,λi→m = (1/1 - g) iD, λi→m  (11)

Therefore only quantify the direct influence transmitted along the walk is not committing a significant error because the graphs G and G1 gain circuit potential will be small when dealing with relations distribution coefficients measured by mostly very low and therefore the ratio (1 / 1 - g) would be worth approximately unity. The successive establishment of thresholds will allow to be selecting the longest walks us and with greater influence between the sectors of the economy.

The framework and the interdependent structure of the Mexican productive structure can be observed in Graph G, standing out that almost all the sectors are related to the rest of the sectors of the economy (Figure 1).

**Figure. 1: Interdependence in the total IO table of graph G**



The table 7 show the matrix of walks associated to the graph G10. It is evident that when considering itself the stronger relations of influence the productive structure has only been reduced to the nucleus of sectors and relations more important (Figure. 3). These relations or are direct, or at the most, need an intermediary sector to take place, as can be observed in the matrix of distances (Table 8). Also, as it can be observed in the matrix of ways and distances, aside from the 27 present direct relations in the graph G10 appear 9 ways of length 2, of which 6 finish in the sector Wholesale trade and Retail trade (18) beginning in the sectors connected Paper industry (8), Printing and related industries (9), Metal products manufacturing (12), Machinery and equipment manufacturing (13), Postal services and Courier and messenger services (27) and Warehousing services (28), 2 finish in the sector Manufacture of transport equipment (15) beginning in the sector Industry of the paper (8) and Manufacture of machinery and equipment (13) and 1 in the Chemical industry (10) that begins in the sector Rental services of tangible goods and nontangibles (32) in the total IO table.

The different itineraries from the transmission of the influence, the intermediary sectors of which finish in the sector Wholesale trade and Retail trade (18), Transportation equipment manufacturing (15) and Chemical industry (10) and their quantifications are the following:

 1: 8 -> 14 -> 18 iDλ1 = 1.20 × 10-2

 2: 8 -> 33 -> 18 iDλ2 = 1.96 × 10-2

 1: 9 -> 33 -> 18 iDλ1 = 2.94 × 10-2

 1: 12 -> 14 -> 18 iDλ1 = 2.27 × 10-2

 1: 13 -> 14 -> 18 iDλ1 = 1.38 × 10-2

 1: 27 -> 30 -> 18 iDλ1 = 2.30 × 10-2

 1: 28 -> 30 -> 18 iDλ1 = 2.51 × 10-2

 1: 8 -> 14 -> 15 iDλ1 = 1.70 × 10-2

 1: 13 -> 14 -> 15 iDλ1 = 1.96 × 10-2

 1: 32 -> 2 -> 10 iDλ1 = 6.08 × 10-2

**Table 7**

**Matrix of walks associated to the graph G10**

**(Total IO table)**



**Table 8**

**Matrix of distances associated to the graph G10**

**(Total IO table)**



Of all the previous ways the one that transmits major it influences economic is the that is to say, -×way λ1 = {32, 2, 10} that is 6.08 × 10-2, Services of rent > Mining - > Chemical industry. This way is between longest and is the one of greater economic influence due to the strong degree of entailment between the mining and the chemical industry, that at first sight, would draw attention but it is necessary to take into account that inside the sector mining is extraction of petroleum and gas and gas and oil well perforation.

Whereas in the domestic IO table, aside from the 19 present direct relations in the G10 graph they appear 5 walks of length 2, of which 4 finish in the sector Wholesale trade and Retail trade (18) beginning the sector connected Industry of the paper (8), Printing and related industries (9), Postal services and Courier and messenger services (27), and Warehousing services (28) and 1 in the Chemical industry (10) that begins in the sector Rental services of tangible goods and nontangibles (32) (Figure 9 and 10). It is possible to emphasize that unlike the total IO table, now in the domestic IO table disappear the indirect relations of the sector metallic Industry (12) and Manufacture of electrical and electronic machinery (14), giving account of the disarticulador character that they have from their high import component.

The different itineraries from the transmission of the influence and the intermediary sectors of which they finish in the sector Wholesale trade and Retail trade (18) are the following:

 1: 8 -> 33 -> 18 λ1 = 1.56 × 10-2

 1: 9 -> 33 -> 18 λ1 = 2.64 × 10-2

 1: 27 -> 30 -> 18 λ1 = 2.21 × 10-2

 1: 28 -> 30 -> 18 λ1 = 2.41 × 10-2

 1: 32 -> 2 -> 10 λ1 = 6.07 × 10-2

Of the previous walks the one that transmits major it influences economic is the walk λ1 = {32, 2, 10}, that is 6,07 × 10-2, i.e. Rental services of tangible goods and nontangibles - > Mining - > Chemical industry.

**Table 9**

**Matrix of walks associated to the graph G10**

**(Domestic IO table)**



**Table 10**

**Matrix of distances associated to the graph G10**

**(Domestic IO table)** 

Another aspect that to emphasize is the fact that in the domestic IO table MIP unlike the total IO table MIP, disappears the three more dynamic manufacturing exporting sectors of the Mexican economy: Machinery and equipment manufacturing (13), Manufacture of electrical and electronic machinery (14) and Transportation equipment manufacturing (15), that is very integrated among them but totally disconnected of the productive structure intern and by consequently, without no capacity of drag the economic growth.

The strong degree of disarticulation of the Mexican productive structure can be observed in the Graph G10, that contrast the degree of interdependence of the Graph G (Figure 2).

**Figure 2. Productive disarticulation in the domestic IO table of the G10 graph**

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**III.3. Sectorial hierarchy by levels: study of the strict causality in the Mexican economy**

The third type of relation of graphs is the strict relations that by means of the sectorial hierarchial structuring by levels, allow us to identify, to follow and to quantify the economic influence transmitted in the productive structure from the sectors sources (or emitters of influence) to the sectors well through the relations of influence (direct and indirect) and of dominance, in such a way that the sectors pertaining to levels superiors are in a privileged position to drag[[6]](#footnote-7) to the sectors of the economy located in levels inferiors to those.

In this case, the sectorial hierarchial structuring by levels[[7]](#footnote-8) between the sectors is the following one:

Level 1: Agriculture, Forestry, Fishing and Hunting (1).

 Textile industry (6).

 Wood industry (7).

 Paper industry (8).

 Nonmetallic mineral products manufacturing (11).

 Metal products manufacturing (12).

 Other manufacturing industries (17).

 Rail transportation (20).

 Water transportation (21).

 Pipeline transportation (24).

 Services related to transportation (26).

 Postal services and Courier and messenger (27).

 Warehousing services (28).

 Rental services of tangible goods and nontangibles (32).

 Waste management and remediation services (34).

Level 2: Printing and related industries (9).

 Machinery and equipment manufacturing (13).

 Manufacture of furniture (16).

 Air transportation (19).

 Health care and social assistance services (36).

 Activities of the government and other international and extra-territorial organizations (40).

Level 3: CFC (29 33).

 Real estate services (31).

 Other services, except government activities (39).

Level 4: Financial and insurance services (30).

Level 5: Mining (2).

 Freight truck transportation (22).

Level 6: Chemical industry (10).

Level 7: Electric power, natural gas and water (3).

 Construction (4).

 Manufacture of electrical and electronic (14).

 Passenger transportation by road, except by rail (23).

Level 8: Transportation equipment manufacturing (15).

 Wholesale trade and Retail trade (18).

Level 9: Food industry, beverages and tobacco industries (5).

Once found the causal structure and this one to the practically triangular being, it allows glimpsing by where the influence is transmitted from the sectors of the first level to those of the last level. These mechanisms of transmission can be contemplated in the figure 3 of the partial graph reduced G5r and for that reason we can emphasize some aspects.

Although they have been reduced considerably the number of relations, certain sectors exist that act mainly like salesmen and who, therefore, form a subgraph within the own reduced graph.

The most important characteristics of this graph are the following:

**a)** Formed by the relations of influence of the sector the Industry of the paper (8) on the strongly connected component (29-33), the sectors Impression and connected industries (9), Activities of the government and other international and extra-territorial organisms (40), chemical Industry (10), Manufacture of electrical and electronic machinery (14), Commerce (18) and Industry of feeding, drink and tobacco (5).

**b)** The subgraph that it has as root or emitting pole of influence to the sector metallic Industry (12). This sector exerts direct influence on the sectors Manufacture of machinery and equipment (13), Manufacture of electrical and electronic machinery (14), Manufacture of transport equipment (15) and Construction (4). Also, indirectly through the sectors Manufacture of machinery and equipment (13), Manufacture of electrical and electronic machinery (14), impels to the sector Manufacture of transport equipment (15).

**c)** Formed by the relations of influence of the sector the Services of rent (32) on the sectors chemical Industry (10), Mining (2), Construction (4), Wholesale trade and Retail trade (18), Food industry, beverages and tobacco industries (5) and the block formed by the sectors Massive means Information (29) and Professional Services (33).

**d)** The subgraph that has like sector polarizer, receiver and transmitter of influence, the strongly connected component that we finished mentioning. In the last hierarchy level, like vertex well of the graph and basic sector of the economy, appears the sector the Food industry, beverages and tobacco industries (5). The sectors with greater capacity of drag economic growth are the sectors Food industry, beverages and tobacco industries (5), Wholesale trade and Retail trade (18) and Construction (4), in that order.

**Figura Nro. 3**

**Sectorial hierarchy by levels in the reduced graph G5r**

**(Total IO table)**

The study of the matrix of connectivity of the G10 of the strong relations sample that does not exist any connected component strongly. The connectivity of the structure, has been seen strongly decreased until the point of which 15 sectors are isolate and we are in the presence of a triangular economy.

The investigation of the sectors that make up the different levels of influence gives us the following hierarchy of sectors:

Level 1: Agriculture, Forestry, Fishing and Hunting (1).

 Textile industry (6).

 Wood industry (7).

 Paper industry (8).

 Printing and related industries (9).

 Nonmetallic mineral products manufacturing (11).

Metal products manufacturing (12).

Machinery and equipment manufacturing (13).

Postal services and Courier and messenger (27).

Warehousing services (28).

Rental services of tangible goods and nontangibles (32).

Waste management and remediation services (34).

Nivel 2: Mining (2).

 Construction (4).

 Food industry, beverages and tobacco industries (5).

 Manufacture of electrical and electronic (14).

 Manufacture of furniture (16).

Financial and insurance services (30).

Real estate services (31).

Professional services (33).

 Health care and social assistance services (36).

Activities of the government and other international and extra-territorial organizations (40).

Nivel 3: Chemical industry (10).

 Transportation equipment manufacturing (15).

 Wholesale trade and Retail trade (18).

The associated hierarchic graph is the one that appears in the figure 4. The most important characteristics of this graph are the following:

**a)** Formed by the relations of influence of the sector the Industry of the wood (7) on the sectors Construction (4), Manufacture of furniture (16) and Wholesale trade and Retail trade (18).

**b)** Formed by the relations of influence of the sector the Industry of the paper (8) on the sectors Manufacture of electrical and electronic machinery (14), professional Industry of feeding, drink and tobacco (5) and Services (33).

**c)** Formed by the relations of influence of the sector the metallic Industry (12) on the sectors Construction (4), Manufacture of electrical and electronic machinery (14) and Manufacture of transport equipment (15).

**d)** Formed by the relations of influence of the sector the Services of rent (32) on the sectors Mining (2) and Construction (4).

In the last hierarchy level, like vertices well of the graph and basic sectors of the economy, appears the sectors chemical Industry (10), Manufacture of transport equipment (15) and Wholesale trade and Retail trade (18).

As we said, the associate hierarchic graph is the one that appears in the Figure. 7. In this occasion it has been possible to mark for each arc the value of the relative influence that is transferred between the sectors at issue. The relations of relative influence more forts in the Mexican economy are those of the sector mineral product Manufacture nonmetalists (11) with Construction (4); Agriculture, forest Advantage, Cattle ranch and Fishing (1) with Food industry, beverages and tobacco industries (5), and Mining (2) with Chemical industry (10). In the first case, an increase of 1% of the production of the sector mineral product Manufacture metalists does not bring about an increase of the 52.3% in the one of the sector construction. In the second case, the sector Agriculture, Forestry, Fishing and Hunting it induces an increase of the 51.5% in the one of Food industry, beverages and tobacco industries. Finally, in the third case, the sector Mining impels in 46.4% to the one of the Chemical industry.

Also, it is possible to emphasize that it enters the most extensive ways and of greater transmission of relative influence in the G10 graph they are between the sectors: Services of rent - > Mining - > Chemical industry, connected Impression and industries - > Professional services - > Wholesale trade and Retail trade, transmitting 6.08% and 2.94%, respectively.

The sectors with greater capacity of drag the economic growth are the sectors Wholesale trade and Retail trade (18) and Construction (4), in that order.

**Figure 4**

**Sectorial hierarchy by levels in the reduced graph G10r**

**(Total IO table)**

Next, we will analyze the MIP home and establish a comparative analysis with the total MIP. Like in the total IO table the elimination of the weak and very weak coefficients ends circularities in the productive structure, with the exception of the interchanges between the sector Information in massive means (29) and Professional services (33), showing the weakness of the inter-sectoral relations in charge to articulate the interdependence in the Mexican productive structure.

The investigation of the sectors that make up the different levels of influence gives us the following hierarchy of sectors:

Level 1: Agriculture, Forestry, Fishing and Hunting (1).

 Wood industry (7).

 Paper industry (8).

 Printing and related industries (9).

 Nonmetallic mineral products manufacturing (11).

 Metal products manufacturing (12).

 Rail transportation (20).

 Water transportation (21).

 Freight truck transportation (22).

 Pipeline transportation (24).

 Services related to transportation (26).

 Postal services and Courier and messenger (27).

Warehousing services (28).

Rental services of tangible goods and nontangibles (32).

Waste management and remediation services (34).

Level 2: Construction (4).

 Transportation equipment manufacturing (15).

 Manufacture of furniture (16).

Air transportation (19).

Real estate services (31)

 CFC (29 33).

Health care and social assistance services (36).

Activities of the government and other international and extra-territorial organizations (40).

Level 3: Manufacture of electrical and electronic (14).

 Financial and insurance services (30).

Level 4: Mining (2).

Level 5: Chemical industry (10).

 Passenger transportation by road, except by rail (23).

Level 6 Electric power, natural gas and water (3).

Level 7: Wholesale trade and Retail trade (18).

Level 8: Food industry, beverages and tobacco industries (5).

The associated hierarchic graph to G5 is the figure 5. The most important characteristics of this graph are the following:

**a)** The subgraph formed by the relations of influence of the sector Industry of the paper (8) on the strongly connected component (29-33), the sectors Chemical industry (10), Wholesale trade and Retail trade (18) and Food industry, beverages and tobacco industries (5).

**b)** The subgraph that it has as root or emitting pole of influence to the sector metallic Industry (12) has reduced its impact to half. This sector now only exerts direct influence on the sectors Manufacture of electrical and electronic machinery (14) and Manufacture of equipment of transport (15) and Construction (4)

**c)** Formed by the relations of influence of the sector the Services of rent (32) on the sectors Chemical industry (10), Construction (4), Mining (2), Wholesale trade and Retail trade (18), Food industry, beverages and tobacco industries (5) and the block formed by the sectors Massive means Information (29) and Professional services (33).

**d)** The subgraph that has like sector polarizer, receiver and transmitter of influence, the strongly connected component that we finished mentioning.

**Figure 5**

**Sectorial hierarchy by levels in the reduced graph G5r**

**(Domestic IO table)**

In the last hierarchy level, like vertex well (pozo) of the graph and basic sector of the economy, appears the sector Food industry, beverages and tobacco industries (5). The sectors with greater capacity of drag economic growth are the sectors Food industry, beverages and tobacco industries (5), Wholesale trade and Retail trade (18) and Construction (4), in that order.

The number of relations is reduced from 73 to 53 of the total IO table to the domestic one. The relations that have disappeared correspond to the sectors of the Industry of export of elevated imported component as Machinery and equipment manufacturing (13), Manufacture of electrical and electronic machinery (14), Transportation equipment manufacturing (15) and Other manufacturing industries (17). The study of the G10 graph of the strong relations in the domestic IO table sample that does not exist any connected component strongly. Connectivity of productive structure, has seen strongly decreased until point of which 20 sectors are isolate (50% of the Mexican structure productive according to 40 to the sectors in which they have been added) and we are in the presence of a triangular economy.

The investigation of the sectors that make up the different levels of influence gives us the following hierarchy of sectors:

Level 1: Agriculture, Forestry, Fishing and Hunting (1).

 Wood industry (7).

 Paper industry (8).

 Printing and related industries (9).

 Nonmetallic mineral products manufacturing (11).

 Metal products manufacturing (12).

 Postal services and Courier and messenger services (27).

 Warehousing services (28).

 Rental services of tangible goods and nontangibles (32).

 Waste management and remediation services (34).

Level 2: Mining (2).

 Construction (4).

 Food industry, beverages and tobacco industries (5).

 Financial and insurance services (30).

 Real estate services (31).

 Professional services (33).

 Health care and social assistance services (36).

 Activities of the government and other international and extra-territorial organizations (40).

Level 3 Chemical industry (10).

 Wholesale trade and Retail trade (18).

The associated hierarchic graph is the one that appears in the Figure. 6. The most important characteristics of this graph are the following:

**a)** Formed by the relations of influence of the sector the Industry of the wood (7) on the sectors Construction (4) and Wholesale trade and Retail trade (18). In relation to the total IO table, the relation of relative influence with the sector disappeared Manufacture of furniture (16).

**b)** Formed by the relations of influence of the sector the Industry of the paper (8) on the sectors Food industry, beverages and tobacco industries (5) and Professional services (33). As it can be observed, the relation of influence of Industry of the paper (8) with the sector of Manufacture of electrical and electronic machinery disappeared (14).

**c)** Formed by the relation of influence of the sector the metallic Industry (12) on the sector Construction (4), disappearing the relations with the more dynamic exporting sectors of elevated component mattered: Manufacture of electrical and electronic machinery (14) and Manufacture of transport equipment (15). In other words, these two last sectors do not have any capacity of drag the economic growth.

**Figure 6**

**Sectorial hierarchy by levels in the reduced graph G10r**

**(Domestic IO table)**

**d)** Formed by the relations of influence of the sector the Rental services of tangible goods and nontangibles (32) on the sectors Mining (2) and Construction (4). These sectors as their essentially domestic sectors as much maintain their number of relations in the total and domestic IO table, indicating their greater degree of productive joint in the Mexican economy. In fact, the sector Mining (2) not only is more between the integrated and extensive sectors but it is the sector that transmits the greater quantity of relative influence in the Mexican productive structure, being that the sector that is dragging the economic growth is the chemical Industry (10). On the other hand, the sector Construction (4) is the one of greater capacity of drag[[8]](#footnote-9) since it has 4 relations of influence by the purchases in all the productive framework in the G10 graph.

**e)** Another aspect to emphasize is the fact that all the subgraph conformed by the sectors disappears: Manufacture of machinery and equipment (13) - > Manufacture of electrical and electronic machinery (14) - > Manufacture of transport equipment (15) and the relations that some of these sectors maintained with the sector textile Industry (6) and the metallic Industry (12). In other words, more dynamic the manufacturing exporting sectors not only are disconnected of the Mexican productive structure but the transmission of the economic influence occurs among them without no multiplication effect on the domestic sectors and therefore, they do not have any capacity of drag the economic growth.

In the last hierarchy level, like vertices well of the graph and basic sectors of the economy, appears the sectors chemical Industry (10) and Commerce (18). These two sectors are those that drag the economic growth of the Mexican economy.

Relations stronger influence in the Mexican economy are those of the sector mineral product Manufacture nonmetalists (11) with Construction (4); Mining (2) with Chemical Industry (10), and Agriculture, Forestry, Fishing and Hunting (1) with Food industry, beverages and tobacco industries (5). In the first case, an increase of 1% of the manufacturing sector non-metallic mineral products causes an increase of 49.6% in the construction sector. In the second case, the sector Mining impels in 46.3% to the one of the chemical Industry. Finally, in the third case, Agriculture, Forestry, Fishing and Hunting, induce an increase of the 43.4% in the one of Food industry, beverages and tobacco industries.

Also worth noting that among the most extensive walks and further transmission of relative influence in the graph G10 are among the sectors: Rental services of tangible goods and nontangibles - > Mining - > Chemical industry and Printing and related industries - > Professional services - > Wholesale trade and Retail trade, transmitting 6.07% and 2.94% of economic influence, respectively.

As we said, between the sectors that they have major capacity of drag the economic growth and greater transmission of relative influence of the Mexican economy appears the sector Chemical industry (10). An aspect to emphasize is the fact that the Chemical industry (10), from the point of view of Hirschman, could generate important potential linkages in the Mexican economy, although is not necessary to forget that they belong to the intensive industries in natural resources, with a little dynamism in the world-wide commerce, jointly with the Food industry, beverages and tobacco industries (5) in the G5 graph.

In summary, the Mexican productive structure presents the typical specialization and conformation of an open and semi-industrialized economy: strong disarticulation and specialization in manufacturing exports of medium and high tech, that nevertheless does not drag the economic growth because they are not integrated in his productive structure and because the footpaths of economic influence transmit between the sectors of the Maquiladora industry and not boosts the domestic of Mexico.

The sectors of machinery and equipment are sectors disconnected in the Mexican productive structure since they are not developed within his internal productive framework but they are obtained from the outside. This result reveals that the process of manufacture of products of these industries demands different technological contents and is being realized in form fragmented in other countries. The majority of the sectors of the Maquiladora present this characteristic.

The investigation of the relation between productive articulation, manufacturing exports and economic growth demonstrates to us that the type of insertion of the Mexican economy in the international economy has two great problems. On the one hand, more dynamic the manufacturing exporting sectors do not drag the economic growth. On the other hand, the keys sectors (with greater capacity of drag the economic growth) of their productive structure as much in the total and domestic IO tables belong to the intensive industries in natural resources (this it is the case of the Food industry, beverages and tobacco industries (5) and chemical Industry (10)).

Then, the productive and exporting structure of Mexico presents a paradox: the manufacturing most dynamic sectors of medium and high tech do not drag the economic growth because they are disarticulated of his productive structure and the sectors of greater capacity of drag belong to the intensive industries in natural resources, with a little dynamism in the world trade. This takes to us to put of relief the relation between the productive articulation and the economic growth of the Mexican economy, that by the empirical evidence are more excellent the capacity of drag the sectors Food industry, beverages and tobacco industries (5) and Chemical industry (10) although does not belong to the sectors most dynamic of the world trade, but certainly fundamental to reach a greater level of growth. That is to say, this would seem to us to indicate as much since in the total and domestic IO tables, that most important to grow is the productive articulation of the sectors that even the technological level that contains, and that ultimately, it comes mainly from activities of assembly of networks of global production, with reduced generation of drag effects that move to all the economy. The Maquiladora industry presents very low level of integration with the Mexican economy in terms of demand of intermediate goods. In the Republic of Korea and China, on the contrary, the more dynamic exporting sectors have, at the same time, a greater weight in the industrial structure, which strengthens their ability to create and multiply linkages.

In any case, which was to emphasize is that neither the type nor the quality of the productive structure of Mexico it seems to provide in the medium and long term majors to him possibilities of growth over 4%.

**IV. Vertical Specialization**

**IV.1. Vertical Specialization: Concepts and measures**

One of the characteristics of the globalization is the increasing importance of the fragmentation of the production process: instead of to realized all the process of production of a good in a country, now this one fragments between different countries, and each specializes in a determined part of the production process.

“International fragmentation of production” (Jones and Kierzkowski, 1990) is one of the most common expressions used in the academic literature to denote the splitting up of production chains into two or more separate segments, to be performed in different countries. Many other terms have been coined in the literature, highlighting some of the several facets of the process. For instance, “cortar la cadena de valor agregado” (Krugman); “*outsourcing”* (Feenstra and Hanson, 1996, 1999); “*global production sharing*” (Feenstra, 1998); “kaleidoscope comparative” (Bagwati and Dehejia, 1994); “*intra-product specialisation*” or “*superspecialisation*” (Arndt, 1998); “*delocalisation”* (Leamer, 1998); "*international production networks”* (Ernst and Guerrieri, 1998); *“international fragmentation of production”* (Jones and Kierzkoski, 2001); *“vertical specialization”* (Hummels, Ishii and Yi, 2001; Goh and Olivier, 2004); *“international outsourcing”* (Grossman and Helpman 2002); *“vertical production networks”* (Hanson, Mataloni, Slaughther, 2005); y *“task trade”* (Grossman and Rossi-Hansberg, 2006).

In this paper we use a measure of *vertical specialization* (Hummels *et al*.*,* 2001) that for a certain country keeps into account all imports of goods and services that are embodied in a country’s exports, irrespective of the relationship the domestic firm has established with the foreign supplier.

For Hummels (2001) three conditions must hold for vertical specialisation to take place: the production process must consist of at least two stages; two or more countries must specialise in some of these stages; at least some of the imported intermediates must be used to produce goods or services that are later exported, thus crossing national boundaries more than once. The third condition is deemed to help distinguish vertical fragmentation of production from the more general notion of trade in intermediates.

The concept of vertical specialization relates the fragmentation of the production to the exports of a sector since it calculates the imports of total inputs (direct and indirect) embodied in the exports. Of this form it gathers how the countries increasingly are involved in the process of production of a good of sequential way.

As an indicator of vertical specialization we choose the import content (*IC*) of exports, calculated on the basis of the input-output tables. Using these tables helps avoiding an arbitrary classification between intermediate inputs and other categories of goods: in fact, the tables consent to disentangle the output of each sector into two parts, the first as an input to the other sectors, the second as a final good. Although providing an exhaustive measure of vertical specialization, the input-output tables do not allow distinguishing among the different channels of internationalization chosen by firms. Moreover, they do not account for the international outsourcing to foreign subsidiaries of the whole production and distribution processes (*export platform*), as this case does not imply flows of goods and services across borders.

As in Hummels *et al.* (2001), in order to calculate the value of imports *directly* contained in the Mexican exports we resort to the following formula, here reported using matrix notation, the formula for VS as a share of total exports for country *k* is

*VS share of total exports* = $uA^{M}X/X\_{k}$ (12)

where *u* is a unit vector of dimension n, *AM* is an n-dimensional square matrix containing the production coefficients for imported inputs, *X* is the n-vector of exports, with n indicating the number of sectors. Each element aMij *a* of the matrix *AM* measures the value of imported intermediate goods and services classified in the branch *i* and used to produce one unit of output in sector *j*.

Using the input-output tables enables us to calculate also the value of inputs which are *indirectly* used in the production of an exported good. In fact, an imported input can be used in a sector, whose output is in turn employed in another sector, then possibly in a third sector and so on, up to being finally included in a good sold abroad. In this case the measure of the import content of exports includes both directly and indirectly imported inputs, the latter defined as those contained in the domestic inputs. The more general way to compute VS as a share of total exports for country *k* with these tables is.The measure for the whole import content is the following:

*VS share of total exports* = $uA^{M}\left[I-A^{D}\right]^{-1}X/X\_{k}$ (13)

where *AD* is the matrix of the input coefficients for domestic intermediate goods and (*I* − *AD*)−1 is the term capturing imported inputs embodied in the domestic output in the first, second, third, etc. stages of production before being used to produce the good that will be eventually exported. As such, they can be used to estimate the contribution that imports make in the production of any good or service for export. An import content of exports of 68% for example means that 68% of the exports are directly and indirectly based on intermediates that have been imported.

The use of the input-output tables as source of initial data for the calculation of the vertical specialization is going to allow to us not only to distinguish the specialization at sectorial level, but also to include in the calculation the indirect imports of inputs, and to obtain, therefore, the total, direct and indirect content, of intermediate imports in the merchandise exported by the Mexican economy. That is to say, this way the vertical specialization also includes the intermediate imports realized by inputs that uses the exporting branch in any round of its production.

The calculation of the vertical specialization including the direct and indirect imports the used procedure differs slightly from the employee by Hummels et al. (2001). The used expression is:

*VS* = $A^{M}\left[I-A^{D}\right]^{-1}<X>$ **(**14)

Where *AM* is the matrix of imported coefficients of inputs, *AD* is the matrix of domestic coefficients and X is the diagonalized vector of exports. The advantage to use the exports as first diagonal is in which this way we can obtain two types different from information:

- on the one hand, the sum by columns of the resulting matrix indicates the intermediate imports of any product that direct or indirectly are necessary to obtain the exports corresponding to a branch. In this case, if we divided the sum of the elements of the column by the exports of the branch we obtain the vertical specialization of the branch by unit of exported final merchandise;

- on the other hand, the sum by rows allows to calculate the total content of intermediate imports of determined input in the set of exports of the economy. Dividing by the total exports of the country we obtain the participation of each product in the vertical specialization of the country.

For the empirical analysis on the Mexican economy we use the symmetric input output tables at current prices referred to year 2003 under North American Industry Classification System (NAICS).

**IV.2. Brief comparative analysis of the vertical specialization of Mexico and the countries of Asia and the OECD.**

If we relate the dynamic export manufacturing, production fragmentation and its consequent effect on economic growth by country experience is markedly different. For example, Mexico in the 1995-2005 period, manufacturing exports and intermediate advanced have been the most dynamic growth respectively in 11.5% and 9.8% (which together account for 77.7% of total) and total manufacturing have increased by 10.2%, well above some export powers such as US, Germany and Japan have reached 4.6%, 6.6% and 2.7% respectively. Although nevertheless, very below China that reached a rate of growth of 18.3% in its manufacturing exports (27.4% in manufacturing advanced, 20.0% intermediates manufacturing and 12.9% in traditional manufacturing). In China, the advanced and intermediate manufacturing accounted for 60.2%. Furthermore, in January-December of 2009-2010, Mexican exports grew by over 32%, particularly the Manufacture of electrical and electronic machinery and Transportation equipment manufacturing with the largest contribution to growth. Other OECD countries such as Hungary, Slovakia and Czech Republic show growth rates similar to China. Focusing on the economies of China and Mexico, we see that the rate of economic growth in China has been at least double that of the Mexican economy.

The developed economies of Japan and the US present comparable shares of imported inputs in exports for 2000 (11.3% and 11.6%). Those shares increased significantly between 2000 and 2008, most probably due to the expansion of off-shoring and intra-firm activities of Japanese and US multinational companies. The derived domestic value added content of these economies' exports is inversely high, respectively 88.7% and 88.4% in 2000, reflecting the high content of national inputs and services embedded in their manufacturing exports as well as the increasing weight of commercial services exports.

**Table 11**



Surprisingly, the vertical specialization observed in 2000 for Indonesia (15.9%) is slightly upper than that of Japan and the US (Table 11). The reason for this slightly upper figure lies with Indonesia's export structure which is mainly composed of primary products that do not require intensive use of foreign inputs (agricultural and oil exports of Indonesia amounted to 61% total exports in 2008).

Conversely, the exports of goods and services originating from Singapore and Malaysia are the most intensive in imported content amongst the AIO countries (respectively 53.2%, and 49.2% in 2000), and Luxembourg, Hungary, Estonia, Ireland, Solvak Republic and Czech Republic (60%, 56%, 51%, 51%, 49% 48% for 2005)[[9]](#footnote-10) amongst OECD members, thus leading to a low magnitude of their trade in value added. Starting from the evidence of a sharp decline of domestic value added in manufacturing, in 2003 Sinn used the expression "bazaar economy" to define the role played by international fragmentation of production in the German economy (Breda y Cappariello, 2010). Germany and Italy are considered as a “bazaar economy” (Breda y Cappariello, 2010).

The estimates for China's import content of exports turn out to be low (around 20 per cent). As previously mentioned, this is because standard II-Os do not apply specific treatment for processing zones trade. For some economies, such as China and Mexico, the share of exports from processing zones in total exports is high, and the measure of import content of exports is obviously underestimated as China's export processing zones employ much more imported inputs than exports stemming from non-processing zone trade.

Our estimations of the vertical specialization for Mexico using the 2003 IO table of INEGI is of 37%, which it agrees with the estimations of the OECD (2010), and domestic component of exports is 63%. The estimations of the vertical specialization for China using 2005 IO table is of 27%. In both cases, important are that the classification of the OECD concerning 48 sectors is used and does not distinguish between the exports of zones processors and processors, reason is possible to compare the obtained results. Although it exists, a difference of ten percentage points that would not seem important, this yes is very relevant since as the technological level is increased the vertical specialization he is more and more increasing, being very superiors those of Mexico with respect to the one of China. Thus, for example, the vertical specialization in high/medium technologies of Mexico is 61% against 37% of China, 37% of Mexico against 21% of China in low/medium low technologies and 71% of Mexico against 48% of China in ICT (OECD, 2010).

The evidence shows that during the 1990s China dramatically increased its market shares in ICT products and now ranks among the top three world exporters. Moreover, China has upgraded from mere assembly of imported inputs to the manufacturing of high-tech intermediate goods. As a result, import dependence has declined and the domestic value added of exports has increased. This supports the hypothesis that industrial upgrading occurred in some tradable sectors through technological learning associated with processing trade. Therefore, a pattern of specialization initially dominated by processing trade could be favourable to a country's long term development, to the extent that entering at the lower end of high-tech sectors is promotive of catching up in more sophisticated technology-intensive production (Amighini, 2005). This would be mostly useful for other developing countries with a current strong specialization in processing and assembly trade, such as Mexico.

The export volume of ICT products has been increased significantly. World exports in ICT products grew by 57% between 2000 and 2007 (for telecommunications equipment 95%) and amounted to 1,514 billion US dollars in 2007, representing about 20% of total world exports.[[10]](#footnote-11) In terms of demand and value added, ICT goods are considered as one of the most dynamic products worldwide (UNCTAD, 2007). Moreover, there is evidence that suggests that countries with strong export specialization and performance in ICT-related products exhibit higher productivity and economic growth rates (Hausmann et al., 2007; Rodrik, 2006; Farberger, 2000; Greenaway et al., 1999).

**IV.2. Vertical Specialization of México**

A very useful concept in empirically gauging the importance of supply chain-related trade for an economy is the notion of vertical specialization shares (Hummels, Ishii and Yi 2001). The use of vertical specialization shares (VS shares) for measuring the extent of China and Mexico in the participation in the global supply chain is particularly meaningful since China and Mexico has an unusually large proportion of trade in the form of processing trade: the policy regime whereby inputs can be imported duty free as long as they are used for further assembly and then exported. Two recent papers, Dean, Fung and Wang (DFW) (2009) and Koopman, Wang and Wei (KWW) (2008) utilize this concept of VS shares to study the characteristics of Chinese exports. These papers find IT related products, such as electronic computers, telecommunication equipment, cultural and office equipment, telecommunication equipment, and computer peripheral equipment, to be among China’s most vertically specialized exports.

Sectoral VS shares give us some indication of how far up Mexico is along the global value chain for various industries. A high VS share indicates that a substantial amount of the content comes from abroad, suggesting that Mexico is mainly engaged in final stages of assembly. A low VS share indicates that a larger degree of the production process is being done within Mexico. This could mean some technological constraint on the degree of fragmentation in the industry, or that Mexico is producing more of the stages of production than simply final assembly. This section is focused in the study for Mexico to sector level.

The Mexican productive structure according to its degree of fragmentation can be divided in two great groups. On the one hand, between those sectors with high VS share like being: Manufacture of electrical and electronic machinery (68%), Other manufacturing industries (45%), Manufacture of transport equipment (44%), Machinery and equipment manufacturing (37%) and Textile industry (39%), which together represent almost 60% of total exports (Table 12). These are the manufacturing sectors of medium and high technology are dynamic of the commercial structure of Mexico but also as they are the fragmented sectors more and, therefore, without no capacity of drag the economic growth. Also, these are the sectors pertaining to the Maquiladora industry that belong to the global value chains. As we saw in the investigation by means of the graph theory these sectors are connected but to each other disconnected of the rest of the sectors of the Mexican economy (Figure 4 and 6).

On the other hand, between the main sectors with low VS share appear Mining (5%), Professional services (7%), Financial Services and of insurances (8%), Food industry, beverages and tobacco industries (16%) and Chemical industry (18%) (Table 12), agreeing with the results of the direct causality of the graph theory like the sectors very integrated in the Mexican productive structure, and the sectorial hierarchy by levels one had been that Food industry, beverages and tobacco industries and Chemical Industry are the sectors with greater capacity of drag (Figure 4 and 6).

**Table 12**



**Table 14**



To reflect the reality and importance of Export Processing Zones (EPZs) in developing economies as China and, Mexico and their role in global value-added trade and production network we estimed the vertical specialization. Considering the domestic IO table (internal economy) the vertical specialization of Mexico falls to 16% and the domestic component of exports increased to 84% from 63% (Table ¿?). This is an important indicator of the impact of the Maquiladora industry and the degree of fragmentation of production is less than half in the case of the domestic economy, not taking into account the maquiladora industry. Even in the domestic economy sectors remain fragmented Transportation equipment manufacturing, Manufacture of electrical and electronic machinery, Machinery and equipment manufacturing, and Textile industry with vertical specialization than 23% and representing 34% of total exports. A noteworthy aspect is that Mining remains one of the most articulate and almost doubled its export share to 19%. The 42% of the aggregate value of the Mexican economy is generated by 7% by exports of sectors of low coefficient of export and resource-intensive, in contrast, only 2.6% of value added is generated by 28% of exports very high ratio of export and technology intensive. The sectors very low export ratio, used less than 7% of imported inputs, y and, sectors of very high ratio of export more than 65% (Ascarraga, 2010).

One of the notable differences between China and Mexico with respect to the role of imports in productive fragmentation is that although both countries started with assembly activities, China has managed to decouple if their imports and exports has been growing increasingly incorporated national component and value added in manufacturing exports, and ultimately, this is one reason why China is growing much more than Mexico. In Mexico, the high propensity to import is strongly limiting economic growth. In this sense, Mexico it does not export if it does not matter and if it matters does not produce neither to export nor for the internal market, demonstrated because exactly in the same quantity in which it matters, it exports, and with identical distribution of the exports and imports between the internal economy and the maquiladora industry (55%, 45% in 2003, respectively).

Also, several econometric studies confirm that in the pasts 15 or twenty years the Mexican economy has increased its structural dependency of the imports, especially the manufacturing sector. The elasticity of the demand of imports of long term of the Mexican economy has been increased noticeably, at the moment its value is near 3. What means that if real income is to grow at an annual average long-term rate of say 5%, its imports in real terms will tend to expand at a rate of 15%, forcing to that the exports grow to a similar rate to maintain the commercial balance in tolerable levels, if to this an adverse movement in the terms of trade is, the expansion of the exports would often have to be greater. In this sense, the Mexican economy in the long term faces an external restriction its economic growth due to of the high elasticity income of the demand of imports, that is been increasing its structural dependency.

**V. Conclusions**

The paper was centered in analyzing why the strong manufacturing exporting dynamism of medium and high technology weakly drags the economic growth of Mexico. The hypothesis that was maintained is that the two conditions so that the manufacturing sector exporting drags the growth of the Mexican economy are: a) integration/disarticulation productive of the exporting sectors with the rest of the sectors of the economy, and b) the participation in the global productive chain where to add more value added along a global production network. This article deals the first question. This first aspect was analyzed from two theoretical-methodologic approaches that, although they are different, are complementary for the study of the productive fragmentation: graph theory and the vertical specialization. On the one hand, from the approach of the graph theory we analyzed integration/disarticulation global productive of the Mexican economy: integration and influences direct, quantification of the footpaths of the economic influence transmitted in all the productive structure and the sectorial hierarchy by levels, establishing the capacity of drag by means of identification, quantification and analysis of the “linkages” in the Mexican productive structure. On the other hand, from the approach of the vertical specialization we analyzed the associate productive fragmentation to the imported component of the exports. The application of the graph theory is justified by the contributions that represent to surpass the shortcomings of the methods of traditional structural analysis and on that the approach of the vertical specialization is also based.

In this paper, a theoretical and methodological approach highlighted two key issues: from the theoretical point of view stresses the importance of the productive structure since not all sectors have the same ability to drag the rest of the economy derived from their linkages, and from the methodological point of view of graph theory is made three major contributions, which overcomes the limitations of the methods of structural analysis input-output and go beyond traditional literature on the relationship between the articulation production and economic growth, plus dynamic linking to external markets. First, by direct causality, we analyze the degree of integration and direct influence. Second, by indirect causation, are detected walks direct, indirect and the distance between the different sectors in order to identify, quantify and analyze the economic influence transmitted in the production structure. Third, by the strict causality, establishing the sectoral hierarchy levels consistent with the hierarchical ordering of the productive sectors so that the sectors belonging to higher levels are in a position to drag the economy sectors located below those levels. The importance of this type of analysis is the identification, tracing and quantifying the economic influence transmitted from the productive sectors to sectors sources well, through the relationships of influence (direct and indirect) and dominance.

The investigation by means of the graph theory shows the strong degree to us of productive disarticulation, essentially of the manufacturing exporting sectors more dynamic than they do not drag the economic growth of the internal economy of Mexico. The reasons of the weak capacity of drag the economic growth are in two aspects. First of all, the strong dynamism of these sectors is reduced to an interrelation and transmission of economic influence between the same connectionless (direct or indirect) and without no multiplying impact on the rest of the Mexican economy. Secondly, the strong degree of disarticulation is due to the imported component elevated one of the sectors of the export industry.

With respect to the first point, the necessary condition so that the connection between exports occurs, internal demand and growth are that the configuration of the exporting sector allows to multiply its dynamic on all the economy through the relations of purchase and sale of inputs between the exporting activities and the rest of the economy. It has been demonstrated that these relations in the Mexican economy are extremely weak, in particular in the sectors that have a decisive weight in the exports of the country, reason why the expansion of the sales to the outside has a small multiplication effect on the rest of the economy by virtue of the high propensity to the import of inputs.

The type of insertion of Mexican in the international economy has two great problems. On the one hand, more dynamic the manufacturing exporting sectors (Machinery and equipment manufacturing, Manufacture of electrical and electronic machinery, and Transportation equipment manufacturing) do not drag the economic growth. On the other hand, the sectors with greater capacity of drag the economic growth of their productive structure as much in the total and domestic IO tables belong to the intensive industries in natural resources (Food industry, beverages and tobacco industries and Chemical industry).

Therefore, the productive and exporting structure of Mexico presents a paradox: the more dynamic manufacturing sectors of medium and high technology do not drag the economic growth because they are disarticulated of his productive structure and the sectors of greater capacity of drag belong to the intensive industries in natural resources, with a weak dynamism in the world trade. This takes to us to put of relief the relation between the productive articulation and the economic growth of the Mexican economy, that by the empirical evidence is more important the capacity of drag the sectors Food industry, beverages and tobacco industries and Chemical industry, although do not belong to the sectors most dynamic of the international trade, but certainly fundamental to reach a greater level of growth. That is to say, this would seem to us to indicate as much since in the total and domestic IO tables, that most important to grow is the productive articulation of the sectors that even the technological level that contains, and that ultimately, it comes mainly from activities of assembly of networks of global production, with reduced generation of drag effects that move to all the economy.

In this paper, we focused to demonstrate theoretic and empirically that in the case of Mexico's manufacturing exports dynamics of medium and high technology have not been an engine of economic growth because they not have increased the demand for intermediate inputs to be broken up of chains between manufacturing export sectors and the rest of the sectors of the Mexican economy, and by the fact that Mexico is part of international production sharing in the productive phase more labor-intensive low-skilled, and of low added value. It has been shown that the most exporters have less capacity of drag in terms of demand by intermediate goods, so that the channels of virtuous link between domestic and foreign markets for Mexico's economic growth are fractured.

This implies that if Mexico wants to grow should change its export structure and form of insertion into the international economy, since, as argued structural stranglings have been generated both on the side of foreign and domestic markets that do not allow growth rates economic than 4%. In fact, the thesis of the paper is that it will be possible only in so far as to instigate a virtuous circle between the two markets. The main structural link between the internal and external market for the viability of the Mexican economy lies in the fact that Mexico is not only matters to export (with the positive effects that implies, the key question is that there is to generate the mechanisms endogenous so that the marginal propensity to matter is had decreasing, which will result from the integration of productive chains), but increasingly more and more important to nourish your internal production process, consumption and much less-even desirable-for investment. In this sense, Mexico it does not export if it does not matter and if it matters does not produce neither to export nor for the internal market, demonstrated because exactly in the same quantity in which it matters, it exports, and with identical distribution of the exports and imports between the internal economy and the maquiladora industry (55%, 45% in 2003, respectively).

The analysis of the relationship between the articulation of production and economic growth in Mexico shows that not matter only the composition of exports but mainly the form in which export sectors are integrated with the rest of the economy, which ultimately determines the capacity of drag for economic growth and the creation of a virtuous circle between foreign and domestic market for both goods and labor market.

The impact of the exports on the economic growth will be higher while be greater are the domestic productive linkages of the exporting activities with the rest of the sectors of the economy. What is at issue is that the exporting companies could provide intermediate inputs and domestic capital goods, which would account for a more integrated supply chain, and therefore would have a double effect. For a first, triggering a direct impetus to export product, every time you increase exports would multiply the effect on aggregate demand and hence on the product, and other indirect effect of exports to other sectors. On the other hand, this would imply a substitution of imports and thus the income elasticity of imports would be lower and reduce the need to import as the product grows, thus raise the external constraint to economic growth. Another channel effect of exports and imports on economic growth less studied in the literature, much less integrated into an analytical framework is the impact on consumption and investment in the domestic economy beyond the densification of the inter-sectoral relations in the productive scope and the locomotive effect they can have on not only the rest of the domestic economy but in the interaction and feedback dynamics between domestic and foreign markets, once established channels of transmission between the two markets, which until now are very weakly connected.

A fundamental characteristic of the Mexican economy in the last decades has been the impressive growth of its manufacturing exports (medium and high technology) and a related aspect less studied is the fragmentation of the production, as explanatory factor of its weak capacity of drag on the economic growth. In this paper, we provide the most up-to-date and comprehensive measures of the degree of vertical specialization in Mexica’s trade, using a new detailed Mexican dataset which allows us to distinguish processing imports and exports from ordinary trade. These data are incorporated into the Hummels, et al. (2001) measure of vertical specialization, using 2003 IO tables. We then quantify vertical specialization by sector.

Our results show that the vertical specialization in Mexica’s exports to the world was more than 36% in 2003. In the sectors with the most fragmented trade-- Manufacture of electrical and electronic machinery, Transportation equipment manufacturing, Other manufacturing industries, Machinery and equipment manufacturing and textile Industry —vertical specialization exceeded 38%. The sector Manufacture of electrical and electronic machinery had highest VS with 68%.

The Mexican productive structure according to its degree of fragmentation can be divided in two great groups. On the one hand, between those sectors with high VS share like being: Manufacture of electrical and electronic machinery (68%), Other manufacturing industries (45%), Manufacture of transport equipment (44%), Machinery and equipment manufacturing (37%) and Textile industry (39%). These are the manufacturing sectors of medium and high technology are dynamic of the commercial structure of Mexico but also as they are the fragmented sectors more and, therefore, without no capacity of drag the economic growth. Also, these are the sectors pertaining to the Maquiladora industry that belong to the global value chains. As we saw in the investigation by means of the graph theory these sectors are connected but to each other disconnected of the rest of the sectors of the Mexican economy.

On the other hand, between the main sectors with low VS share appear Mining (5%), Professional services (7%), Financial Services and of insurances (8%), Food industry, beverages and tobacco industries (16%) and Chemical industry (18%), agreeing with the results of the direct causality of the graph theory like the sectors very integrated in the Mexican productive structure, and the sectorial hierarchy by levels one had been that Food industry, beverages and tobacco industries and Chemical Industry are the sectors with greater capacity of drag.

However, it is noted that graph theory has allowed us to go far beyond the vertical specialization to identify, quantify and analyze the footpaths of economic influence and the establishment of the sectoral hierarchy levels allowed us to measure the drag in the productive structure of Mexico.

One of the notable differences between China and Mexico with respect to the role of imports in productive fragmentation is that although both countries started with assembly activities, China has managed to decouple if their imports and exports has been growing increasingly incorporated national component and value added in manufacturing exports, and ultimately, this is one reason why China is growing much more than Mexico. In Mexico, the high propensity to import is strongly limiting economic growth. In this sense, Mexico it does not export if it does not matter and if it matters does not produce neither to export nor for the internal market, demonstrated because exactly in the same quantity in which it matters, it exports, and with identical distribution of the exports and imports between the internal economy and the maquiladora industry (55%, 45% in 2003, respectively). In this sense, the Mexican economy in the long term faces an external restriction its economic growth due to of the high elasticity income of the demand of imports, that is been increasing its structural dependency.

China has upgraded from mere assembly of imported inputs to the manufacturing of high-tech intermediate goods. As a result, import dependence has declined and the domestic value added of exports has increased. This supports the hypothesis that industrial upgrading occurred in some tradable sectors through technological learning associated with processing trade. Therefore, a pattern of specialization initially dominated by processing trade could be favourable to a country's long term development, to the extent that entering at the lower end of high-tech sectors is promotive of catching up in more sophisticated technology-intensive production (Amighini, 2005). This would be mostly useful for other developing countries with a current strong specialization in processing and assembly trade, such as Mexico

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1. The calculation of the matrices associated to the graph is highly intensive in programming and algoritmia. In fact, an important area of the Mathematical Theory (Graphs) and of the Programming in the denominated computer science Structure of Data and Algorithm analysis. There is tree methods for the calculation of the matrix of distances: the algorithm of Harary, Norman and Cartwright (1968), algorithm of Warfield (1974), and the one of Rossier (1980). For the calculation of the matrix of transitive closure the algorithm of Harary, Norman and Cartwright is used (1968). [↑](#footnote-ref-2)
2. There is an ample tradition in the Literature with respect to which only over an equal value or superior to 0.05 it can be considered that the coefficients are representative of average and strong relations in the structure, cataloguing to the rest like weak or, even, manifestly despicable. [↑](#footnote-ref-3)
3. In Morillas (2004) the outer semidegree is an indicator of integration by purchases and the inner semidegree of integration by sales. This must to that it uses the transposed matrix of the distribution coefficients. In this work it has been chosen not to transpose it without it alters the results. The calculated outer semidegree this way will solely indicate integration by sales and the interior semidegree, integration by purchases. [↑](#footnote-ref-4)
4. As it maintains Lantner [1998, p. 7], «It can be convenient for a policy maker to know the main “direct” effects (carried by the paths from vertex j to vertex i in the influence graph) and, for each one of them, the value of its amplification by the cycles and feedbacks. Thus the schedule of the effects could be foreseen […]. More generally Influence Graphs theory allows the economists not only to know the sequence of effects but to understand the links between all the effects». [↑](#footnote-ref-5)
5. For example, if the way is i → j → k → l → m, then, iDi→m = dji.dkj.dlk.dml. [↑](#footnote-ref-6)
6. By the duality principle the passage of a type from influence to another one is immediate, investing the direction of the arcs, according to it is wanted to analyze the relation of influences by sales or purchases. [↑](#footnote-ref-7)
7. The calculations have been realised by means of the given algorithm in Warfield (1976). [↑](#footnote-ref-8)
8. We remember that by the duality principle the passage of a type from influence to another one is immediate, in such a way that if wishes to investigate the influence by the purchases, it is necessary to invest the direction of the arcs. However, it is not necessary to lose of view that works with the matrix D, that in other advantages weighs the coefficients of the matrix To with the productions of the respective sectors, being thus in a definition based on the position and the relative weight of each sector inside the structure of interchanges more than the simple technical coefficient (*dij* = *aij*.(*xj*/ *xi*). [↑](#footnote-ref-9)
9. OECD (2010). [↑](#footnote-ref-10)
10. World Trade Organization international trade database. [↑](#footnote-ref-11)