Exports as an Engine of Economic Growth and the Position of Emerging Countries in the Global Value Chains: A Comparative Analysis between China and Mexico

Wilmar Ascárraga-Sejas
Ph.D. Student, Departament of Economics, National University of Mexico.
E-mail: wilmar.ascarraga@comunidad.unam.mx.

ABSTRACT

This paper aims to contribute to explain why the growing exports of medium and high technology products has weakly driven Mexico's economic growth and the strongly in the Chinese economy. From a set similar features of the Chinese economy and Mexican a comparative analysis is performed in order to establish why the Chinese manufacturing exports have become an engine of economic growth, however, in the Mexican economy is not the case. Our point of departure is that exports constitute an engine of economic growth if they fulfill two conditions: a) the productive integration/ articulation between the export sectors and the rest of the economy, b) the country's participation in the global production network in the stages of production which add more domestic value added.

These two aspects are analyzed from two different but complementary theoretical and methodological approaches for the study of the fragmentation of production: Vertical Specialization and Average Propagation Lengths. Its approaches we analyze the international fragmentation of production, which will allows us to establish the capacity to push and analysis of the "linkages" and the distances between sectors. On the other hand, trough vertical specialization we analyze the value added content of exports derived from the participation of China and Mexico and their positions in the global value chains.

The main conclusions highlight that China exhibits strong linkages and Mexico weak linkages between exports and the rest of the economy because a high import content of exports. China moving up in the global value chains and Mexico is not the case.

I. Introduction:

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.

At the end of the eighteenth century, Adam Smith famously noted that making a pin was divided into about 18 distinct operations. Today, as mentioned by Levine (2010), making a Boeing 747 requires more than 6,000,000 parts, each of them requiring many more operations.

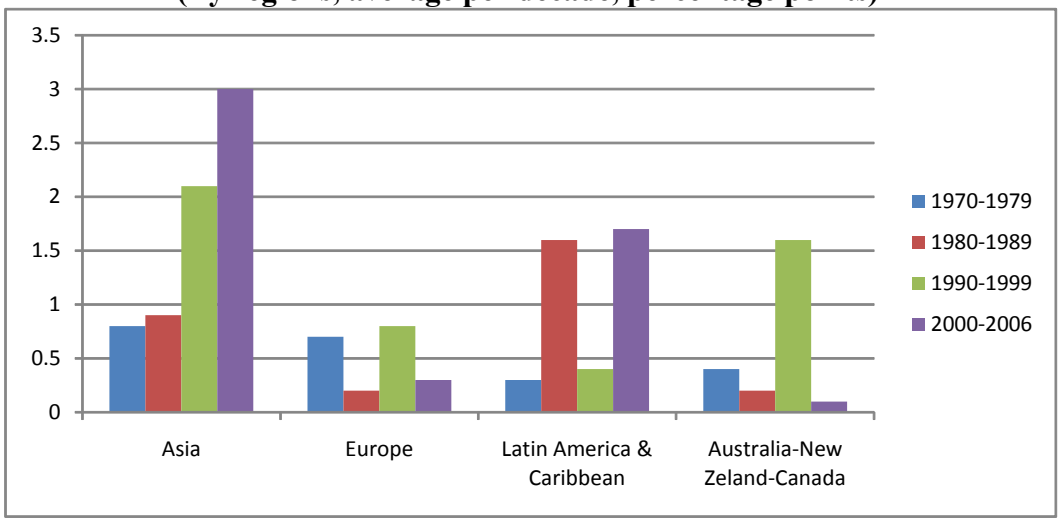
The relationship between exports and economic growth has been the object of many investigations, theoretical and empirical respectively. The theoretical approach argues that exports contribute to accelerate economic growth. The previous statement was the basis of the proposal that countries that follow 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.

While export-led growth has often been cited as the engine behind the Asian miracle, recent research has shifted the focus of the debate away from the mere fact of exporting and towards the importance of export composition for growth. For instance, one of the recent stylized facts of development is the finding that countries promoting exports of more "sophisticated" goods grow faster (Rodrik 2006; Hausmann, Hwang and Rodrik 2006).

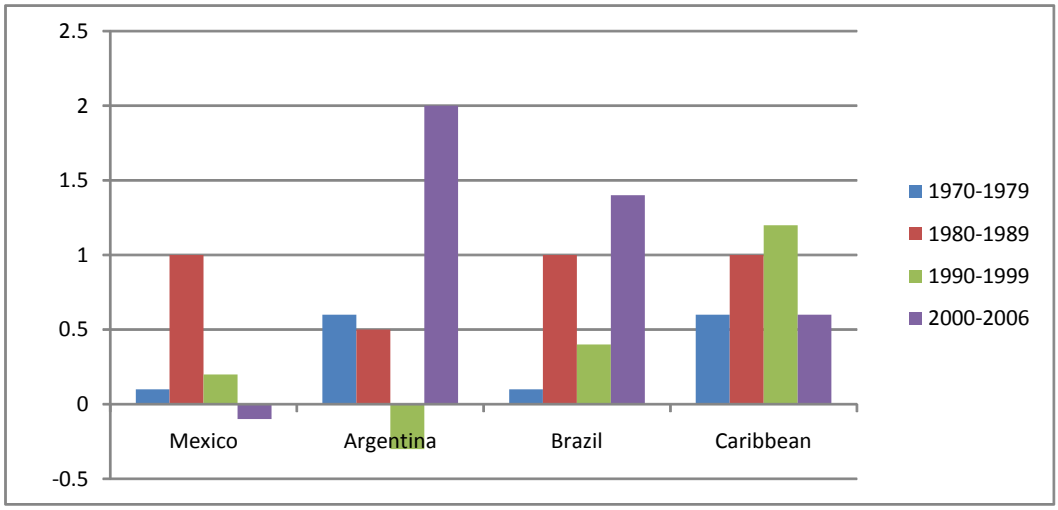
Asia is the region of the world where exports make greater contribution to growth, with 8 and 3 percentage points in the period 2000-2006, gross and net respectively (Figure 1).

Figure 1
Contribution of net exports to economic growth, 1970-2006
(By regions, average per decade, percentage points)



Source: United Nations-DESA.

Figure 2
Contribution of net exports to economic growth, 1970-2006
(By country, average per decade, percentage points)



Source: United Nations-DESA.

Mexico, despite being the country with the most dynamic export manufacturing medium and high technology in the region, shows a negative contribution of net exports to economic growth (Figure 2).

Controlling by the same share in the advanced manufacturing exports of China, Mexico and Korea (40%), Mexico ranks second place to worldwide in the growth rate of total and advanced manufactured exports after China (Table 1).

Table 1
Composition of manufacturing exports by dynamism and technology
(Percentages)

Country	Manufacturing					
	Avanced		Intermediate		Traditionals	
	1995	2005	1995	2005	1995	2005
China	19.4	**40.8**	16.9	19.4	63.7	39.8
Mexico	36.2	**40.8**	38.5	36.9	25.3	22.3
Korea	35.7	**40.3**	31.4	42.4	32.9	17.3
United States	36.2	36.2	39.8	43.4	24.0	20.4
Japan	37.9	31.8	49.6	55.1	12.5	13.1
France	21.6	22.3	43.1	48.5	35.3	29.2
Germany	18.8	21.4	53.8	55.2	27.4	23.4
Brazil	5.9	11.2	28.6	33.4	65.5	55.4
India	3.3	4.5	17.4	27.6	79.3	67.9

Source: Author's calculations based on United Nations, Comtrade Database.

These three countries show the greater dynamism and quality of its manufactured exports that the export powers (U.S., Japan and Germany). However, Mexico, unlike China and Korea, shows a low rate of economic growth (Table 2). This contradicts the claim of much of the theoretical and empirical literature argues that manufacturing exports are engines of economic growth.

Table 2
Growth rate of GDP, Exports and Imports and Income Elasticity of Demand for Imports, 1996-2006 (Percentages)

	Growth rate of:			Income Elasticity of	Exports	Imports
	Exports	Imports	GDP	Demand for Imports	as percent of GDP	
China	20.84	17.73	**9.51**	1.86	26.65	23.14
India	14.84	13.02	6.68	1.95	14.32	15.93
Korea	12.93	8.64	**4.59**	1.88	37.10	34.14
Mexico	9.04	11.82	**3.79**	3.12	28.74	29.99
United States	4.94	7.88	3.32	2.38	10.51	14.15
Brazil	8.33	4.01	2.55	1.57	11.54	11.14
France	5.20	6.09	2.19	2.78	14.32	15.93
Germany	8.00	6.45	1.49	4.33	34.08	31.23
Japan	6.28	3.95	1.22	3.23	11.87	10.53

Source: Author's estimates based on World Development Indicators (2011).

From a set similar features of the Chinese economy and Mexican (mid-eighties of last century more than half of total exports were manufacturing exports and over 50% of manufacturing exports are processing trade, have recently acquired a significant participation in the global value chains, both economies have important participation of manufacturing, etc..) a comparative analysis is performed in order to establish why the Chinese manufacturing exports have become an engine of economic growth, however, in the Mexican economy is not the case.

China and Mexico embarked, around the early 1980s, on the process of liberalization of trade and FDI and established some export oriented industries through assembly operations with the help of FDI.

Other imports reasons of motivation of paper are that growing intermediate inputs are a growing force in world trade. 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. Its have important implications: Bilateral trade balances are not appropriately measured, and the importance of exports as drivers of short-term demand is overestimated.

Table 3

China and Mexico: Evolution of processing exports as a share total exports, 1990-2006 (Percentages)

	1990	1993	1994	1995	2000	2005	2006
China	41	48	47	49	55	55	53
Mexico	34	42	43	39	48	45	45

Source: Author's calculations based on China Statistical Yearbook and Bank of Mexico.

Table 4
China and Mexico: Evolution of processing exports as a share manufacturing exports, 1990-2006 (Percentages)

	1990	1993	1994	1995	2000	2005	2006
China	55	59	56	58	62	58	56
Mexico	50	53	53	47	55	56	55

Source: Author's calculations based on China Statistical Yearbook and Bank of Mexico.

Table 5
China and Mexico: Evolution of processing exports as a share total imports, 1990-2006 (Percentages)

	1990	1993	1994	1995	2000	2005	2006	2010
China	35	35	41	44	41	42	41	30
Mexico	25	25	26	36	35	34	34	

Source: Author's calculations based on China Statistical Yearbook and Bank of Mexico.

Table 6
China and Mexico: Evolution of processing exports as a share manufacturing imports, 1990-2006 (Percentages)

	1990	1993	1994	1995	2000	2005	2006
China	55	59	56	58	62	58	56
Mexico	50	53	53	47	55	56	55

Source: Author's calculations based on China Statistical Yearbook and Bank of Mexico.

Table 7
China and Mexico: Composition of exports, 1980-2006
(Percentages)

	China		Mexico	
	Primary Goods	Manufactured Goods	Primary Goods	Manufactured Goods
1980	50.3	49.7	69.3	30.7
1985	50.6	**49.4**	62.4	**37.6**
1986	36.4	**63.6**	40.9	**59.1**
1990	25.6	74.4	31.7	68.4
1993	18.2	81.8	20.8	79.2
1994	16.3	83.7	18.2	81.8
1995	14.4	85.6	17.3	82.7
1996	14.5	85.5	17.2	82.8
1997	13.1	86.9	14.9	85.1
1998	11.2	88.8	10.7	89.3
1999	10.2	89.8	11.1	88.9
2000	10.2	89.8	13.0	87.0
2001	9.9	90.1	11.2	88.8
2002	8.8	91.2	12.0	88.0
2003	7.9	92.1	14.4	85.6
2004	6.8	93.2	15.6	84.4
2005	6.4	93.6	18.0	82.0
2006	5.5	94.5	18.7	81.3
Average 1996-2006	**9.5**	**90.5**	**14.3**	**85.7**

Source: Author's calculations based on China Statistical Yearbook and Bank of Mexico.

At the end of the eighteenth century, Adam Smith famously noted that making a pin was divided into about 18 distinct operations. Today, as mentioned by Levine (2010), making a Boeing 747 requires more than 6,000,000 parts, each of them requiring many more operations.

This paper aims to contribute to explain why the growing exports of medium and high technology products has weakly driven Mexico's economic growth and the strongly in the Chinese economy. Our point of departure is that exports constitute an engine of economic growth if they fulfill two conditions: a) the productive integration/ articulation between the export sectors and the rest of the economy, b) the country's participation in the global production network in the stages of production which add more domestic value added.

Since the mid-eighties China and Mexico have begun the process of trade liberalization and deepening of the attraction of foreign direct investment to establish assembly operations using the strategy of export-led growth in manufacturing, aiming increase the value added in processing industries for exports. Although both countries share a similar feature set such as manufacturing export boom of medium and high technology, 55% of manufacturing exports are processing trade, the impact and capacity of drag have been markedly different in each country depending on two key issues discussed in the research: 1) the degree of articulation of the export sectors with the rest of the economy, 2) of the country's participation in the stage of the global production chain which add more value to along the global network of production and value added embodied in exports.

The structure of the paper 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. Section 2 highlighting the mains concepts and measures of the vertical specialization. Section 3 we performed a comparative analysis between Mexico and the OECD countries and some countries in Asia on vertical specialization and global value chains. Section 4 analyze the first reason why China is growing faster than Mexico based on the degree of integration by focusing on the linkages, vertical specialization and by means of average propagation lengths. Section 5 analyze the second reason consistent in the position of countries in the global value chains and value added content in exports. Section 6 concludes.

II. Vertical Specialization

II.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, "*slicing up the value-added chain*" (Krugman, 1996); "*outsourcing"* (Feenstra and Hanson, 1996, 1999); "*global production sharing*" (Feenstra, 1998); "kaleidoscope comparative" (Bagwati and Dehejia, 1994); "*intra-product specialization*" or "*superspecialization*" (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; Go 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 specialization 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

$$VS \text{ share of total exports} = \boldsymbol{u}\boldsymbol{A}^{M}\boldsymbol{X}/\boldsymbol{X}_{\boldsymbol{k}} \qquad (1)$$

where u is a unit vector of dimension n, A^M 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 a^M_{ij} a of the matrix A^M 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:

$$VS\ share\ of\ total\ exports = \boldsymbol{uA^M[I - A^D]^{-1}X/X_k} \qquad (2)$$

where A^D is the matrix of the input coefficients for domestic intermediate goods and $(I - A^D)^{-1}$ 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 Chinese and 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:

$$VS = \boldsymbol{A^M[I - A^D]^{-1} < X >} \qquad (3)$$

Where A^M is the matrix of imported coefficients of inputs, A^D 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.

The VS share measure represents the intermediate imports directly and indirectly induced by export demand, which can also be described as the value of imported intermediates embodied in a country's exports. This indicator also represents the backward linkage in inter-industrial production chains, since it's based on the Leontief inverse.

Sectoral VS shares give us some indication of how far up Mexico and China 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. Next section is focused in the study for China and Mexico to sector level.

III. 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.

Table 8
Growth rate of manufacturing exports, 1995-2005
(Percentages)

Country	Manufacturing			
	Avanced	Intermediate	Traditionals	Manufacturing Total
China	**27.4**	**20.0**	**12.9**	**18.3**
Brazil	16.1	10.6	7.1	8.9
India	14.9	16.4	9.5	11.2
Mexico	**11.5**	**9.8**	**8.8**	**10.2**
Korea	**9.5**	**11.5**	**1.5**	**8.2**
Germany	8.0	6.9	5.0	6.6
France	4.7	5.5	2.3	4.3
United States	4.6	5.5	2.9	4.6
Japan	0.9	3.8	3.1	2.7

Source: Author's calculations based on United Nations, Comtrade Database.

Table 9
Composition of manufacturing exports by dynamism and technology
(Percentages)

Country	Manufacturing					
	Avanced		Intermediate		Traditionals	
	1995	2005	1995	2005	1995	2005
China	19.4	**40.8**	16.9	19.4	63.7	39.8
Mexico	36.2	**40.8**	38.5	36.9	25.3	22.3
Korea	35.7	**40.3**	31.4	42.4	32.9	17.3
United States	36.2	36.2	39.8	43.4	24.0	20.4
Japan	37.9	31.8	49.6	55.1	12.5	13.1
France	21.6	22.3	43.1	48.5	35.3	29.2
Germany	18.8	21.4	53.8	55.2	27.4	23.4
Brazil	5.9	11.2	28.6	33.4	65.5	55.4
India	3.3	4.5	17.4	27.6	79.3	67.9

Source: Author's calculations based on United Nations, Comtrade Database.

The developed economies of Japan and the US present comparable shares of imported inputs in exports for 2008 (16.9% and 15.2%). 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 83.1% and 84.8% in 2008, 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 10

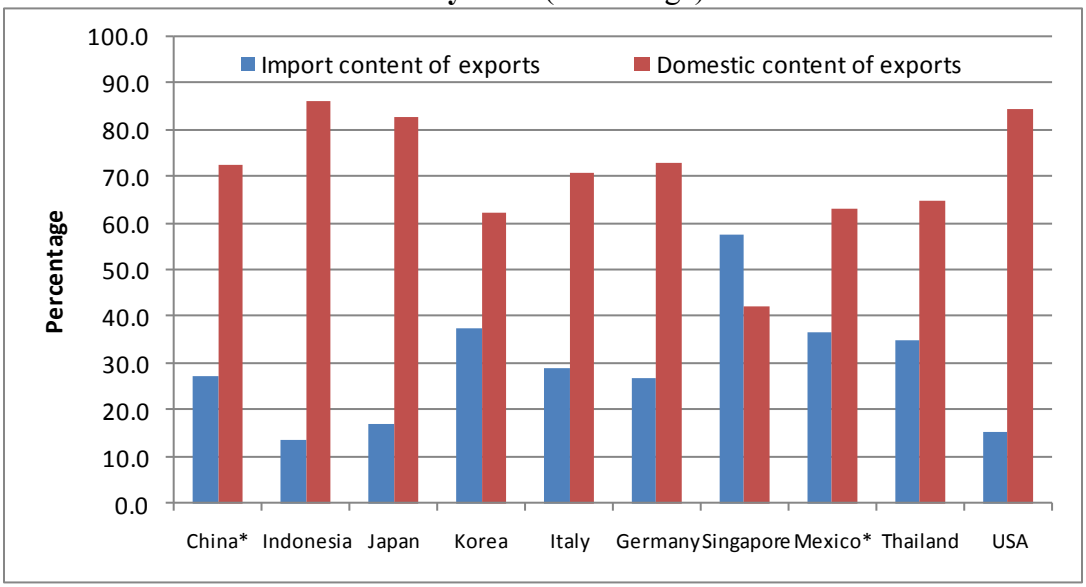
OECD and Asian Countries: Import content and domestic content of total exports, 2005 y 2008 (Percentage)

	China* 2005	**Indonesia** 2008	**Japan** 2008	**Korea** 2008	**Italy** 2005
Import content of exports	27.4	13.5	16.9	37.4	29.0
Domestic content of exports	72.6	86.5	83.1	62.6	71.0
	Germany 2005	**Singapore** 2008	**Mexico*** 2003	**Thailand** 2008	**USA** 2008
Import content of exports	27.0	57.9	36.7	35.0	15.2
Domestic content of exports	73.0	42.1	63.3	65.0	84.8

Source: Estimates based on IDE-JETRO AIO tables, OECD Database and estimates for Mexico based on 2003 INEGI-IO tables

Figure 3

OECD and Asian Countries: Import content and domestic content of total exports, 2005 y 2008 (Percentage)



Source: Estimates based on IDE-JETRO AIO tables, OECD Database and estimates for Mexico based on 2003 INEGI-IO tables.

Surprisingly, the vertical specialization observed in 2008 for Indonesia (13.5%) is slightly upper than that of Japan and the US (Table 10). 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, Slovak Republic and Czech Republic (60%, 56%, 51%, 51%, 49% 48% for 2005)[1] 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).

Due the similarity of manufacturing export structure is possible to compare China, Korea and Mexico, with a share of over 40% of advanced manufacturing exports. Mexico is the country with the greater fragmentation of production among the major exporters of manufactures advanced, such as China and Korea, with 37% of import content in exports (Table 10). In contrast, the U.S. export powers and Japan show over 83% the domestic content in exports.

The estimates for China's import content of exports turn out to be low (around 27 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 (representing 53% and 45% respectively in 2006, with a decreasing trend in the case of China's economy and as a share (proportion) of manufacturing exports accounted for 55% in both economies and further reduced this ratio in China, in the 2008 is 47%), and the measure of import content of exports is obviously underestimated as China and Mexican's export processing zones employ much more imported inputs than exports stemming from non-processing zone trade.

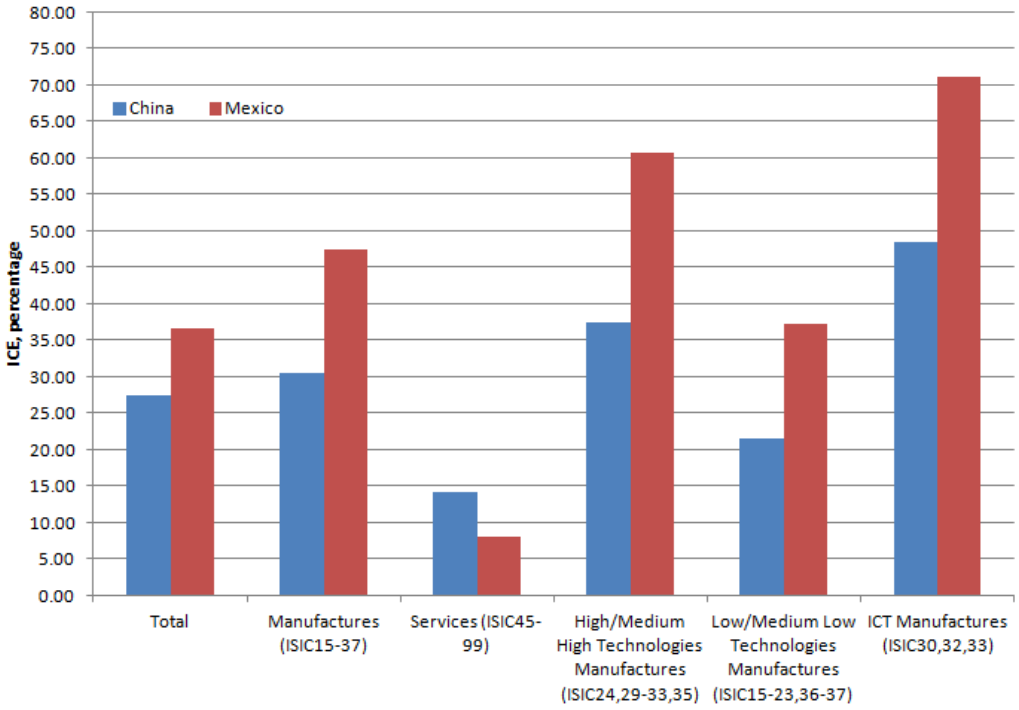
Koopman, Powers, Wang and Wei (2010) taking into account this aspect, they find that the imported component of exports of Mexico is 48.0% compared to 35.7% from China, ie the added value of China's most that observed for the Mexican economy.

Our estimations of the vertical specialization for Mexico using the 2003 IO table of INEGI is of 37%. 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 37 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,

[1] OECD (2010).

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.

Figure 4
China and Mexico: Import content of exports (ICE) by technology content, 2005 (Percentage)



Source: Autor´s estimates based on OECD Input-Output Database, 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.[2] In terms of demand and value added, ICT goods are considered as one of the most

[2] World Trade Organization international trade database.

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).

Lee (2011) empirically investigates the extent to which the technological characteristics of exports affect patterns of economic growth driven by trade between countries, based on a regression between real per capita real income, the Balassa index by technological intensity and set of control variables for a sample of 71 countries for the periods 1970-74 and 2000-2004. The results included to highlight that technology seems to be important in the observed phenomenon of export-led growth; they find that countries that have specialized in exporting high technology products such as aircraft, pharmaceuticals and electronics generally have grown faster. By contrast, countries that have fallen behind have tended to specialize increasingly in the export of "traditional" or low-tech, such as textiles and food products.

IV. Fragmentation: A Comparative Analysis between China and Mexico

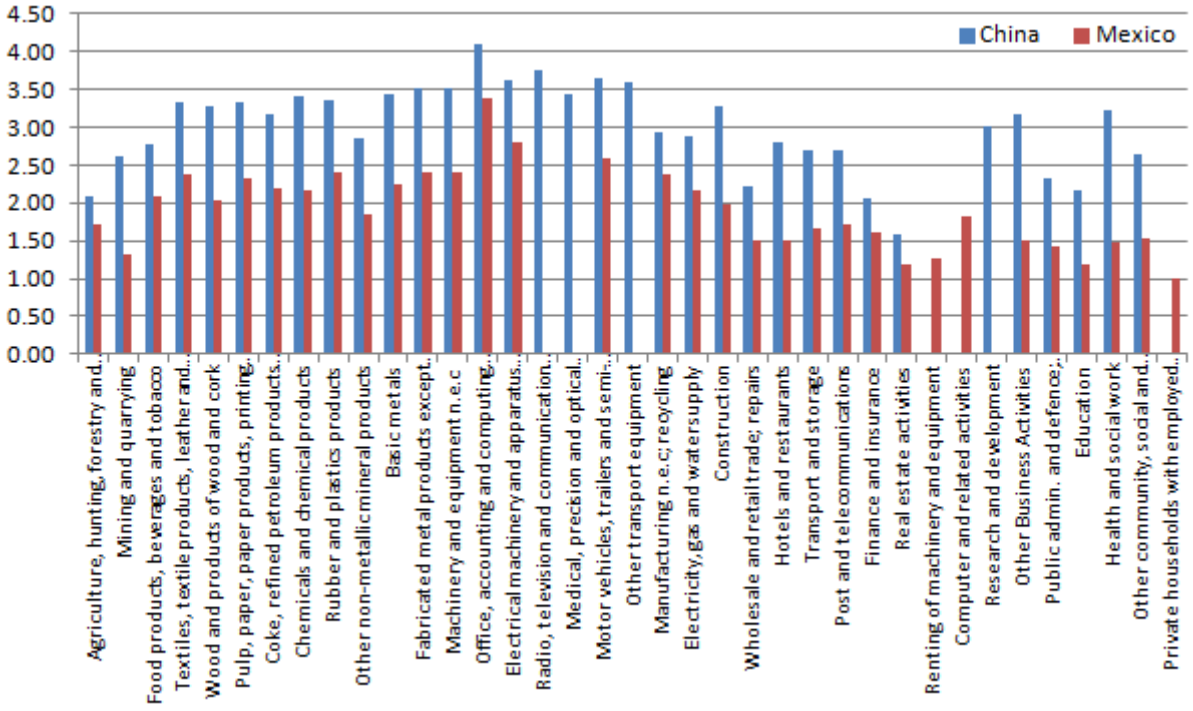
IV. 1. Linkages

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 delinking if their imports and exports has been growing increasingly incorporated domestic 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 (Table ¿?). 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).

A first empirical evidence of the strong degree of articulation of the Mexican economy in comparison with China is that all the backward linkages in all sectors, both in total and household IO in China are larger than Mexico (Figure 5 y 6).

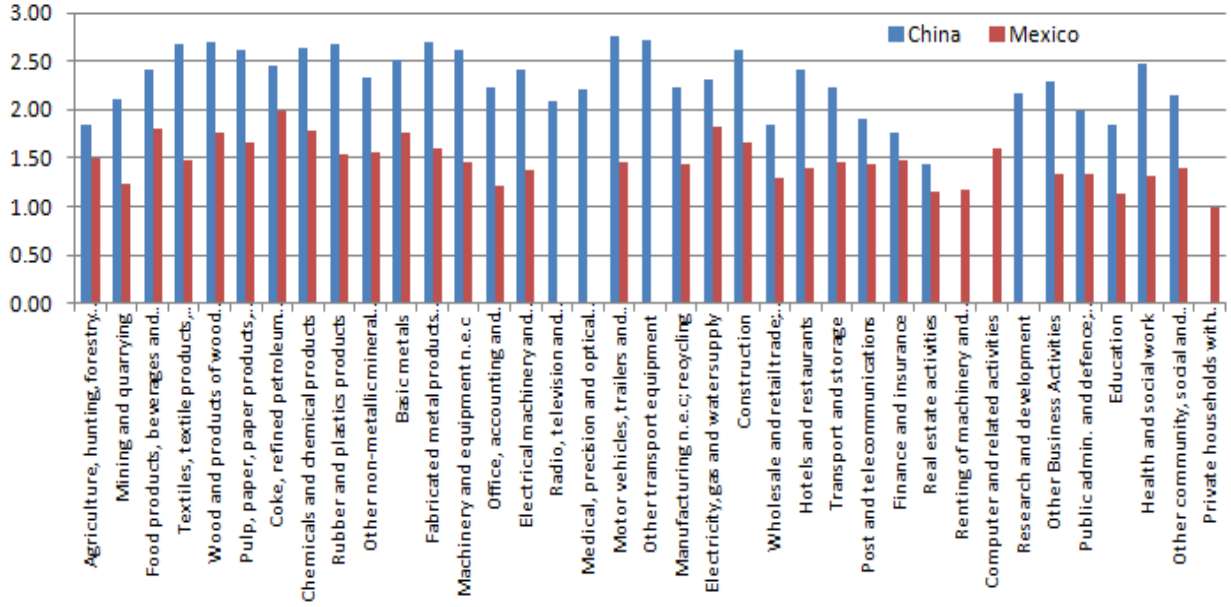
Considering the domestic IO table (internal economy) the vertical specialization of Mexico falls to 16% and the domestic component of exports increased to 84% from 63%. This is an important indicator of the impact of the maquiladora industry and the degree of fragmentation of production is less than half in the case of the domestic economy, not taking into account the maquiladora industry.

Figure 5
China and Mexico: Backward Linkage (BL), 2005
(Total IO table, Total Economy)



Source: Autor´s estimates based on OECD Input-Output Database, 2010.

Figure 6
China and Mexico: Backward Linkage (BL), 2005
(Domestic IO table, Total Economy)



Source: Autor´s estimates based on OECD Input-Output Database, 2010.

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 3.12 (Table 2). In the period 1996-2006, Mexico's economic growth depended increasingly on foreign goods: a 1 percent GDP growth was accompanied by a 3.1 percent growth of imports in that period, more than in decades past and that not only is the highest compared to similar countries such as manufacturing export structure of China and Korea but is one of the highest worldwide. This means that if real income increases at a rate of say 5 percent, imports would at a rate of 15.6 percent requiring that exports will grow at a similar rate to keep the trade balance at tolerable levels, if this is added to an adverse movement in the terms of trade in manufactures in the period 2000-2010 have been increased only by about 7% compared to mineral-exporting countries (primary) which have increased by approximately 50% based on 2000, the expansion of exports would have to be many times 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.

The argument is as follows. The lower elasticity of imports from China in relation to Mexico explains that Chinese manufacturing exports have greater push´s capacity because of their strong linkages between the manufacturing export sector and the rest of China's economy, and therefore, higher growth economy. Because domestic production of intermediate goods imports need not grow up to export more, which implies an increase of trade surplus for the incorporation of local inputs and value added in exports and,

consequently, a greater contribution from net exports economic growth in China, in short, as a result of delinking of exports of intermediate imports and greater production linkages.

In the nineties, the prevailing view that China's economic growth has been essentially domestic, and that China is not only a global workshop in which one becomes abundant labor inputs in consumer goods and real unsophisticated export capital. This position was supported by Shu and Yip (2006), which indicated that changes in relative prices have had little effect on exports, the trade balance and economic growth in China because it is a processing center, ie changes in exports and imports in general are void.

However, this interpretation does not reflect the current reality. Perhaps it was right at the beginning of the reform of China's economy when, due to the lack of technical knowledge, production and exports of the country depended on imports of intermediate and capital goods (Lemoine and Ünal-Kesenci, 2002) but a study shows that the situation may have changed in recent years. The domestic content of China's exports has increased and its products have become more sophisticated, in part because of substantial investments and technological upgrades that have expanded the economy's production capacity (Cui and Syed, 2007).

Over the past four years, China's trade surplus has risen sharply, reaching about $218 billion, or more than 8 percent of GDP in 2006, from an average of about 3 percent of GDP between 2000 and 2004. The trade surplus has been propelled by a sharp rise in the manufacturing sector surplus. In particular, machinery, electronic appliances, and transportation equipment account for more than half of the trade surplus, compared with a significant deficit only a few years ago.

The widening of the trade surplus has been driven mainly by a significant slowdown in imports, which started to lag export growth by large margins in early 2005. In contrast, during most of the past decade, import and export growth were typically on a par, consistent with China's role as a processing center.

Cui and Syed (2007) using panel estimates show that the positive relationship between the parts and components imports and exports of final products initially strong and has weakened significantly in recent years, while it has become more positive relationship between imported inputs and domestic demand, which suggests that China is increasingly more parts and components imports to meet domestic needs production (which grow with the expanding domestic production capacity). Therefore, the conventional view of China's main role in international trade as an assembly center is not as good a fit as it once was.

The slowdown in imports occurred during a period of booming investment, as China's increased domestic production capacity has enabled greater domestic sourcing for intermediate products.

With the expansion of domestic supply, China is increasingly shifting from simple assembly operations toward operations that have greater scope for using domestic inputs. The share of the former has declined sharply, accounting in 2006 for only about 10 percent

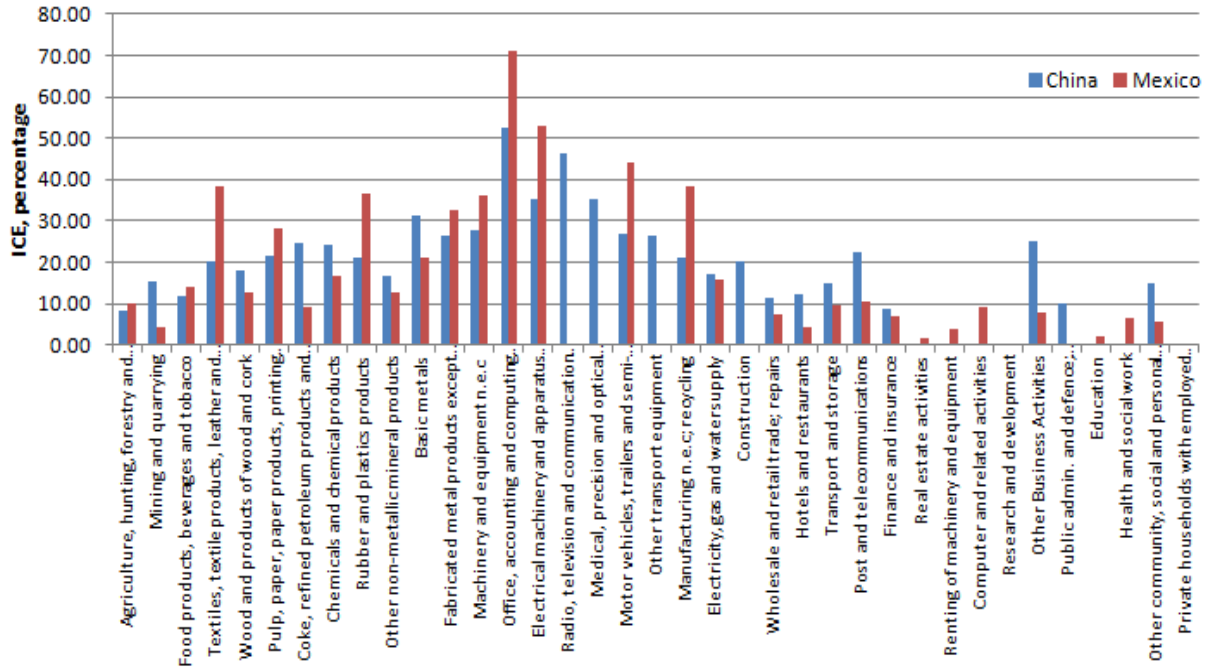
of the processing trade balance, down from more than 30 percent in the late 1990s. The latter, in contrast, has increased in importance (Cui and Syed, 2007).

IV.2. Vertical Specialization of China and México at level sectoral (meso)

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.

Sectoral VS shares give us some indication of how far up Mexico and China 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.

Figure 7
China and Mexico: Import content of exports (ICE), 2005
(Percentage)



Source: Autor´s estimates based on OECD Input-Output Database, 2010.

Vertical specialization not only shows the important participation in global value chains and the fragmentation of China and Mexico but also in practically all sectors Mexico exhibits greater degree of fragmentation than China (Figure 7). The sectors Office, accounting and computing machinery, Electrical machinery and apparatus n.e.c, and Textiles, textile products, leather and footwear has with high of import content in exports.

IV. 3. Analysis of fragmentation by means Average Propagation Lengths

While vertical specialization represents an important step to explicitly incorporate the backward linkages associated with exports and establish the industrial linkages of some segments of production chains, however, the sequence can be traced for more than two consecutive stages production. Vertical Specialization, therefore, fails to provide a complete picture of entire production chains, and is bound to give us only a partial indication of the dynamics of international fragmentation.

Complexity may be defined as the degree of sectoral intermediate production interaction and is measured by the number and size of the internal linkages. In the input-output literature, multiple indicators have been proposed to capture complexity. In fact, any measure for the size of the linkages can be considered as an indicator of the complexity of the system.

While backward linkage indicator only shows the overall effects of marginal changes in final demand for each sector in target economy, the *Average Propagation Lengths* (APLs) allows us to evaluate the fragmentation process into spatial fragmentation and functional fragmentation. It is based on the input-output model recently developed by Eric Dietzenbacher and others, which show the average number of production stages that are passed through for an exogenous change in one industry to affect another. They focus their attention has shifted from the size of the effects between sectors to the distance between the sectors. The idea of distance is reflected by the number of steps it takes a stimulus in one sector to affect another sector. It thus yields a measure of the time and cost of adjustment, and, consequently, of the system's complexity. APL is an indicator which indicates the complexity of inter-industrial transactions in the input-output table (Dietzenbacher and Romero, 2007; Dietzenbacher and Temurshoev, 2008, Romero *et al*., 2009; Inomata, 2009). The new measurement is formulated such that it captures every aspect of the vertical sequence of production linkages.

When considering the distances from one sector to any sector in the production system, we take averages. This may be done from two perspectives, a forward and a backward. The forward average APL is defined as:

$$FA_i = \frac{1}{n}\sum_{j=1}^{n} APL_{ij} \qquad (4)$$

and the average backward APL is defined as:

$$BA_j = \frac{1}{n}\sum_{i=1}^{n} APL_{ij} \quad (5)$$

where *n* is the number of sectors, in the case of the economies of China and Mexico *n=37*.

The forward average APL (FA_i) gives the average distance from sector *i* to any *sector* j when considering the effects on the output value of sector *j* due to a cost-push in sector *i*. Figures 8 and 9 gives the FAs and BAs in 2005. The largest FA corresponds to Food products beverages and tobacco (2.98) and the smallest to the Post and telecommunications (2.11). In the case Mexican economy, the largest FA corresponds to Agriculture hunting forestry and fishing (2.14) and the smallest to the Manufacturing nec. recycling (include Furniture) (1.25).

The backward average APL (BA_j) gives the average distance from sector *j* to any sector *i* when considering the effects on the output value in sector *i* due to of a demand-pull from sector *j*. For the estimated input-output table of 2005 China´s economy, Figures 8 and 9 shows that the largest BA corresponds to the Coke refined petroleum products and nuclear fuel sector (2.73) and the smallest to Research & development (2.03). In the case Mexican economy, this sectors are Coke refined petroleum products and nuclear fuel (1.84) and Manufacturing nec. recycling (include Furniture) (1.37). Its an indicator of strong fragmentation of the manufacturing exports are most dynamic and represent the main percentage of the total exports.

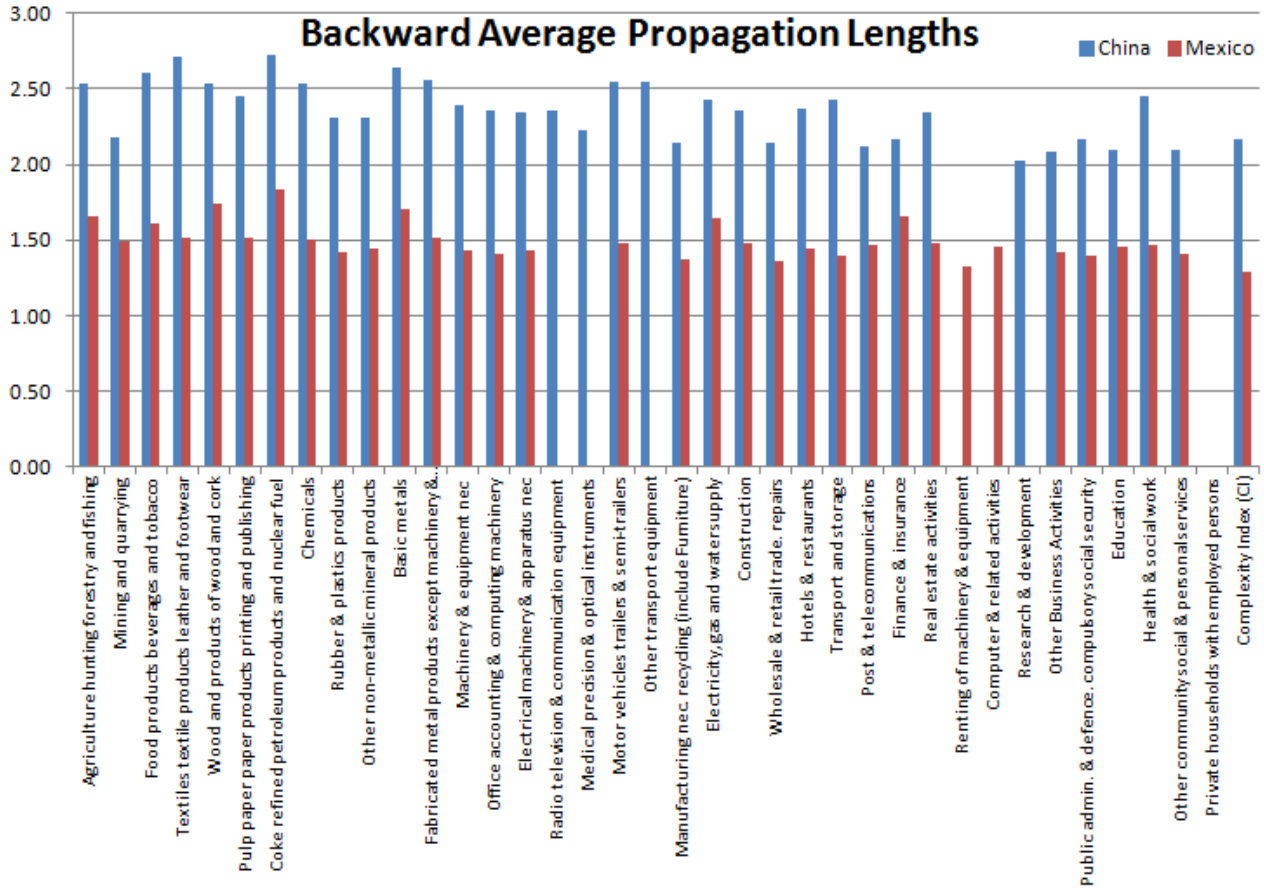
A large FA together with a small BA indicates that a sector is situated at the beginning of production chains. This is, for instance, the case for Mining and quarrying in Figures 8 and 9 for 2005 (FA = 2.97; BA = 2.18). A large BA and a small FA indicate that a sector is situated at the end of production chains. An example in the 2009 input-output table might be the Fabricated metal products except machinery and equipment sector (BA = 2.56; FA = 2.24). In the Mexican economy these are: Mining and quarrying (FA = 2.11; BA = 1.49) and be the Fabricated metal products except machinery and equipment sector (BA = 1.51; FA = 1.37).

Finally, the overall average of the APLs can be used as an index for measuring complexity of the production system. That complexity index (*CI*) would be given by the following expression:

$$CI = \frac{1}{n^2}\sum_{i=1}^{n}\sum_{j=1}^{n} APL_{ij} = \frac{1}{n}\sum_{i=1}^{n} FA_i = \frac{1}{n}\sum_{j=1}^{n} BA_j \quad (6)$$

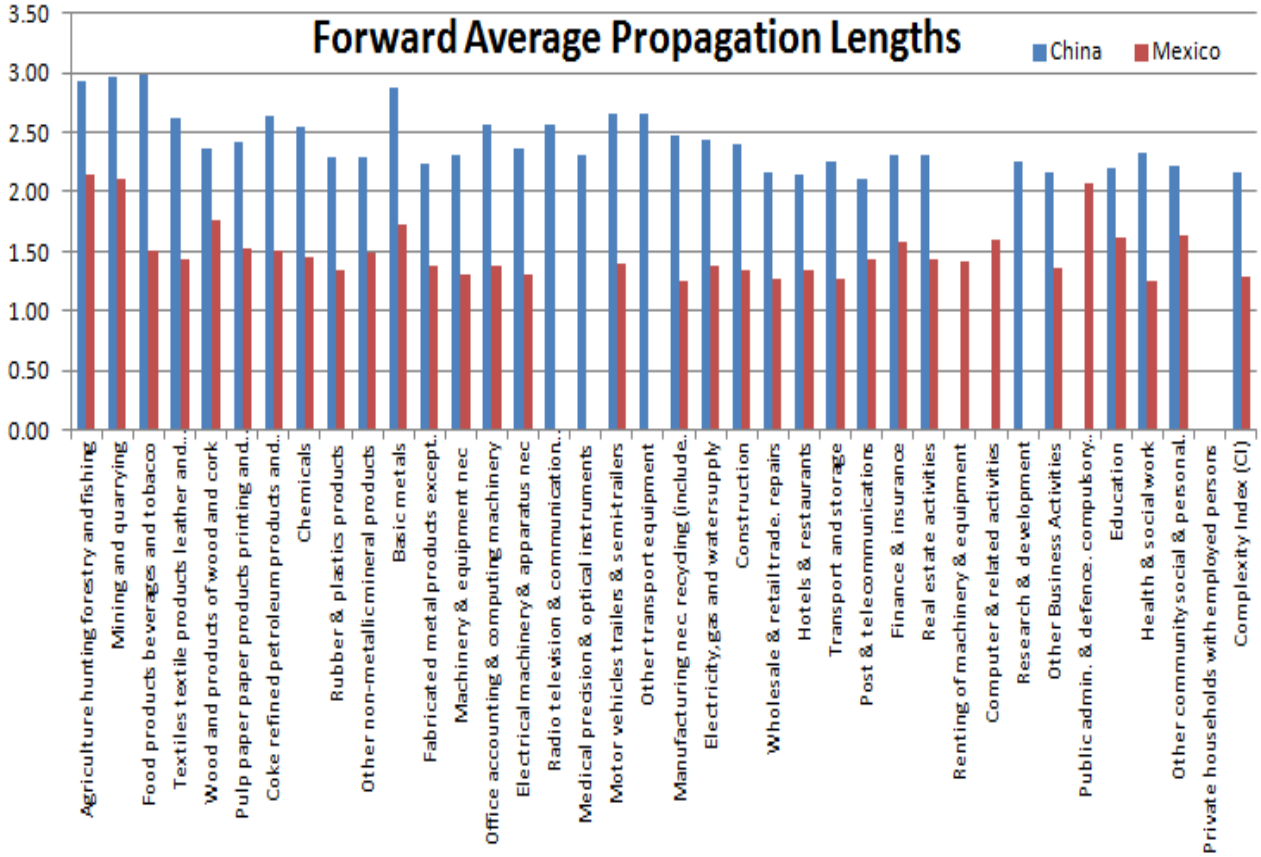
The complexity index of China is 2.17 and of Mexico is 1.30, indicating the average distance between any possible pair of sectors in the 37x37 input-output tables, i.e. the China´s economy is most complexity that Mexican economy.

Figure 8
China and Mexico: Backward Average Propagation Lengths, 2005



Source: Autor´s estimates based on OECD Input-Output Database, 2010.

Figure 9
China and Mexico: Forward Average Propagation Lengths, 2005



Source: Autor´s estimates based on OECD Input-Output Database, 2010.

V. Analysis of Position of countries in the Global Value Chains

Based on data from Koopman et al (2010) constructed an indicator to show the position of countries in global value chains, in aggregate and highlight two interesting features. First, compared with advanced economies, emerging economies, such as Mexico, China and EU accesion countries have relatively high import content in exports. Second, emerging economies such as Mexico and China, tend to have a lower proportion of indirect exports are sent to third countries, which meaning that in the end in the global supply chains and low value added. The relationship of these two measures provides a useful indicator of the country's position in the global supply chain, confirming the position downstream of the emerging economies and position upstream of the advanced economies in the global supply chain. This means that countries like Mexico and China are focusing on assembly activities, but as argued below, China moving up in the global value chains unlike Mexico after more than 40 years of maquila industry has not upgrading.

Table 11
Position of countries in the Global Value Chains, 2004
(Percentages)

	Imported contents embodied in gross exports	Indirect exports sent to third countries	*Usptream* or *downstream position*
Avanced economies			
Japan	12.2	31.3	2.6
United States	12.9	26.9	2.1
EU-15	11.4	20.7	1.8
Asian Newly Industrialized Countries			
Korea	33.9	23.3	0.7
Hong Kong	27.5	19.6	0.7
Taiwan	41.1	27.4	0.7
Emerging Countries			
China	35.7	12.6	0.4
EU accesion countries	30.8	11.2	0.4
Mexico	48.0	10.0	0.2

Source: Authors´ calculations based in Koopman et al (2010).

EU-15:Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and UK.

EU accession: Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia and Slovenia.

As an important indicator of the overall level of processing trade, the value-added ratio of the processing trade, the ratio of export value to import value over a specific period, reflects the size of added value in processing. This indicator is useful in understanding the position of China's processing trade in the global industrial chain. The value-added ratio of the processing trade is an indicator that measures the added value created by an industry and indirectly reflects the upgrading status of the industry on the global value chain. Over the decade from 2001, the year in which China joined the WTO, to 2010, the proportion of processing exports to China's overall exports dropped from 55.4% to 46.9%, while the

value-added ratio climbed from 56.9% to 77.4%. In this sense, the rise of the value-added ratio of the processing trade and the decreased of processing trade not only means the increasing role the sector plays in boosting the national economy, but also reflects the progress that China has made in the transformation and upgrading of processing trade by increasing their opportunities for economic growth.

With the expansion of domestic supply, China is increasingly shifting from simple assembly operations toward operations that have greater scope for using domestic inputs. The share of the former has declined sharply, accounting in 2006 for only about 10 percent of the processing trade balance, down from more than 30 percent in the late 1990s. The latter, in contrast, has increased in importance (Cui and Syed, 2007).

The argument is as follows. The lower elasticity of imports from China in relation to Mexico explains that Chinese manufacturing exports have greater push´s capacity because of their strong linkages between the manufacturing export sector and the rest of China's economy, and therefore, higher growth economy. Because domestic production of intermediate goods imports need not grow up to export more, which implies an increase of trade surplus for the incorporation of local inputs and value added in exports and, consequently, a greater contribution from net exports economic growth in China, in short, as a result of delinking of exports of intermediate imports and greater production linkages.

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 delinking if their imports and exports has been growing increasingly incorporated domestic 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. Moreover, China has upgraded from mere assembly of imported inputs to the manufacturing of high-tech intermediate goods.

On average, Mexico's domestic value-added in manufacturing exports is approximately 34% (Cruz, Koopman and Wang, 2011), a share that is relatively lower that of China of 51% (Koopman, Wang and Wei, 2008). Low domestic content industries in both countries include computers and accessories and telecommunications equipment. Some higher domestic value-added industries that are similar in both countries include motor vehicles, cement, and pesticide and fertilizers.

The domestic content of non-trade processing for computers of Mexico (63.9%) is lower than China (80.6%). The domestic content of processing trade Mexico for computers (8.5%) is higher than China (3.9%), suggesting some degree of backward integration in information and communication technology in Mexico. The literature cites the case of the creation of complex high-tech electronics in Jalisco as the "Silicon Valley" of Mexico as a result of partnerships between national, foreign companies and the university system in the city of Guadalajara. However, despite this important endeavor the country has moved very modestly in the global supply chain in the areas of software development and services information technology. In fact, the domestic value added processing trade of Mexico in the

communication equipment (14.9%) is half that of China (31.2%), while the electronic component is 15% for both countries but again the domestic value-added processing trade is not conducive to China with regard to Mexico (86.9% vs. 80.3%). The industries with high value added domestic processing trade in Mexico are railroad rolling stock manufacturing (63.0%) and pesticides, fertilizers and other agricultural chemicals (82.4%) than higher than China (33.1% and 30.2% respectively). In contrast, the domestic value added of non-processing trade in the railroad rolling stock manufacturing of China (86.7%) is higher than Mexico (59.9%).

If the domestic added value of processing trade in China is higher than that of Mexico, it is the domestic value added of non-trade processing. This is an important structural indicator of industrial upgrading in global value chain that is indicating that China's economy is to shift from of processing and assembly to production process, thereby generating the potential linkages between the manufacturing export sectors and the rest of the economy and upgrading to the stages of global production chains, which add more value added.

Under the current context of increasing International fragmentation of production the conditions and sources of economic growth and development is the process of industrial upgrading of the sectors that are heavily involved in global production chains.

China, as a result of the process of industrial upgrading in global value chains, has created domestic and global champions in the sectors of high-speed rail transport, information technology, machinery and transport equipment, and aerospace[3]. In this sense, an important research finding is that these sectors, which today are manufacturing sectors that serve as an engine of economic growth in China is precisely where it has made a consistent and systematic policy of upgrading in last decades. The criterion that has guided China's industrial policy is that a country becomes what it exports, it exports and determines your level of future economic growth, so that the measures and instruments for upgrading exporter has become a key issue for economic growth and development. A fundamental element of industrial upgrading for export has been foreign direct investment. The key element of the virtuous relationship between foreign direct investment and economic growth has been to support the integration of domestic producers in the global production networks led by transnational corporations through the building of capabilities domestic firms, which ultimately have resulted in the creation of national champions and global bearings that are driving economic growth.

In China, unlike of Mexico the manufacturing exports and foreign direct investment by acting together have become engines of economic growth, which allowed the export

[3] China has an important role on the new 787 Dreamliner airplane, building the rudder, wing-to-body fairing panels, leading edge and panels for the vertical fin, and other composite parts. Also, Airbus reports that over half of its fleet worldwide contains components produced by Chinese companies.

industrial upgrading and achieved high rates of economic growth. It has played a role fundamental the industrial policy. Since it is not the objective of the research did not delve into this aspect.

Moreover, China is a success case of overcoming the constraint of global factory that forced her to participate only as a supplier of cheap labor in global value chains, with weak or no capacity of drag the economic growth. In this sense, there are important lessons that Mexico can learn of China to convert the manufacturing sectors of medium and high-tech in engine of economic growth.

Due the strong degree of interdependencies as result of the Global Value Chains a crisis have effect in cascaded throughout along the Global Value Chains, increasing the severity of the problem. GSC intensified vertical specialization and increased trade, particularly in intermediate goods. A decline of the demand for industrial goods equivalent to a -1 per cent demand shock in the United States is estimated to cause a reduction of exports from South America by 0.9 per cent or from China by 0.95 per cent and 2.34 from NAFTA (Canada and Mexico), demonstrating the high degree of vertical integration of these economies (Bems, Johnson and Yi 2009).

The impact of the past crisis was different to the type of specialization of the various economies within global production networks: the more forward linkages of the export industry, the greater the impact of the crisis on exports (Japan and Germany). By contrast, the coexistence of forward and backward linkages imposed a more evenly between exports and imports (China) or import effect on economic growth. This follows from the fact that United States and Japan export intermediates to China and get more and more final goods in return. In reality more the 55% of the manufacturing exports are intermediates (Table 9).

VI. Conclusions

This paper aims to contribute to explain why the growing exports of medium and high technology products has weakly driven Mexico's economic growth and the strongly in the Chinese economy. From a set similar features of the Chinese economy and Mexican (mid-eighties of last century more than half of total exports were manufacturing exports and over 50% of manufacturing exports are processing trade, have recently acquired a significant participation in the global value chains, etc..) a comparative analysis is performed in order to establish why the Chinese manufacturing exports have become an engine of economic growth, however, in the Mexican economy is not the case. Our point of departure is that exports constitute an engine of economic growth if they fulfill two conditions: a) the productive integration/ articulation between the export sectors and the rest of the economy, b) the country's participation in the global production network in the stages of production which add more domestic value added.

The argument is as follows. The lower elasticity of imports from China in relation to Mexico explains that Chinese manufacturing exports have greater push´s capacity because of their strong linkages between the manufacturing export sector and the rest of China's economy, and therefore, higher growth economy. Because domestic production of intermediate goods imports need not grow up to export more, which implies an increase of trade surplus for the incorporation of local inputs and value added in exports and, consequently, a greater contribution from net exports economic growth in China, in short, as a result of delinking of exports of intermediate imports and greater production linkages.

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 delinking if their imports and exports has been growing increasingly incorporated domestic 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. Moreover, China has upgraded from mere assembly of imported inputs to the manufacturing of high-tech intermediate goods.

These two aspects are analyzed from two different but complementary theoretical and methodological approaches for the study of the fragmentation of production: Vertical Specialization and Average Propagation Lengths. Its approaches we analyze the international fragmentation of production, which will allows us to establish the capacity to push and analysis of the "linkages" and the distances between sectors. On the other hand, trough vertical specialization we analyze the value added content of exports derived from the participation of China and Mexico and their positions in the global value chains.

The strong degree of fragmentation of the Mexican economy in comparison with China is that all the backward linkages in all sectors, both in total and household IO in China are larger than Mexico. Vertical specialization not only shows the important participation in global value chains and the fragmentation of China and Mexico but also in practically all sectors Mexico exhibits greater degree of fragmentation than China. The sectors Office,

accounting and computing machinery, Electrical machinery and apparatus n.e.c, and Textiles, textile products, leather and footwear has with high of import content in exports.

While vertical specialization represents an important step to explicitly incorporate the backward linkages associated with exports and establish the industrial linkages of some segments of production chains, however, the sequence can be traced for more than two consecutive stages production. Vertical Specialization, therefore, fails to provide a complete picture of entire production chains, and is bound to give us only a partial indication of the dynamics of international fragmentation.

Complexity may be defined as the degree of sectoral intermediate production interaction and is measured by the number and size of the internal linkages. In the input-output literature, multiple indicators have been proposed to capture complexity. In fact, any measure for the size of the linkages can be considered as an indicator of the complexity of the system.

While backward linkage indicator only shows the overall effects of marginal changes in final demand for each sector in target economy, the *Average Propagation Lengths* (APLs) allows us to evaluate the fragmentation process into spatial fragmentation and functional fragmentation. It is based on the input-output model recently developed by Eric Dietzenbacher and others, which show the average number of production stages that are passed through for an exogenous change in one industry to affect another. They focus their attention has shifted from the size of the effects between sectors to the distance between the sectors. The idea of distance is reflected by the number of steps it takes a stimulus in one sector to affect another sector. It thus yields a measure of the time and cost of adjustment, and, consequently, of the system's complexity. APL is an indicator which indicates the complexity of inter-industrial transactions in the input-output table (Dietzenbacher and Romero, 2007; Dietzenbacher and Temurshoev, 2008, Romero *et al*., 2009; Inomata, 2009). The new measurement is formulated such that it captures every aspect of the vertical sequence of production linkages.

The complexity index of China is 2.17 and of Mexico is 1.30, indicating the average distance between any possible pair of sectors in the 37x37 input-output tables, i.e. the China´s economy is most complexity that Mexican economy.

The main conclusions highlight that China exhibits strong linkages and Mexico weak linkages between exports and the rest of the economy because a high import content of exports. Mexico and China are focusing on assembly activities, but as argued China moving up in the global value chains unlike Mexico after more than 40 years of Maquila has not upgrading. Moreover, China has upgraded from mere assembly of imported inputs to the manufacturing of high-tech intermediate goods.

Thus, although the proportion of processing exports to overall exports has been declining, its value-added ratio has continued to rise. Over the decade from 2001, the year in which China joined the WTO, to 2010, the proportion of processing exports to China's overall

exports dropped from 55.4% to 46.9%, while the value-added ratio climbed from 56.9% to 77.4%. The rise of the value-added ratio of the processing trade not only signifies the increasing role that the sector plays in driving the domestic economy, but also reflects the progress China has made in transforming and upgrading its processing trade.

The emerging economies such as Mexico and China, tend to have a lower proportion of indirect exports are sent to third countries, which meaning that in the end in the global supply chains, which imply confirming the position downstream of the emerging economies and position upstream of the advanced economies in the global supply chains.

On average, Mexico's domestic value-added in manufacturing exports is approximately 34% (Cruz, Koopman and Wang, 2011), a share that is relatively lower that of China of 51% (Koopman, Wang and Wei, 2008). Low domestic content industries in both countries include computers and accessories and telecommunications equipment. Some higher domestic value-added industries that are similar in both countries include motor vehicles, cement, and pesticide and fertilizers.

The domestic content of non-trade processing for computers of Mexico (63.9%) is lower than China (80.6%). The domestic content of processing trade Mexico for computers (8.5%) is higher than China (3.9%), suggesting some degree of backward integration in information and communication technology in Mexico. The literature cites the case of the creation of complex high-tech electronics in Jalisco as the "Silicon Valley" of Mexico as a result of partnerships between national, foreign companies and the university system in the city of Guadalajara. However, despite this important endeavor the country has moved very modestly in the global supply chain in the areas of software development and services information technology. In fact, the domestic value added processing trade of Mexico in the communication equipment (14.9%) is half that of China (31.2%), while the electronic component is 15% for both countries but again the domestic value-added processing trade is not conducive to China with regard to Mexico (86.9% vs. 80.3%). The industries with high value added domestic processing trade in Mexico are railroad rolling stock manufacturing (63.0%) and pesticides, fertilizers and other agricultural chemicals (82.4%) than higher than China (33.1% and 30.2% respectively). In contrast, the domestic value added of non-processing trade in the railroad rolling stock manufacturing of China (86.7%) is higher than Mexico (59.9%).

If the domestic added value of processing trade in China is higher than that of Mexico, it is the domestic value added of non-trade processing. This is an important structural indicator of industrial upgrading in global value chain that is indicating that China's economy is to shift from of processing and assembly to production process, thereby generating the potential linkages between the manufacturing export sectors and the rest of the economy and upgrading to the stages of global production chains, which add more value added.

Under the current context of increasing International fragmentation of production the conditions and sources of economic growth and development is the process of industrial upgrading of the sectors that are heavily involved in global production chains.

China, as a result of the process of industrial upgrading in global value chains, has created domestic and global champions in the sectors of high-speed rail transport, information technology, machinery and transport equipment, and aerospace. In this sense, an important research finding is that these sectors, which today are manufacturing sectors that serve as an engine of economic growth in China is precisely where it has made a consistent and systematic policy of upgrading in last decades. The criterion that has guided China's industrial policy is that a country becomes what it exports, it exports and determines your level of future economic growth, so that the measures and instruments for upgrading exporter has become a key issue for economic growth and development. A fundamental element of industrial upgrading for export has been foreign direct investment. The key element of the virtuous relationship between foreign direct investment and economic growth has been to support the integration of domestic producers in the global production networks led by transnational corporations through the building of capabilities domestic firms, which ultimately have resulted in the creation of national champions and global bearings that are driving economic growth.

In China, unlike of Mexico the manufacturing exports and foreign direct investment by acting together have become engines of economic growth, which allowed the export industrial upgrading and achieved high rates of economic growth. It has played a role fundamental the industrial policy. Since it is not the objective of the research did not delve into this aspect.

Moreover, China is a success case of overcoming the constraint of global factory that forced her to participate only as a supplier of cheap labor in global value chains, with weak or no capacity of drag the economic growth. In this sense, there are important lessons that Mexico can learn of China to convert the manufacturing sectors of medium and high-tech in engine of economic growth.

References

Amighini, A. (2005): "China in the international fragmentation of production: evidence from the ICT industry", *The European Journal of Comparative Economics*, vol. 2, N° 2, Castellanza, Università Carlo Cattaneo.

Akyüz, Yilmaz, (2010): "Export Dependence and Sustainability of Growth in China and the East Asian Production Network", *Research Paper Nº 27*, South Centre, April.

Bems, Rudolfs, Robert Johnson, and Kei-Mu Yi, (2010): "The Role of Vertical Linkages in the Propagation of the Global Downturn of 2008," Mimeo Prepared for IMF/Paris School of Economics Conference, January.

Breda, E., and R. Cappariello (2010): A tale of two bazaar economies: an input-output analysis for Germany and Italy, Occasional paper n. 79, Bank of Italy.

Breda, Emanuele, Rita Cappariello y Robert Zizza, 2007, "Measures of the External Trade Impulse to Economic Growth: How Relevant Is the Internationalization of Production?, Banca d'Italia, Economic Research Department.

Chenery, H. B. y Watanabe, T., (1958): "International comparison of the structure of production", *Econometrica*, vol. XXVI, No. 26, pp. 487-521.

Chen, Xikang, Leonard Cheng, K C Fung y Lawrence Lau, 2008, "The Estimation of Domestic Value-Added and Employment Induced by Exports: An Application to Chinese Exports to the United States." In China and Asia: Economic and Financial Interactions, edited by Yin Wong Cheung and Kar Yiu Wong. Routledge.

Chen, Hogan, Matthew Kondratowicz y Kei-Mu Yi, 2005, "Vertical specialization and three facts about U.S. international trade," *North American Journal of Economics and Finance*, 16(1): 35–59.

Cui, Li, y Murtaza Syed, (2007): "The Shifting Structure of China's External Trade and Its Implications", IMF Working Paper WP/07/214, *(Washington: International Moneary Fund).*

Dean, Judith, K.C. Fung y Zhi Wang, 2008, "How Vertically Specialized is Chinese Trade?" USITC Working Paper No. 2008-09D, September.

De la Cruz, J., Koopman, R.B., and Wang, Z. (2011): "Estimating Foreign Value- added in Mexico's Manufacturing Exports", Office of Economics Working Paper, No. 2011-04A, U.S. International Trade Commission, Washington, DC.

Dietzenbacher, E. and Temurshoev, U. (2008): "Ownership relations in the presence of cross-shareholding", *Journal of Economics,* 95: 189-212.

Dietzenbacher, E. and Romero, I. (2007): "Production chains in an interregional framework: Identification by means of average propagations lengths", *International Regional Science Review*, 30: 362-383.

Dietzenbacher, E.; Romero I. and Bosma, N.S. (2005): "Using average propagation lengths to identify production chains in the Andalusian economy", *Estudios de Economía Aplicada,* 23: 405-422.

Ernst, Dieter y Paolo Guerrieri, 1998, "International Production Networks and Changing Trade Patterns in East Asia. The Case of the Electronics Industry", *Oxford Development Studies*, Vol.26, No.2, June.

Feenstra, R.C. y Hanson, G.H., 1996, "Globalization, Outsourcing, and Wage Inequality", *American Economic Review*, nº 86, pp. 240-245.

Feenstra, R.C. y Hanson, G.H., 1999, "The impact of outsourcing and high-technology capital on wages: Estimates for the United States, 1979-1990", *Quarterly Journal of Economics*, nº 114, pp. 907-940.

Hanson, G., R, Mataloni, M.J. Slaughther, 2005, «Vertical Production Networks in Multinational Firms», *Review of Economics and Statistics*, Vol. 87, no. 4, pags. 664-678.

Haussmann, Ricardo, Hwang, Jason and Rodrik, Dani, 2007, "What you Export Matters", *Journal of Economic Growth* 12: 1-25.

Hicks, John, 1950, *A Contribution to the Theory of the Trade Cycle*, Oxford: Clarendon Press.

Hummels, D., Ishii, J. y Yi, K., 1998, "The nature and growth of vertical specialization in world trade", *Journal of International Economics*, vol. 54 (1), pp. 75-96.

Hummels, D., Ishii, J. y Yi, K., 2001, "The nature and growth of vertical specialization in world trade", *Journal of International Economics*, vol. 54 (1), pp. 75-96.

Hijzen, A., Görg, H. y Hine, R.C., 2005, "International outsourcing and the skill structure of labour demand in the United Kingdom", *Economic Journal*, vol. 115, nº 508, pp. 860-878.

Instituto Nacional de Estadística, Geografía e Informática, 2002, *Sistema de clasificación industrial de América del Norte, México 2002*, INEGI, México.

Instituto Nacional de Estadística Geografía e Informática, 2008, "Sistema de consulta de la matriz insumo-producto", INEGI, México.

Jones, R.W. – Kierzkowsky, H., 2001, «A framework for fragmentation» in Arndt S.W. - H. Kierzkowsky (eds.), *Fragmentation. New Production Patterns in the World Economy*, Oxford University Press.

Koopman, Robert, Zhi Wang, y Shang-Jin Wei, 2008, "How Much Chinese Exports Is Really Made in China—Assessing Foreign and Domestic Value-added in Gross Exports," *NBER Working Paper* 14109.

Koopman, Robert, William Powers, Zhi Wang, y Shang-Jin Wei, (2010): "Give Credit Where Credit Is Due: Tracing Value Added in Global Production Chains", *NBER Working Paper* No. 16426.

Lee, J. (2011), 'Export Specialization and Economic Growth around the World,' *Economic Systems 35*(1): 45-63.

Lemoine, F. and Ünal-Kesenci, (2002): "China in the International segmentation of Production Processes", CEPII Working Paper, n°2002 – 02 March.

Leontief, Wassily, (1936): Quantitative Input and Output Relations in the Economic Systems of the United States. *The Review of Economic Statistics*, 18(3): 105-125.

Leontief, Wassily, (1963): "The Structure of Development", Chapter 8 in Leontief, *Input-Output Economics*, Second ed., Oxford University Press, 1986.

Rodrik, Dani (2007): Industrial Development: Stylized Facts and Policies, United Nations, industrial development for the 21st Century, UN, New York.

Romero, I. Dietzenbacher, E. and Hewings, J. D. (2009): "Fragmentation and complexity: Analyzing structural change in the Chicago regional economy". Revista de Economía Mundial, Núm. 23. 2009, pp. 263-282.

Shu and Yip (2006): "Impact of Exchange Rate Movement on the MainlandEconomy," Hong Kong Monetary Authority, *China Economic Issues*.

Smith, Adam, (1776): *Investigación sobre la naturaleza y causas de la riqueza de las naciones*, México: FCE (edición 1958; reimpresión 1987).

Sonis, M., Guilhot, J.J.M., Gewings, G.J.D. y Martins, E.B., 1995, "Linkages, Key Sectors, and Structural Change: some new perspective". *The Developing Economies*, XXXIII-3. pp. 233-270.

Yi, Kei-Mu, 2003, "Can vertical specialization explain the growth of world trade?". *Journal of Political Economy*, v. 11, n. 1, pp.52-102.