The Domestic Content of Mexico's Maquiladora Exports: 1988-2006[1]

Juan Carlos Castillo, UNU MERIT, Maastricht
Gaaitzen J. de Vries, University of Groningen

Paper prepared for the Workshop "The Wealth of Nations in a Globalizing World"
Groningen, The Netherlands, July 18-19, 2013

Abstract

This paper studies the domestic value added content of exports by Mexico's foreign assembly plants during the past 30 years. Mexico's industrial policy for export processing firms gradually shifted from providing employment towards promoting intermediate deliveries among upstream domestic firms and technological upgrading within maquiladora firms. We combine a recently released input-output table for maquiladora industries with detailed longitudinal data on output, domestic and imported intermediate inputs, and skill requirements to study the effects of these industrial policies. We find that domestic value added content differs across industries but did not change much over time. Structural changes in the composition of output drive changes in the domestic value added embodied in aggregate maquila exports. Changes in the industry composition of assembly plants appear related to external shocks such as the North American Free Trade Agreement (NAFTA) in the late 1980s and China's entry into the World Trade Organization in 2001. Within industries, we find few signs of increasing intermediate input deliveries by domestic firms or higher embodied value added and skill use in the production process among maquiladoras over time.

JEL Codes: C67, L6

Keywords: Domestic content, Industrial policy, Export processing, Mexico

[1] We thank Klaas de Vries for excellent research assistance.

1. Introduction.

The cross-border fragmentation of production is a key feature of the modern international economy. For a country to develop, it is considered crucial to join global value chains. Joining a value chain creates the opportunity to climb the technology ladder by means of a process of Industrial Upgrading (IU). According to Humphrey and Schmitz (2002), this process of IU can be defined as the capacity of a manufacturing firm to innovate and to increase the value added of its product and process.

Mexico's maquiladora industry is one of the oldest and one of the largest international production networks in the World. It is also one of the main suppliers of intermediate and final goods to the US market. The maquiladora industry in Mexico was established during the 1960s and nowadays accounts for about 55% of Mexico's manufacturing exports, produced by 2 million workers in 5,113 maquiladora firms (INEGI, 2011). Over the years, a number of factors have been used to infer the existence of a process of IU in the Mexican maquiladora industry. Carrillo and Zarate (2009), for instance, indicated that the level of technology embodied in some maquiladora sectors has risen substantially. In the perspective of these authors, the production process has evolved from making wooden cabinets (labor intensive and simple commodities) to flat panels and high definition television sets in the case of electronics, and from simple cables to designing developed modules of ignition sets with high technology in the autoparts sectors.

The existence of more research and development (R&D) departments as well as the increasing amount of highly skilled workers are other factors commonly used to infer a process of IU. Carrillo (2004) identified 72 R&D centers in the maquiladora industry that mainly relied on the use of local engineers. Likewise, greater decision making and autonomy at the local level have also been documented as factors that point toward a process of IU in the maquiladora. According to Carrillo et al. (1999) and Dussel Peters (2003) equipment purchases, supplier selection, improvements to manufacturing process, selection of manufacturing technology and other decisions have been more common at the local level. Finally, Sargent and Mathews (2006) also indicated that entrepreneurial efforts at a subsidiary level can also account for a process of IU.

If we stick to the definition provided by Humphrey and Schmitz (2002), we can see that most of the studies on maquiladora have analyzed the process of IU solely on the basis of one factor; an increasing capacity to innovate. These studies have thus largely overlooked the remaining factor posited by Humphrey and Schmitz (2002) which, to our view, also constitutes one of the main outcomes that the process of IU can trigger; the existence of higher levels of domestic value added (DVA). During the process of IU, producers learn how to master new manufacturing procedures. The knowledge acquired by the producers enables them to reorganize the manufacturing system. They gain the necessary skills to transform inputs into outputs more efficiently, to move into more sophisticated product lines and to perform new functions that increase the overall skill content of their activities (Humphrey and Schmitz, 2002). At the end of this process of IU, since their manufacturing skills have been locally increased, the producers are now able to produce with higher levels of DVA (Azadegan & Wagner, 2011). This situation means that, as a result of IU, manufacturing producers do not simply add cheap labor to the production that takes place in the global production network. Now, they also add technology by means of inputs that have been domestically produced.

A more thorough analysis of the previous theoretical argument tells us that the process of IU can also trigger other important outcome aside from higher levels of DVA. As can be seen, if the

maquiladora firms pursue a process of IU then, they will have to locally increase their industrial abilities. To achieve that objective, one option that maquiladora firms have is to rely on domestic suppliers. These domestic suppliers mainly offer geographical proximity to the maquiladoras (both type of firms are located in the same country). In that context, by demanding inputs from domestic suppliers, the maquiladora firms that achieved a process of IU can also increase the industrial abilities of these domestic suppliers. Such an objective can be reached by means of externalities. This interaction between firms producing for the global production networks (maquiladoras) and domestic suppliers is called productive linkages. Such productive linkages are to be reflected in an increasing amount of local inputs that are sold from the domestic supplier to the maquiladora industry. In that way, higher levels of productive linkages with domestic suppliers can also increase the levels of DVA added by the maquiladora because this industry is relying more on the inputs domestically produced by the suppliers. Therefore, to our view, these productive linkages are the other benefit that can be triggered as a result of pursuing a process of IU

Taking this whole context into account we see that, to the best of our knowledge, the process of IU in the maquiladora industry has not been widely analyzed on the basis of their two main outcomes: higher levels of DVA in the maquiladoras producing for global production networks and, the existence of productive linkages between maquiladoras and domestic suppliers that can also foster higher levels of DVA. Therefore, in order to fill this gap, our research posits the following research questions; what has been the evolution of DVA in the manufacturing sectors of maquiladora industry? Are there any productive linkages between maquiladoras and domestic suppliers that foster increasing levels of DVA? Finding an answer for these questions will be the main objective of this research. Achieving such objectives should let us know if the maquiladora industry has indeed achieved an important level of IU as previously research has pointed out (Carrillo and Zarate, 2009).

To achieve our objectives, our research will construct Input-Output tables (IOTs) for the maquiladora industry. The novelty of our research is that we will construct those maquiladora IOTs for a rather long period of time that goes from 1988 to 2006. To construct these IOTs, we will mainly rely on the methodology and data sources provided by the Mexican Statistical Office (INEGI) and the Central Bank of Mexico (BANXICO). The information contained in our IOTs should allow us to implement a modified version of the index of vertical specialization proposed by Yang et al. (2010) which basically measures the imported input content in the manufacturing exports of countries highly engaged in global production networks. Likewise, with the different data sources prepared by INEGI, we can also provide additional analysis in terms of labor qualification and productivity that can further confirm the existence (or the lack thereof) of a process of IU across manufacturing sectors in the maquiladora industry. At the end of our research, we will see that, unlike previous findings, the maquiladora industry as a whole and at the level of manufacturing sectors has achieved few signs of industrial upgrading and that the sectors showing high levels of DVA and of productive linkages are of limited importance for the maquiladora.

The remainder of our research is organized as follows. Section 2 provides a brief literature review on the main determinants of IU and historical events of maquiladora industry over the years. On the basis of the arguments there presented, our research will posit its hypotheses. Section 3 presents the methodology of our research which mainly deals with the proposed modified version of the index of vertical specialization prepared by Yang et al. (2010). The fourth and fifth sections present the data to be used for constructing IOT and their descriptive statistics respectively. Section 6 indicates our main results while section 7 provides the conclusion of this research.

2. Literature review: Determinants and historical evolution of the process of industrial upgrading in the Mexican maquiladora industry.

This section provides a literature review about the process of industrial upgrading (IU) in the Mexican maquiladora industry. On the basis of these theoretical and empirical findings, our research will develop its hypotheses. We will divide this literature review in two sections. The first sub-section develops a description of the underlying factors that might have an impact on IU. On the other hand, the second sub-section provides an overview of changes in the legal framework and historical events that have been present in the evolution of the maquiladora industry. By including these set of historical elements, we expect to develop a better understanding of the ideas presented by researchers on each of the stages from the evolution of the maquiladora industry.

2.1 Main determinants of the process of Industrial Upgrading and their impact on the maquiladora industry.

Achieving higher levels of DVA and developing productive linkages with domestic suppliers by means of a process of IU is remarkably important for the industrial growth in developing countries. That is because these two factors mainly involve the use of progressively more domestic resources. Several researchers believed that these factors were behind the industrial development of the economies in East Asia. The process of IU in these economies during the 1960s largely relied on the participation of domestic suppliers that provided locally produced inputs (with important technological complexity) to domestic manufacturing firms. Therefore, few decades later, the economies in East Asia were able to transform themselves from technologically backward and poor, to relatively modern and affluent economies (Nelson & Pack, 1999; Gallagher & Shafaeddin, 2010).

Nonetheless, it is important to mention that pursuing a process of IU is by no means exempted from obstacles. Undergoing IU involves significant financial and learning efforts to understand and to internalize new industrial capabilities (Gereffi, 1999). These issues can be summarized by considering the theoretical set of external and internal factors that impact the process of IU. The type of network governance in which manufacturing producers in the developing country are involved account for the set of external factors. The degree of collective efficiency from similar manufacturing producers in the developing country and the characteristics from each manufacturing sector constitute the internal factors that impact IU. We will now describe each of those factors.

We first start with the set of external factors. There are basically two types of network governance that might impact the process of IU; (1) the parent-subsidiary relationship and; (2) the transactions of firms in the developing country with foreign independent buyers. The impact of the first type of network governance has been studied by Humphrey and Schmitz (2000). In their view, it might be that the parent company located in the advanced country is not interested in implementing a process of IU for the subsidiary located in the developing country. One reason for that is that the costs of conducting such a process of IU in the subsidiary can be prohibitive for the parent company. Other reason can be the fact that the characteristics of the subsidiary in the developing country already fulfill the strategy of the parent company. The cheap labor and/or the geographical proximity to important markets that developing economies can provide might be the only reason why the parent company in the advanced country decided to establish a subsidiary in the developing country. Consequently, the parent company has no incentive to develop a process of IU in the subsidiary because the technologically complex activities are more efficiently performed at the parent company.

On the other hand, Gereffi (1999) and Gereffi and Kaplinsky (2001) have studied the impact of the second type of network governance. According to these authors, the difference with the parent-subsidiary relationship is that independent foreign buyers can engage in transactions with manufacturing producers in the developing country without belonging to the same company. Nonetheless, even though they are not part of the same company, independent foreign buyers can also foster or deter a process of IU in manufacturing firms. Those foreign buyers might be interested in that a manufacturing firm in the developing country pursues IU. In that way, independent foreign buyers can demand goods with higher quality and lower price from the developing country. However, if the manufacturing producers in the developing country are not able to domestically meet those standards, then foreign buyers will prefer to demand those goods from other more efficient producers located in other parts of the developing country or, more importantly, the world.

We will now describe the set of internal factors that account for IU. First of all, we have the case of the collective efficiency from other manufacturing producers operating in the same manufacturing sector at the developing country. The impact of collective efficiency in IU was initially described by Schmitz (1995). The theoretical reasoning proceeds as follows. It might be that a manufacturing producer achieves some degree of IU. Nevertheless, the extent at which this level of IU can be further increased or decreased depends upon the degree of collective efficiency observed in other manufacturing firms that produce similar goods. According to Schmitz (1995), collective efficiency refers to the level of technological complexity and productivity by which manufacturing producers in a given sector operate their industrial process. If this level of collective efficiency in a given manufacturing sectors is high, then the level of IU achieved by firms belonging to this manufacturing sector can also be high. That is true if we consider that, as a result of an important degree of collective efficiency, the externalities might be more easily spread across other manufacturing producers in the same sector.

The last of the internal factors that impact the process of IU is the characteristics that define each manufacturing sector. Giuliani et al. (2005) classify the manufacturing sectors of maquiladora according to their level of technological complexity. They first posited the existence of traditional manufacturing sectors which can include the textile, footwear, tiles and furniture sectors as well as the natural resource-based sectors (food industry, minerals and the paper industry). According to the aforementioned authors, the technology in these traditional manufacturing sectors has important tacit elements. This means that operating a complex procedure or technology in these traditional sectors requires all sorts of knowledge that cannot be explicitly transfer in blue prints (Polanyi, 1967). Thus, the process of IU in these traditional manufacturing sectors will strongly depend on the intensity of technological externalities and cooperation among local actors. On the other hand, Giuliani et al. (2005) also proposed the existence of more complex manufacturing sectors (including, among others, automobiles, aircraft industries, ICT and consumer electronics sectors). In those more complex sectors the technology is more codified in blue prints. Such technology, however, is mainly created in advanced economies at the headquarters of the parent company or at independent research laboratories. Having this reasoning in mind, we see that accessing to those external sources of knowledge becomes crucial for achieving a process of IU in the more complex manufacturing sectors.

Several authors have identified, to some extent, the impact of these set of internal and external factors on the process of IU in the maquiladora industry. The main conclusion that they have drawn is the existence of three generations of maquiladora that differ on their technological complexity.

The "first generation of maquiladoras" (Brown & Dominguez, 1989) mainly performs activities which require few skills and a low level of technology (assembly activities). In general, these maquiladoras appeared in the 1960s and were the dominant type of firm in the maquiladora industry until the mid-1980s (Carrillo & Hualde, 1997). These firms were more interested in the output than in the quality of production. Moreover, this first generation of firms only take advantage of the immediate benefits offered by the maquiladora program (tariff exemptions, cheap labor and geographical proximity) without any further incentive of developing technological capabilities in Mexico. On the other hand, we also have the second and third generation of maquiladoras. The second generation maquiladoras possess some degree of autonomy with respect to the headquarters and also apply more sophisticated organizational procedures than the first generation of maquiladoras. According to Carrillo & Hualde, (1997), these second of maquiladoras mainly appeared from the mid-1980s until 1994 when the NAFTA agreement was signed. Finally, the third generation of maquiladoras is the one where some design and research activities are observed which require higher qualified local labor force. These maquiladoras of third generation are the ones that have appeared from 1994 onwards. In both generation of maquiladora (the second and the third), it can be seen that the productive process becomes less orientated toward assembly and more toward manufacture (Carrillo, 2007).

With this whole background context in mind, we decided to develop the following classification. To our view, the maquiladoras of first generation mainly operate in the more traditional manufacturing sectors because these sectors mainly operate with low levels of technology. On the other hand, we also believe that the second generation and third generation of maquiladoras are mainly observed in the more complex manufacturing sectors because these two sectors possess higher levels of technology. From this reasoning, it is also important to consider the following remark. The fact that our research considers that the first generation of maquiladoras mainly contains firms in the more traditional sectors does not necessarily mean that all the traditional firms operate with low levels of technology. For instance, there might be firms in the textile sector (a traditional sector) that operate with high levels of technology and that can thus be regarded as firms belonging to the second or third generation of maquiladoras. The same analogy is applicable to the more complex manufacturing sectors. Not all the firms in the more complex manufacturing sectors might have high levels of technology. There might also be firms in the electronic, machinery and transport sectors (more complex sectors) that operate with low levels of technology and that can be thus classified as first generation of maquiladora2.

This last classification proposed by our research is then performed because we want to indicate that the opportunities for achieving IU might largely differ within the particular manufacturing sectors of maquiladora industry. This means that firms operating in the more complex sectors have higher chances of pursuing a continuous process of IU because most of the firms there operating (second and third generation) have higher levels of technology. These high levels of technology thus favor higher levels of collective efficiency that can also foster more productive linkages in the more complex manufacturing sectors. On the other hand, firms operating in the more traditional sectors have lower chances of pursuing a continuous process of IU because the technology observed in those sectors is more limited and thus, the degree of collective efficiency is also lower.

In this whole context, we can expect different opportunities for industrial upgrading in the different manufacturing sectors of maquiladora industry. Therefore, from this stream of ideas, and

[2] Yet another important remark to be considered is the fact that the three generations of maquiladora coexist with one and other. This means that the existence of one generation of maquiladora does not eliminate the other one (Contreras and Munguia, 2007). Such an argument is also important because it confirms that different generations of maquiladora exist within a particular industry.

provided that this research will infer a process of IU on the basis of higher levels of DVA and productive linkages, we present our first hypothesis;

H1.a: The levels of DVA will largely differ across industrial sectors. We therefore expect to see (on average) high and medium levels of DVA in the second and third generation of maquiladoras which mainly operate at the more complex manufacturing sectors with higher levels of technology. Conversely, we expect to identify (on average) low levels of DVA in the first generation of maquiladoras which mainly operate in the traditional manufacturing sectors with low levels of technology.

H1.b Given that DVA and productive linkages go hand in hand, we expect to see similar levels of productive linkages in the maquiladora's domestic suppliers (high to medium levels of productive linkages in the more complex manufacturing sectors and low in the more traditional sectors).

2.2 Historical events and changes in the legal framework of maquiladora.

Since we are dealing with the evolution of the maquiladora over the years, it is also important to take into account the impact of historical events as well as the impact of changes on the legal framework of this industry. Analyzing these factors will let us identify when the main changes in the process of IU occurred.

So as to achieve that objective, this sub section will divide the evolution of maquiladora into three periods. The first period (1965-1989) will indicate the limited role and contribution of maquiladora to the Mexican economy. This situation will be attributed to the restrictive legal framework under which the maquiladora operate during most of these years. The second period (1990-2000) will study the most outstanding development in the history of maquiladora. This second period is the one where researchers identified the first signs of industrial upgrading (Carrillo et al., 1999). The beginning of NAFTA and the fact that policy makers now conceived maquiladora as one of the key drivers of the export growth strategy in Mexico account for this issue. Finally, the last period (2001-2006) analyses the first important contraction in maquiladora and its current performance considering the economic crisis of 2001 in the US and the increasing manufacturing competition of more efficient producers (mainly China).

2.2.1. 1965-1989: Limited signs of a process of IU.

The maquiladora program emerged in the 1960s as an emergency program to cope with the rising unemployment observed in the north part of Mexico at that time. According to Contreras (2008), during this initial period (from the 1960s to the late 1980s), the initial scope of the maquiladora program was quite restrictive. The program was planned to be applicable to a specific type of manufacturing firms and implemented only in some parts of the Mexico. The reason for this was that the maquiladora program was not in line with the Import Substitution Industrialization (ISI) prevailing in Mexico. Providing tariff exemptions to manufacturing firms with foreign capital engaged in the maquiladora program was simply a policy contrary to the strategy of ISI. Consequently, during the period here analyzed, the government in Mexico hardly implemented policies aiming at the industrial development of the firms under the maquiladora program.

The following review of policies established from the 1960s to the late 1970s indicate why the maquiladora program was applicable to a specific type of manufacturing firms and only implemented in some parts of Mexico. In 1966, the firms in the maquiladora program were supposed to be located

within 20 kms of the Mexican border and owned by a minimum of 51% of national capital with the obligation of re-exporting the total amount of their production. In the subsequent years, such an initial legal framework was further modified as unemployment was also present in other parts of the country. Several laws permitting the creation of maquiladoras in coastal areas were passed in 1971 and in the whole country by 1972. Likewise, in 1977 laws allowing the existences of completely foreign owned maquiladoras were established (Urias, 1978).

As mentioned already, very few attempts were made in order to promote a process of industrial upgrading for the firms engaged in maquiladora. The most remarkable one was a law where local firms could qualify for the benefits of the maquiladora program provided that 20% of their inputs were of local origin (Urias, 1978). Moreover, as suggested by Buitelaar & Padilla (2000), the restrictive legal framework did not seem to allow any technological development in the maquiladora program. For instance, in line with regulations implemented by the Mexican general Law on Foreign Investment of 1973, the government was allowed to control and review the implementation of technology in maquiladora. Furthermore, it was able to forbid the installation of any foreign firm that could harm the national industry (González, 1990). This situation largely limited the possibility of a process of industrial upgrading in the maquiladora during the early 1980s as it continuously posed restrictions for the implementation of foreign technology.

In the mid-1980s, a number of measures were taken in order to liberalize the Mexican economy. At this respect, the key policy change was that Mexico joined the General Agreement on Tariffs and Trade (GATT) in 1985, something which served as the initial push of the domestic and international trade reforms during the upcoming years. Once this new economic model was established, major changes were seen in maquiladora's legal framework. Before the opening up of the economy in 1985, only minor modifications had been implemented to the previous legal system with the allowance for selling 20% of their total production in the domestic market being the most remarkable change by 1983. Nonetheless, it was until 1989 when maquiladora began to be fully recognized as one of key drivers of the new export-led development in Mexico. According to the new regulation, the maquiladora was now supposed to meet the following objectives: (1) to provide higher levels of employment; (2) to increase manufacturing exports and the levels of foreign exchange; (3) to stimulate the development and transfer of knowledge and; (4) to promote investment in human capital through a further integration with the local Mexican manufacturing industry (Mexico, Government of, 1989).

Considering this new context, a new modification was introduced in the maquiladora framework by 1989. This was related to increase the ability of maquiladora to sell domestically, since now those firms were allowed to sell up to an equivalent of 50% of their total exports or one third of the total production.

Several authors document the introduction of technology in the maquiladora industry by the end of this decade (1980s). This mainly occurred in the automotive and electronic sectors (Wilson, 1992, Carrilo and Hualde, 1997). Nevertheless, despite this initial introduction of technology, the activities in maquiladora mostly remained rather monotonous and still limited to the assembly of components in most of the industrial sectors. During this period, more technology was introduced in order not to develop local capabilities but to obtain more precision, control and quality at labor intensive activities. This basically means that, in most of the cases, the old machinery was replaced by technologically more sophisticated instruments that still needed low qualified workforce to operate (Carrilo and Hualde, 1997).

At the same time, more autonomous level of decision making was also observed in the more complex manufacturing industries (Carrilo and Hualde, 1998). Nevertheless, this remained restricted to minor issues such as recruitment and human resource management. Hardly ever did local managers participate in the selection of inputs or in the decision process of manufactures to be produced as most of the technical specifications mainly came from abroad. Along the same lines, local management had little influence, if any, on investment, finance or production technology decisions (Wilson, 1992).

Taking this whole context into account, we can derive the following ideas. To our view, due to the restrictive legal framework that operated during most of the 1980s, very few signs of industrial upgrading are to be seen in these years. The restrictive legal framework that prevailed during most of this period is the underlying reason. Notwithstanding the major legal changes that were implemented at the end of the decade, the maquiladora still required more time to achieve all the objectives set by the Mexican government. Likewise, despite the first signs of technology in the maquiladora, its characteristics (the development of assembly activities) still had a limited effect in fostering a process of IU. From this reasoning, we derive the following hypothesis;

H2.a: In the late 1980s we expect to see low levels of DVA (and low levels of productive linkages with domestic suppliers) in most of the sectors in maquiladora industry given the restrictive legal framework that prevailed in most of the decade.

2.2.2 1990-2000: the Maquiladora as a part of the export led growth in Mexico.

The decade of the 1990s is the second period in the evolution of maquiladora. That is because these years stand out as the period where the maquiladora showed the most remarkable results in their history. During this time, the maquiladora moved from being a relatively less important sector employing few firms and employees to become one of the key drivers in the Mexican manufacturing industry (Gallagher & Shafaeddin, 2010). The implementation of NAFTA, remarkable changes on the restrictive legal framework of maquiladora and the introduction of more complex technological procedures account for this issue.

During this second period, the industrial growth of maquiladora was not solely supported by the legal changes of the late 1980s (mentioned in section 2.2.1) but also, by other laws that were more in line with the liberalization of the economy. For instance, the new Law on Foreign Investment of 1990 represented a major relaxation relative to that of 1973 since it reduced uncertainty and allowed for long term planning of operations. This new regulation was thought to induce a change in the current corporate strategies of foreign firms under maquiladora so that they could develop progressively more technologically complex activities in the country away from the labor intensive ones (Carrillo, 2007). Along the same lines, import licensing continued to decline in importance and easier and faster administrative procedures were also passed.

At the same time, other export promoting programs for the manufacturing industry were executed. In 1990, the “Programa de Importación Temporal para la Exportacion” (PITEX) came into effect with the intention of permitting firms to import intermediate inputs and machinery free of duty as long as 30% of their total sales were exported. The difference between the firms under PITEX and the maquiladoras lied in the fact that the industries under the latter program were exempted to a bigger amount of taxes. Similarly, unlike maquiladoras, PITEX firms were located at the interior of Mexico as most of their production was destined to domestic consumption (De la Cruz et al., 2010).

In 1994, the removal of trade and investment barriers allowed by the North American Free Trade Agreement (NAFTA), represented other important boost for the production and industrial organization of maquiladora. This agreement largely increased the preferential access of maquiladora firms to the US market due to the execution of the principles of national treatment and most-favoured-nation (NAFTA Article 102). National treatment for goods means that once goods have been imported into any NAFTA member country, they will not be subject to tariff discrimination. On the other hand, Most-favoured-nation treatment implied that the signatories of NAFTA have to extend trading benefits to each other equal to those accorded to any (that is, the most favoured) non-NAFTA country (Javorcik et al., 2008). In this context, non-NAFTA originated inputs had to pay Mexico's Most Favored Nation (MFN) tax, around 35%, while the intermediate goods originated in the NAFTA region could be imported free of duty. This whole new regulation created an important incentive for the production of parts and components in maquiladora because the inputs eligible for the tariff exemption could not only be those including pure NAFTA content, but also those from other regions that have been previously processed in Mexico.

Notwithstanding the support provided by NAFTA and given the new importance assigned to this sector, the Mexican government kept on implementing policies that could further strength the industrial growth in the maquiladora. In the first years after the implementation of NAFTA, the tariff exemption was possible for inputs that were both imported within and outside the region of North America. Nonetheless, as of 2001 only the North American inputs were to be exempted from tariffs. Thus, in order not to lose competitiveness, the policy makers in Mexico implemented a new program called "Sectoral Programmes" (PROSECs) that provided tax exemption to the import of a specific percentage of inputs not produced in North America across selected industries. Similarly, and aiming at a greater integration with the local industry, in 1994 the benefits of maquiladora were also extended to companies that supplied them goods and services (domestic suppliers). Finally by 2001, the maquiladoras were allowed to sell all their production in the domestic market. Although the information for domestic sales is not reported in the published statistics, INEGI has carried out unpublished surveys, and has consistently found that maquiladoras sell less than 5% of their output domestically (Verhoogen, 2008)

The development of these reforms provided remarkable outcomes for the production in maquiladoras. The maquiladora achieved the highest level of manufacturing exports that has been observed during its whole existence: by 1980 the exports of maquiladoras were of 2.5 million dollars, however this data dramatically changed to 79.8 million dollars by 2000 (INEGI, 2001). Consequently, the participation of maquiladora in total manufacturing exports rose from 14% in 1980 to 45% in 1998 (Capdevielle et al., 2000). Thus, along with the oil industry and the remittances, the maquiladora became one of the major providers of foreign exchange for the Mexican economy.

With this economic environment in Mexico, many manufacturing producers started introducing more technological complex procedures in the maquiladora industry. According to Buitelaar and Padilla (2000), modern management systems were commonly seen in most of the maquiladoras; total quality control, just in time, operation manuals as well as norms regarding organizational culture and labor discipline. Similarly, the existence of an increasing number of highly qualified workers as well as the development of more local R&D centers is also documented. The introduction of more technologically complex procedures, however, was not equally spread across sectors. Such a situation can be confirmed by the fact that it is in this period where the second and third generation of maquiladora started coexisting with the first generations of maquiladora. From this whole reasoning, our research expects

higher levels of IU during this second period with respect to the ones expected in the first period (1960-1980s). Therefore, we derive the following hypothesis.

H2.b: During the early and late 1990s, we expect an increasing number of sectors showing high levels of DVA (and therefore, higher levels of productive linkages with domestic suppliers). The implementation of NAFTA and the first important boom in the production of maquiladora will account for this issue.

2.2.3 2000-2006: Increasing competition and the first important contraction of maquiladora.

During the early 2000s, the maquiladora presented its first important contraction on its production. This situation can be attributed to the recession in the US economy by 2001 but mainly to the industrial emergence of more efficient producers (mainly China).

In the last years, China has become a major player in the global economy. It has widened and deepened its global supply chains over the last 10 years, and is a dominant source of manufactured products all over the world. According to Sargent and Mathews (2009), China's emergence as an international trader has had a profound negative effect on maquiladoras. Researchers generally believed that the reason for this negative effect is found in the similarity of the composition of US imports from Chinese and Mexican producers (Dussel Peters, 2005; Gallagher et al., 2008). This situation largely contributed to the first major contraction in the history of the maquiladora program. In October 2000, 3,655 maquiladoras employed 1,347,803 people. By December 2003, the number of plants and employees had fallen to 2,802 and 1,050,201, respectively (a net loss of 853 maquilas and 297,602 jobs) (INEGI, 2006). As of October 2006, maquila employment was still below the level reached in 2000.

In light of this increasing competition, the government in Mexico implemented more changes on the legal framework of maquiladora that aimed to induce an increasing number of maquiladoras to exit low-tech, labor intensive industries and evolve toward higher value added, technology intensive sectors (Sargent and Mathews, 2008). During the early 2000s, for the first time the government provided significant tax incentives to maquiladora firms engaged in research and development activities (R&D) and created a fund to promote Mexico's software industry (Ruiz Durán et al., 2005). State governments, industry chambers, and universities were also involved in the upgrading efforts. The branch of Mexico's largest private university system in Guadalajara established institutes designed to accelerate the development of design engineering centers, software development firms, and technology intensive startups in the city's cluster of electronics firms. The government in Mexico was especially interested in attracting new companies engaged in applied research, product and process development, product testing, and high-tech manufacturing in five industries; biotechnology, mechatronics, information technology, health, and nanotechnology (Sargent and Mathews, 2008).

To our view, the most outstanding change in maquiladora developed during this third period was the one that occurred in 2006 when the Maquiladora program was merged with the PITEX program. The underlying idea for such a decision was not only simplifying procedures for an increasing amount of firms in an attempt to make the manufacturing industry more competitive due to the increasing Chinese competition. Thus, as a consequence, a new regime to promote exports named the Manufacturing Industry, Maquiladora and Export Services Program (IMMEX) arose.

From these previous arguments, we infer that due to this increasing competition of China a limited number maquiladoras continued with the process of Industrial upgrading. To our view, mainly

the second and third generations of maquiladoras were the ones that effectively dealt with the Chinese competition because they characteristic allowed them to implement progressively more levels of technology. On the other hand, we also believe that the great amount of maquiladoras that were wiped out from the market were those of the first generation. This is mainly because those maquiladoras in the first generation operate with low levels of technology, an element which was not sufficient to cope with the cheap production of China. Having in mind this idea of limited levels of IU during this period, we posit the last hypothesis.

H2.c: In the early and mid-2000s, we expect to see very few industrial sectors showing high levels of DVA and a large amount of them presenting medium to low DVA. The same analogy will be applicable to the case of productive linkages with domestic suppliers. The emergence of more efficient producers and the first important contraction in this history of maquiladora will be the underlying determinants behind this hypothesis.

The above standing hypotheses will be tested in this research. Now, we will first discuss the methodological issues of this study.

3. Methodology.

The main objective of our research is to study the evolution of DVA in the manufacturing sectors of the Mexican maquiladora industry and the productive linkages between these maquiladora firms and domestic suppliers. One alternative for studying this is to utilize the index of vertical specialization (VS) initially proposed by Hummels et al. (2001). This index, by means of input-output tables (IOTs), calculates the imported input content in the manufacturing goods exported by an economy. This imported input content is reported by this index in a scale of 0 to 1. Therefore, if we focus on the remaining part of this index of VS (the one that is not the level of imported input content), we can have a measure for the level of DVA observed in the manufacturing exports of a country. Likewise, one of the components of this index (the so called indirect effect) on its adapted version offers a measure of the level of domestic inputs used during the total intermediate consumption of manufacturing sectors, something that closely matches our idea of productive linkages between domestic suppliers and maquiladora.

Nevertheless, it is important to mention that our research will not implement the original index of VS prepared by Hummels et al. (2001) but a modified version of this index that has been proposed by Yang et al. (2010). The reasoning behind this decision is that Yang et al. (2010) prepared a mathematical adaptation for this index of VS that allows studying the specific case of countries highly engaged in global production networks (GPN). Such adaptation is remarkably important for our research because, as we know, Mexico and the maquiladora industry are part of those GPN. Considering this situation, in order to implement this new index our research must describe the above mentioned mathematical adaptation of VS as well as the methodological changes in IOTs that are required to work this modified index. Explaining all this issues will be the objective of the next sub-sections.

3.1 Mathematical adaptation of the index of Vertical Specialization.

This section will describe the methodological adaptation for the concept of VS that is needed for studying the case of countries highly engaged in GPN. To do this, we will mainly draw upon the arguments proposed by Yang et al. (2010) on their study of processing exports for the case of China. Before conducting such adaptation, our research will first explain some useful definition about the

original concept of VS proposed by Hummels et al. (2001). Doing this should help us better understand the underlying formulas this research has to work with.

As previously mentioned, the index of VS measures the imported input content of the manufacturing exports produced by an economy. This index of VS includes three effects: the direct effect, the indirect effect and the total effect. The "direct effect of Vertical Specialization" (DVS) covers the underlying definition of VS. It simply indicates the imported inputs required for producing a good being exported. An example may clarify what this direct effect actually measures. Consider the production of furniture. Producing furniture might require importing intermediate products (such as wood) that have not been previously processed and have been entirely produced in a foreign country. The DVS will only take into account the imports of this kind of intermediate goods.

On the other hand, the "direct effect of vertical specialization" (TVS) will take into account the domestic inputs whose production required imported inputs. Let us analyze one more time the example of furniture so that this definition can be clearer. The production of furniture also requires inputs that have been domestically produced (such as fabric). Nevertheless, so that these inputs can be produced in the domestic economy, they also require other type of inputs (such as thread) that can be imported. These imported inputs required for producing domestic inputs are part of the indirect effect of VS. Finally, we will have the "total effect of vertical specialization"(TVS) which will take into consideration the imported intermediate goods studied in the direct effect but also the imported inputs included in the indirect effect.

Having explained these concepts, we are now able to mathematically describe the proposed adaptation of VS prepared by Yang et al. (2010).

First of all, we need to obtain a matrix for the direct requirements of imported inputs per unit of output. This matrix will be called $\mathrm{B}^{\mathrm{maq}}$ (where maq = maquiladora) and it will be determined as follows:

$$\mathrm{B}^{\mathrm{maq}} = \mathrm{M}^{\mathrm{maq}}\left(\widehat{\mathrm{x}^{\mathrm{maq}}}\right)^{-1} \quad (1)\ 3$$

Where $\mathrm{M}^{\mathrm{maq}}$ = the matrix with the intermediate imports of maquiladora (m_{ij}) of product i by industry j.

$\left(\widehat{\mathrm{x}^{\mathrm{maq}}}\right)$ = the vector of maquiladora gross output per manufacturing sector converted into diagonal matrix.

By multiplying $\mathrm{M}^{\mathrm{maq}}$ and $\left(\widehat{\mathrm{x}^{\mathrm{maq}}}\right)^{-1}$, we will obtain a matrix $\mathrm{B}^{\mathrm{maq}}$ that shows the share of imported intermediate consumption in maquiladora's gross output per manufacturing sector. For instance, in a given column of this $\mathrm{B}^{\mathrm{maq}}$ matrix, we will see the imported intermediate goods of the textile sector demanded by the automotive sector as a percentage of the gross output of the textile sector.

Then, with this information, we can obtain the degree of direct vertical specialization of maquiladora ($\mathrm{DVS}^{\mathrm{maq}}$) as follows:

[3] Matrices are indicated by boldfaced capital letters (e.g. **A**). Rows are identified by italicized boldfaced lowercase letters (e.g. ***w***) while columns are indicated by boldfaced lower cases (e.g. **x**). Scalars (the numbers contained in the matrices) are presented in italicized lower case letter (e.g. *a*). A prime indicates transposition (e.g. x') and a hat (or circumflex) indicates a diagonal matrix (e.g. $\hat{x}$) with the main elements of a vector on its main diagonal and all the entries equal to zero.

$$DVS^{maq} = \frac{u' B^{maq} e^{maq}}{u' e^{maq}} \quad (2)$$

Where e^{maq}= vector of maquiladora exports per manufacturing sector
u = summation vector consisting of ones.

Finding the product of B^{maq} and e^{maq} must give us a vector with the value in Mexican pesos of the imported intermediate consumption per manufacturing sector with respect to the exports per manufacturing sector. Then, dividing this new vector by e^{maq} will finally give us the imported input content in exports per manufacturing sectors. The summation vectors are then used to obtain the level of DVS for the maquiladora industry as a whole.

On the other hand, so as to measure the total effect of VS of the maquiladora industry (TVS^{maq}) we need to calculate a matrix of direct requirements for domestic input per unit of output (A^{maq}). This matrix can be determined in the following way;

$$A^{maq} = Z^{maq}\left(\widehat{x^{maq}}\right)^{-1} \quad (3)$$

Where Z^{maq} = the matrix with the domestic inputs used by maquiladora (z_{ij}) of product i by industry j.

In this case, the product of Z^{maq} and $\left(\widehat{x^{maq}}\right)^{-1}$ will trigger the matrix A^{maq} that shows in columns the share of domestic intermediate consumption in the gross output observed per manufacturing sector.

Given that $L^{maq} = (I - A^{maq})^{-1}$ is the so called Leontief Inverse, we calculate the total effect of vertical specialization from maquiladora with the following formula;

$$TVS^{maq} = \frac{u' B^{maq} L^{maq} e^{maq}}{u' e^{maq}} \quad (4)$$

Multiplying B^{maq} and L^{maq}will produce a matrix that indicates the total share of imported intermediate consumption in the maquiladora's gross output per manufacturing sector. It is important to notice that this new matrix ($B^{maq} * L^{maq}$) will differ from B^{maq} in that it not only shows the inputs directly imported by the maquiladora industry but also, as it includes the imported inputs used in the domestic inputs demanded by the maquiladora. In this context, the shares presented in this matrix ($B^{maq} * L^{maq}$) must be larger than the ones observed in B^{maq}.

Finally, the product of $B^{maq} * L^{maq} * e^{maq}$ should indicate a vector with the value in Mexican pesos of the total imported intermediate consumption per manufacturing sector with respect to the exports per manufacturing sector. One more time, dividing this last vector by e^{maq} will show the share of imported input content in the manufacturing exports of maquiladora. Similarly, the summation vectors in this equation (4) will let us obtain the total effect of VS for the maquiladora industry as a whole.

As the reader may already notice, the data obtained in TVS^{maq} must be higher than the one in DVS^{maq} because the latter includes the direct imports while the first include the direct imports and the indirect imports (those imports used in the production of domestic inputs). This situation enables us to calculate the indirect effect of vertical specialization of the maquiladora industry ($IDVS^{maq}$) where we

only include the imports used in the domestic intermediate consumption. This simply implies the following substraction;

$$\mathrm{IDVS}^{\mathrm{maq}} = \mathrm{TVS}^{\mathrm{maq}} - \mathrm{DVS}^{\mathrm{maq}} \quad (5)$$

Now that we have described and further explained the methodological adaptation proposed by Yang et al. (2010), we can show how we plan to measure the levels of DVA of maquiladora and the level of productive linkages on the basis of the above presented formulas. From the previous analysis, we see that in order to measure the imported input content of manufacturing exports we can have a total effect of VS which is the sum of a direct and indirect effect. Provided that the remaining part of the effect of VS (in a scale of 0 to 1) accounts for the domestic intermediate content of manufacturing exports, we can rephrase this information and posit the existence of a direct level of domestic value added in the maquiladora ($\mathrm{DDVA}^{\mathrm{maq}}$), an indirect level of DVA ($\mathrm{IDVA}^{\mathrm{maq}}$) and a total level of DVA ($\mathrm{TDVA}^{\mathrm{maq}}$).

The $\mathrm{DDVA}^{\mathrm{maq}}$ will indicate the level of domestic intermediate inputs that are totally produced in Mexico and that are embodied in the exports of the maquiladora. The $\mathrm{DDVA}^{\mathrm{maq}}$ will be calculated as follows;

$$\mathrm{DDVA}^{\mathrm{maq}} = 1 - \mathrm{DVS}^{\mathrm{maq}} \quad (6)$$

On the other hand, the indirect level of domestic value-added (IDVA) will study the level of domestic intermediate inputs that have been used in the production of other domestic intermediate inputs used by the maquiladora and that are embodied in the exports of this industry. This index can be determined as follows;

$$\mathrm{IDVA}^{\mathrm{maq}} = 1 - \mathrm{IDVS}^{\mathrm{maq}} \quad (7)$$

In this part, it is important to mention that we can use this last index of $\mathrm{IDVA}^{\mathrm{maq}}$ to measure the level of productive linkages between maquiladora and domestic firms as this index will solely indicate the domestic inputs produced by domestic suppliers and demanded by the maquiladora. Therefore, our measure of productive linkages will imply multiplying $\mathrm{IDVA}^{\mathrm{maq}}$ times the total level of domestic inputs used by the maquiladora. The outcome of this will give us a value in Mexican pesos that only indicates the intermediate inputs of domestic origin demanded by the maquiladora.

Finally, the total level of DVA (TDVA) will account for the total level of domestic intermediate inputs embodied in the exports of maquiladora. Thus;

$$\mathrm{TDVA}^{\mathrm{maq}} = 1 - \mathrm{TVS}^{\mathrm{maq}} \quad (8).$$

The value triggered by this index of $\mathrm{TDVA}^{\mathrm{maq}}$ must be in a scale of 0 to 1. Therefore, if we multiply this index of $\mathrm{TDVA}^{\mathrm{maq}}$ by the gross production of maquiladora we will have a value in Mexican pesos indicating the domestic value added embodied in the exports of maquiladora.

The above standing formulas will be the ones our research will be working with in order to evaluate the level of DVA and the productive linkages over the years in the maquiladora industry. These formulas and the adaptation of the index of VS that studies the case of economies highly engaged in GPN can be well supported by a recent stream of knowledge. For instance, Koopman et al. (2008) and De La Cruz et al. (2011) have criticized the underlying assumption of the original index of VS initially developed by Hummels et al. (2001). A key assumption needed for the original formula of VS to work is that the intensity in the use of imported inputs is the same between different types of production;

production for processing exports (maquiladora type production) and the production for the domestic use. Nonetheless, such an assumption does not hold for economies highly engaged in GPN. This is because policy preferences for firms engaged in GPN lead to significant differences in the intensity of imported inputs (De La Cruz et al., 2011). Firms engaged in GPN might use more imported inputs in their production for processing exports than firms that solely produce for the domestic market. Recognizing this situation, Koopman et al. (2008) posited that if a distinction between the production for processing export and the production for domestic use is not provided, then the weighted average observed in the index of VS will underestimate the share of foreign value added in a country's exports. Therefore, if we use the original index of VS to study the case of the maquiladora industry we would not correctly estimate the levels of DVA as these will be overestimated. As seen in this section, these problems of underestimation of foreign value added and overestimation of DVA will not be present in our research since we will implement the suggested distinction between the production for processing exports (maquiladora type production) and the production for domestic use.

With this context in mind, it is now time for our research to describe the type of data we need to implement the previous formulas to the case of the maquiladora industry. Such an objective must be met in the next section.

4. Data: Maquiladora IOTs from 1988-2006.

Normally, the main sources of information for working with the index of VS are contained in IOTs tables. These IOTs are part of the National Accounting System of any country and provide information in terms of gross production, domestic consumption, imports, exports and so forth. To implement the original index of VS, Hummels et al. (2001) used IOTs for the total economy. These IOTs for the total economy are designed to reflect the whole production of the country.

Nevertheless, to work with the modified version of VS presented in our methodology, this research cannot rely on IOTs for the total economy. The most important reason for this is that IOTs for the total economy cannot be used if our objective is to evaluate the levels of DVA in a specific type of industry that is engaged in GPN. That argument was one of the main conclusions reached by Yang et al. (2010) when studying the case of the processing exports in China which account for the GPN of this country. In the perspective of those authors, even though processing exports are an important part of total exports they have a rather small participation in total production of the economy. Thus, the typical production corresponding to GPN is likely to be underestimated if we rely on IOTs for the whole economy as proposed by Hummels et al. (2001). Considering this issue, it can be seen that if we want to use the modified version of the index of VS we will need specific IOTs for the maquiladora industry.

In 2010, the Mexican Statistical Office (INEGI) prepared a specific IOT for studying the maquiladora industry. Such maquiladora IOT is remarkably important for research purposes because it is the very first time in history that INEGI divides the total production of the Mexico in IOTs for the domestic economy and IOT for the maquiladora industry (INEGI, 2010). This maquiladora IOT, however, was only prepared for studying a single year (2003). Such a situation represents an important time constraint for our research because we cannot analyze the evolution of DVA of the maquiladora industry with an IOT for one year. To cope with this constraint, our research decided to construct maquiladora IOTs for several years. In the next lines, we will describe how we plan to achieve that objective as well as the data sources and manufacturing sectors our research should rely on.

4.1 Construction of IOTs.

A method for creating IOTs can be the so called Generalized RAS procedure (GRAS). Such a method, developed by Junius & Oosterhaven (2003), is generally used to update or regionalize a given matrix. The underlying idea behind the GRAS procedure is to iteratively adjust an old matrix A, with the row sums $w_0$and column sums v_0, to a "new" matrix (X) that satisfies the given set of rows sums w and column sums v. With minimum loss of information the GRAS-procedure will produce the new (target) matrix (X) with the required row and column sums. The main advantage of this GRAS-procedure is that, unlike the original RAS procedure (Stone, 1961; Stone & Brown, 1962), it allows for the existence of positive and negative values.

After analyzing the description of the GRAS procedure, it can be inferred that our research needs "an old matrix" and "new information" for several years in rows and columns. That should be sufficient information to construct "new matrices". The maquiladora IOT prepared by INEGI for 2003 can be used as the old matrix. On the other hand, to obtain the new information in rows and columns our research decided to carefully study the methodology of the maquiladora IOT of 2003.Understanding the methodology and the sources of information by which this maquiladora IOT was constructed should let us know the specific type of new information that we need to allocate in rows and columns according to the GRAS procedure. Therefore, a thorough description of the methodology of the maquiladora IOT of 2003 is now provided.

4.2 Description of the maquiladora IOT of 2003

According to INEGI (2006, 2010), the foundations for constructing the maquiladora IOT of 2003 were the so called "Cuadros de Oferta y Utilización" for the maquiladora industry which can be named as "Maquiladora Chart of Supply" and "Maquiladora Chart of Use".

4.2.1 Maquiladora Chart of Supply.

The maquiladora chart of supply analyses the production of 208 industries at purchasers' price. Purchaser's price means that the price of each good includes the trade and transport margins as well as the net taxes where subsidies over goods and services are subtracted. This chart of supply contains the following elements: (a) a matrix of production at a subsector level; (b) a vector of the products purchased at the domestic economy; (c) a vector of trade margin and a vector of transport margin; (d) a vector of imports and, finally; (e) a vector of total supply. In the forthcoming lines, we document the source of information for each of these charts.

(a) **Matrix of production at a subsector level.**

This matrix describes the production of maquiladora at "basic prices" (selling price in the place of production). In this matrix, the sum of columns represents the value of the production from each industrial sector. On the other hand, the sum of each row represents the production that other industries demand to this industry for their own production. The main outcome of this matrix is a vector that indicates the total production at selling prices. Such vector is obtained by adding each row in the matrix. Given that the total production of maquiladora is exported, the final outcome from the sum of each row also constitutes the total exports from this industry.

The main source of information for creating this matrix was the Monthly Statistical Report for the Maquiladora Industry (EMIME in Spanish) prepared by INEGI on its edition of 2003.The EMIME edition of 2003 contained information for a sample 2,562 maquiladoras in terms of domestic and intermediate consumption, wage bill, working hours and the like (INEGI, 2010). Nevertheless, in order to construct the matrix we are describing (that of the production at a subsector level), INEGI had to rely on a second source of information that complement that of EMIME. Such second source of information was the Foreign Trade Database prepared by the Central Bank of Mexico (BANXICO) which contained data in terms of imported intermediate consumption that had not been measured in EMIME. Once the information from BANXICO and EMIME was gathered by INEGI, a new sample of maquiladora firms was created where 2,114 maquiladora firms (82.5% from the total reported in EMIME) accounted for 97.5% of the total production (INEGI, 2010).

(b) **Vector of the products purchased at the domestic economy.**

This vector reports at basic prices the total amount of products that are domestically purchased. It basically refers to the purchases of goods and services that the maquiladora industry demands from other firms in the domestic economy. By definition, these goods and services are to be transformed and exported by the maquiladora. The main source of information was in this case the EMIME of 2003.

(c) **Vector of trade margin and a vector of transport margin.**

The first vector refers to the trade margin from products purchased at the domestic economy. This trade margin is related to the difference between the selling and the purchasing price of products from the domestic economy both valuated at the moment of selling. The first step to measure this trade margin is to quantify the composition of intermediate domestic consumption with the data provided by EMIME and the "Economic Census of 2004" (EC04) developed by INEGI. Afterwards, the weighted average of the trade margin by product was estimated according to the information contained in the Commercial Census of 2004 prepared by INEGI.

The second margin here described consists of those transport charges paid separately by the purchaser when the goods are delivered. This information was also taken from EMIME in the section which is called "freight and cartage". These were taken for each activity and distributed proportionally for each maquiladora activity.

(d) **Vector of imports.**

The vectors of imports are reported in Cost Insurance and Freight (CIF) values. CIF values means that the shipper/trader has to pay the cost of shipment up to the ship, insurance cost of cargo and freight cost up to destination port. In order to obtain this data, information was retrieved from BANXICO, the EC04 and the "Encuesta Complementaria de los Censos Económicos de 2004" (CEC04). This data gathered from different sources represented a 97.7% of the total imported intermediate consumption reported by EMIME.

(e) **Vector of total supply.**

Finally, the vector of total supply of production from the maquiladora industry was obtained by adding the vector of total production at selling prices, the vector of products purchased at the domestic economy, the vector of trade and transport margins as well as the vector of imports.

4.2.2 Maquiladora Chart of Use.

The information there provided is also reported in purchasers' price. This information is divided as follows; (a) one matrix of maquiladora intermediate consumption; (b) a quadrant analyzing the gross value added of maquiladora; (c) a vector studying the final demand to the maquiladora industry and, lastly; (d) a vector of final use. Each of these elements is explained in the next lines.

(a) Matrix of maquiladora intermediate consumption.

This matrix shows in each row the intermediate consumption of maquiladora firms at purchasers' price for all the manufacturing sectors that appear in columns. This intermediate consumption includes inputs demanded by the maquiladora that were imported and those that were domestically produced by non-maquiladora firms. It does not include the intermediate inputs created by the maquiladora industry because all the production created by this industry is exported. The data for intermediate demand was retrieved from EMIME, the EC04 and the CEC04 and classified according to their industrial origins in terms of North American Industrial Classification System (NAICS).

(b) Quadrant analyzing the gross value added of maquiladora.

This quadrant is located below the matrix of intermediate consumption. It analyzes the gross value added of maquiladora at basic prices. Gross value-added means the production costs that arise during the intermediate consumption of maquiladora firms. The information of gross value-added is the sum of wage bill, net taxes on subsidies from production and the gross operating surplus. The "National Survey of Employment for 2003" prepared by INEGI was the underlying source of information for this quadrant.

(c) Vector of final demand to the maquiladora industry.

This vector is located at the right hand side of the matrix of intermediate consumption. Such a vector considers the production of the maquiladora that is demanded at purchasers' price. Since all the production of maquiladora is exported, this vector is the same as the vector of production at a subsector level reported in the maquiladora chart of supply.

(d) **Vector of final use.**

Finally, the vector of final use considers the intermediate consumption of maquiladora plus the total level of production (exports). Therefore, this vector of final use is calculated by adding the vector of maquiladora intermediate consumption and the vector of final demand to the maquiladora industry.

At the end of this whole analysis, we should see that vector of total supply (in the maquiladora chart of supply) and the vector of final use (in the maquiladora chart of use) must be the same.

4.3 Sources of information for creating maquiladora IOTs from 1988 to 2006.

We conducted the previous analysis of the methodology and sources of information for the maquiladora IOT of 2003 because we wanted to know the type of information we need in order to construct new maquiladora IOTs for several years. From such analysis, we can infer that the following

new information is needed; (1) the gross production of maquiladora at a subsector level; (2) the intermediate consumption of maquiladora, which must include imported inputs and inputs that were domestically purchased and produced by non-maquiladora firms; (3) the gross value added of maquiladora that involves the sum of wage bill, net taxes on subsidies from production and the gross operating surplus and; (4) the levels of total exports and imports from the maquiladora. This new information will be the one that we should allocate in rows and columns in order to implement the GRAS procedure.

Obtaining these four elements from the same sources that INEGI used was an objective relatively difficult. From the analysis in section 4.2, we inferred that the sources of information for constructing the maquiladora IOT of 2003 were the Economic, Commercial and Employment censuses, the information contained in EMIME and the data base prepared by BANXICO. The Economic, Commercial and Employment censuses are only published by INEGI every five years. Such a situation means that we cannot rely on those because we need information on a yearly basis. Nevertheless, we do not see this as an important constraint for our data construction objective since we also saw in section 4.2 that INEGI mainly relied on those censuses to complement the information provided by EMIME and BANXICO which are indeed presented on a yearly basis.

Fortunately, all the information that we need is contained in EMIME and BANXICO. This information can be found in three main sources. The first source is in two documents prepared by INEGI (2001, 2005) which are called “La Producción, Salarios, Empleo y Productividad de la Industria Maquiladora de Exportación; Total Nacional”. These two documents are a reliable source of information because they report data for the maquiladora industry on the basis of the EMIME (INEGI, 2010). Furthermore, the advantage for our research is that those two documents contain information from EMIME for more than one year, something which allows us to create maquiladora IOT for various years. The information of maquiladora reported in these two documents is the following; gross production, intermediate consumption (which is the sum of imported inputs and domestic inputs), gross value added, remunerations, salaries, gross operating surplus and number of employees. All this data is reported from 1988 to 2004 at a national level (the whole production of maquiladora), at a sub-sector level (the production of each manufacturing sector in maquiladora) at current and constant Mexican pesos of 1993.With this initial period of time, that covered 1988-2004, we decided to look for more recent information.

This led us to our second source of information which is INEGI's official web site. Specifically, we relied on the section called “Banco de Información Económica (BIE)”4. Here, data for maquiladora can be found in the sub-section called “Time Series that are no longer updated”. The information is reported on a monthly basis from 1990 to 2006. It contains pretty much the same information that can be found on the documents prepared by INEGI (2001, 2005) because it was also prepared on the basis of EMIME. Lastly, the third source of information for constructing maquiladora IOT was the official website of BANXICO in the section that reports data for the Mexican balance of payments5. Here, we retrieved data for the level of exports and imports from maquiladora. This is reported in thousands of dollar at a subsector level from 1993 to 2006.

[4] http://www.inegi.org.mx/sistemas/bie/

[5] http://www.banxico.org.mx/SieInternet/consultarDirectorioInternetAction.do?accion=consultarCuadro&idCuadro=CE55&sector=1&locale=es

Once we gathered these three data sources, we had information for constructing maquiladora IOTs from 1988 to 2006. Nevertheless, several aspects prevented our research from extending our analysis to the latest year where information was available. These aspects are related to a change in the maquiladora legal framework that occurred in 2006. As studied in section 2.2.3 from our literature review, the IMMEX program arose in 2006. That program merged in a single framework the firms engaged in the maquiladora program and the firms operating in the PITEX program. Therefore, as of 2007, INEGI does not report data that only studies the maquiladora firms because EMIME does not exist anymore. The maquiladoras are now studied by INEGI within the whole framework of IMMEX with data reported from 2007 onwards in the so called "Estadística Mensual sobre Establecimientos con Programa IMMEX". Such a situation, in terms of our research, means that we have data for constructing IOTs from 2007 to 2010 but this data includes maquiladora firms and firms that are not part of the maquiladora. This was the main reason why our research decided to study the evolution of maquiladora from 1988 to 2006.

4.4 Manufacturing sectors to be studied in the maquiladora IOTs.

Finally, the last problem we faced was differences in the information contained in our three main data sources. Those three main sources report data for the maquiladora on a different level of disaggregation in terms of manufacturing sectors. For instance, while the documents from INEGI (2001, 2005) show information for 41 manufacturing sectors, INEGI's web site presents data for 12 manufacturing sectors and BANXICO does the same for 97 sectors. Furthermore, the information from INEGI is reported in terms of the "Codificator for the National Accounting System of Mexico of 1993" (INEGI, 2001) while that of BANXICO draws upon the Harmonized System (HS). Having this problem in mind, we decided to match the information from INEGI and BANXICO by utilizing the "Codificator for the National Accounting System of Mexico of 1993". The table where we match the different manufacturing sectors reported by INEGI and BANXICO to create new aggregate manufacturing sectors for our research is presented in the table A.1 of the appendix. From that table, we obtained the following 12 manufacturing sectors which will be the basis for analyzing the maquiladora IOTs; (1) Food and tobacco manufacturing; (2) Textile, leather and footwear; (3) Furniture assembly and other wooden and metal products; (4) Paper and printing industry; (5) Chemical products; (6) Mineral products; (7) Basic metal industries; (8) Transportation equipment; (9) Non electric machinery and equipment; (10) Machinery, electric and electronic manufacturing; (11) Other manufacturing industries and, finally; (12) Business services6.

Now, in order to gain further insights about the data we are going to work with, we must understand the behavior of those manufacturing sectors during the proposed period of study. To that end, the next section will present descriptive statistics about the data we gathered for constructing maquiladora IOT.

5. Descriptive statistics.

Presenting descriptive statistics about the data we gathered should allow us to better comprehend the performance of the maquiladora industry as a whole industry and the performance of its manufacturing sectors. Therefore, this section will evaluate such performances by focusing on the four types of information required for constructing maquiladora IOTs that were described in section 4.3.

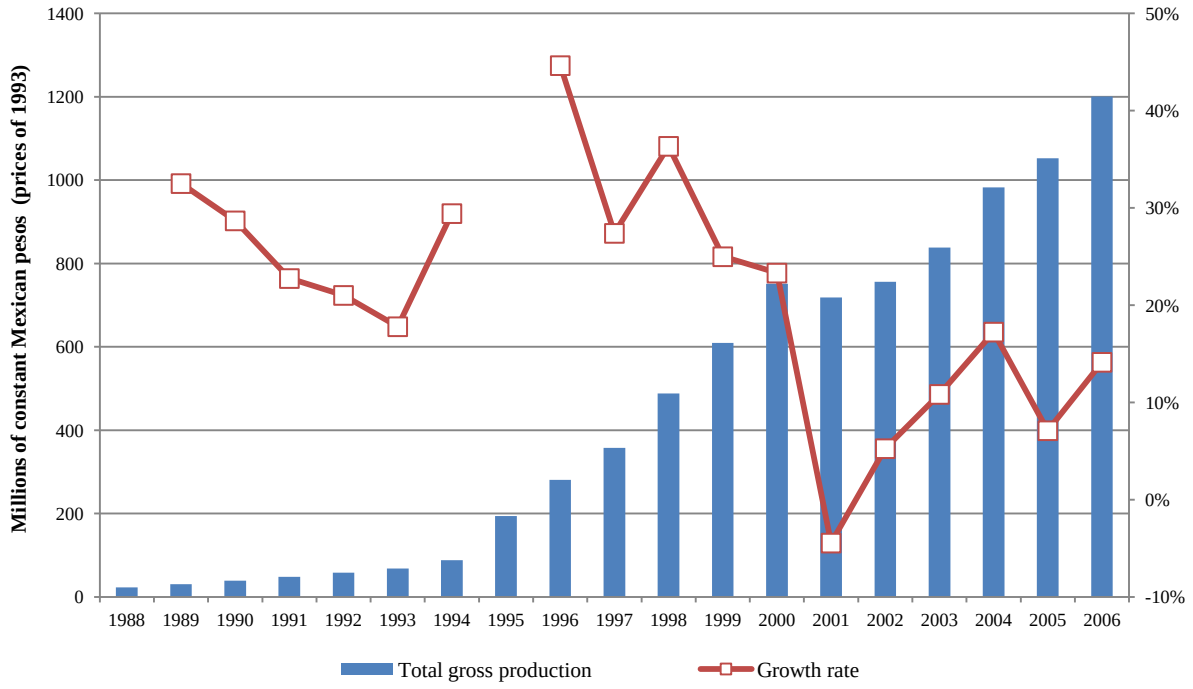
[6] According to the methodology presented by INEGI (2010), "Business services" cannot be regarded as a manufacturing sector per se as it mainly includes activities such as "professional services", "leisure services" and "other services" (see table A.1). Nonetheless, "Business services" is here presented and studied with the other 11 pure manufacturing sectors of maquiladora because those services facilitate the performance of the pure manufacturing sectors of the maquiladora industry (INEGI, 2010).

Our main results derived from the these descriptive statistics are presented in the forthcoming paragraphs.

5.1 Gross production of maquiladora.

Figure (1) presents the evolution of the gross production and the growth rate of the maquiladora industry as a whole from 1988 to 2006. The axis on the left hand side of this figure describes the gross production in constant Mexican pesos (prices of 1993), while the axis on the right hand side of the same figure describes the growth rate of that production. At first glance, this figure shows us a continuous upward trend in the total gross production of this industry. The boom in production triggered by NAFTA in 1994 can also be observed. According to our data, by 1995 NAFTA created a growth rate in gross production of 120% to the level of 1994. For illustration purposes, this boom in 1995 is excluded from the figure (1) since it may lead us to overestimate the evolution of gross production of the maquiladora over time (it represented a growth rate of 120% from 1994 to 1995).

Figure (1): Gross production and growth rate of maquiladora industry.

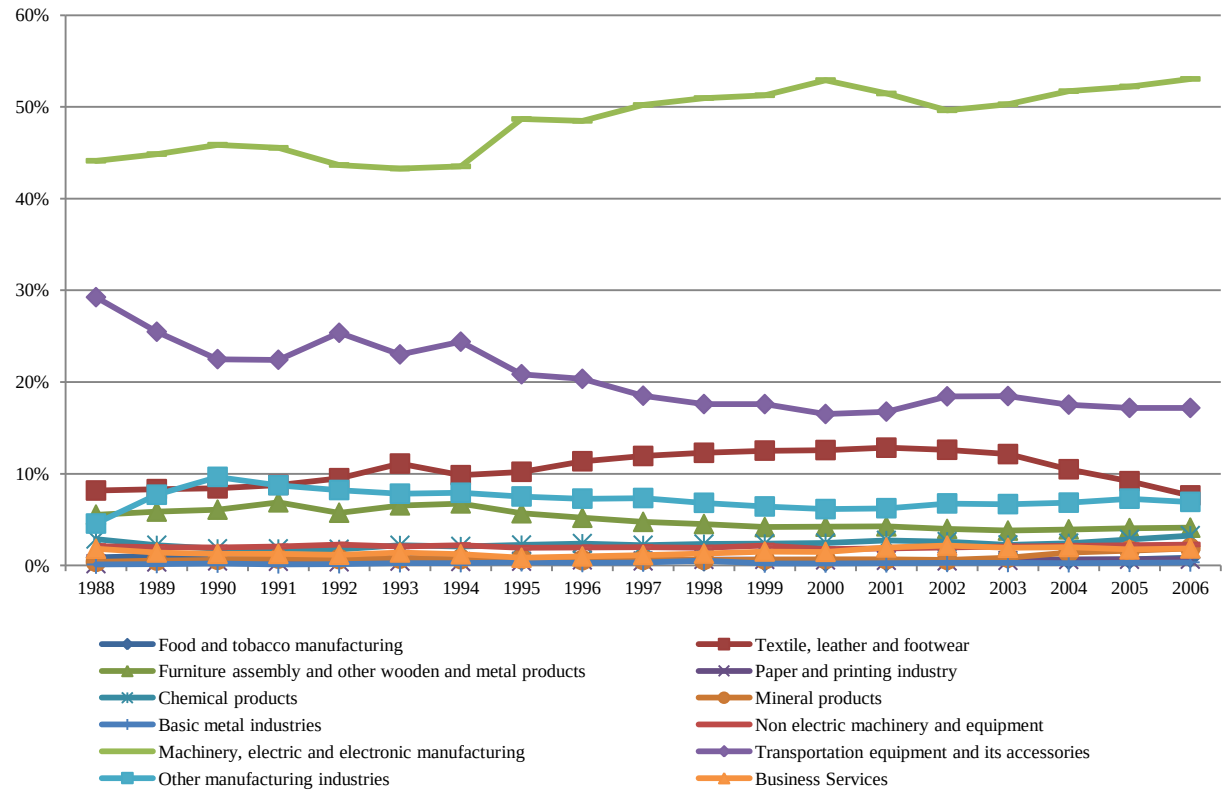


Source: Authors' calculation based on INEGI (2001, 2005) from 1988 to 2004 and INEGI's official web site (BIE) from 2005 to 2006.
Note: growth in 1995 is excluded from the graph.

After having excluded this boom in 1995, we see that the maquiladora industry is indeed facing a continuous downward trend. From 1996 onwards a sharp and continuous decline in the growth rate can be observed. The lowest level was registered in 2001 when the growth rate with respect to 2000 was of -4%. Such decline in maquiladora's gross production can be associated to the boom in Chinese production documented during the literature review of this essay and to the economic crisis faced by the US in 2001. In this whole context, we can see that despite the important amount of production created by the maquiladora from 1988 to 2006 (as it moved from producing 23 million of Mexican pesos in 1988 to 1200 in 2006), the maquiladora is showing lower growth rates than the one it had during the late 1980s.

On the other hand, figure (2) presents the participation of our 12 manufacturing sectors in the total gross production of maquiladora. These shares were also derived from the constant prices series of 1993. In that figure, we can observe that the manufacturing sector with the highest level of participation over time is "Machinery, electric and electronic manufacturing" as it accounts for an average of roughly 49% of maquiladora's total gross production during the whole period of study. Then, we have "Transportation equipment" which presents a medium to high participation in the total production (its average participation from 1988 to 2006 was of 20%). Likewise, we found sectors with medium to low average participation; "Textile, leather and footwear manufacturing" (10%), "Other manufacturing industries" (8%) and "Furniture assembly and other wooden and metal products" (5%) respectively. Lastly, the other six manufacturing sectors defined by our research in section 4.4 showed an average participation in maquiladora's total gross production that was lower than 2%.

Figure (2): Participation of manufacturing sectors in the total gross production of maquiladora industry per year



Source: Authors' calculation based on INEGI (2001, 2005) from 1988 to 2004 and INEGI's official web site (BIE) from 2005 to 2006.

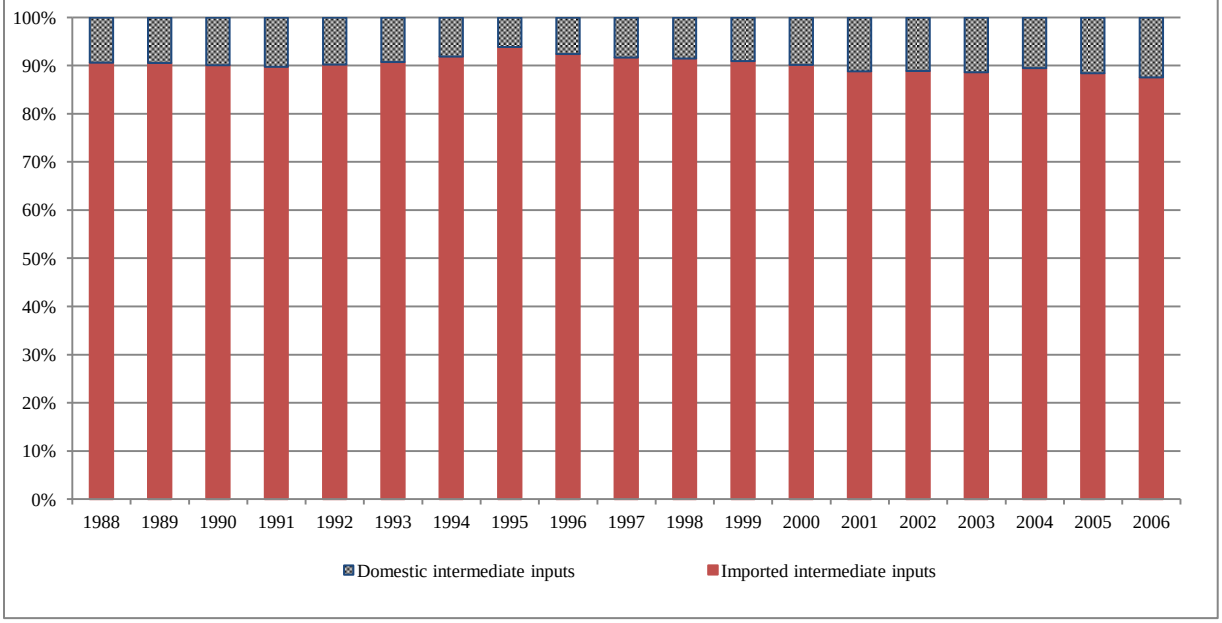
Figure (2) also indicates that the composition of maquiladora's total gross production per manufacturing sector has not been widely modified neither as a result of NAFTA nor as a consequence of the industrial emergence of China. This situation means that the shares of manufacturing sectors in total production have been relatively the same during the period here analyzed. Notwithstanding this constant tendency in the shares per manufacturing sectors, we were able to identify some remarkable findings.

One of the most important findings derived from figure (2) is that NAFTA further triggered the dominance of the "Machinery, Electric and electronic manufacturing" as it enabled this sector to move from a share of 43.5% in 1994 to 48% in 1995, a level that had not decreased until the end of 2006. Other change that we observe is a continuous decline in the share of "Transportation equipment", since it moved from 24% in 1994 to 17% in 2006. This decreasing tendency of transportation equipment in the share of maquiladora's gross production can be related to an increasing participation of other manufacturing sectors such as textile and other manufacturing industries. Nonetheless, despite this decreasing tendency, "Transportation equipment" still accounted in 2006 for the second place in the share of maquiladora's total gross production. Finally, one more interesting remark is the decline observed in the "Textile, leather and footwear" sector as of 2001. That situation is important because prior to 2001 this manufacturing sector was doing well and even approaching to the share of the production of "Transportation equipment" in 2000. Nevertheless, the Mexican textile industry has reduced in 6 years almost half of their share in total gross production since it moved from 13% in 2000 to 7% by 2006. This sector is generally understood as the one that have more seriously affected due to the increasing Chinese competition (Sargent and Mathews, 2009).

5.2 Intermediate inputs used by the maquiladora

Figure (3) studies the total intermediate inputs used by the maquiladora industry. Here, total intermediate inputs are divided in imported intermediate inputs and domestic intermediate inputs. In such graph, it can be seen how the imported intermediate goods have historically dominated the share in total intermediate inputs at the maquiladora industry, a tendency which has not changed much over the years. In most of the years here analyzed, the participation of domestic inputs in the total intermediate inputs is of less than 10%, while that of the imported goods is more than 90%. One more time, it can be inferred that neither NAFTA nor the emergence of China changed the participation of imported and domestic intermediate goods in the total intermediate inputs of maquiladora.

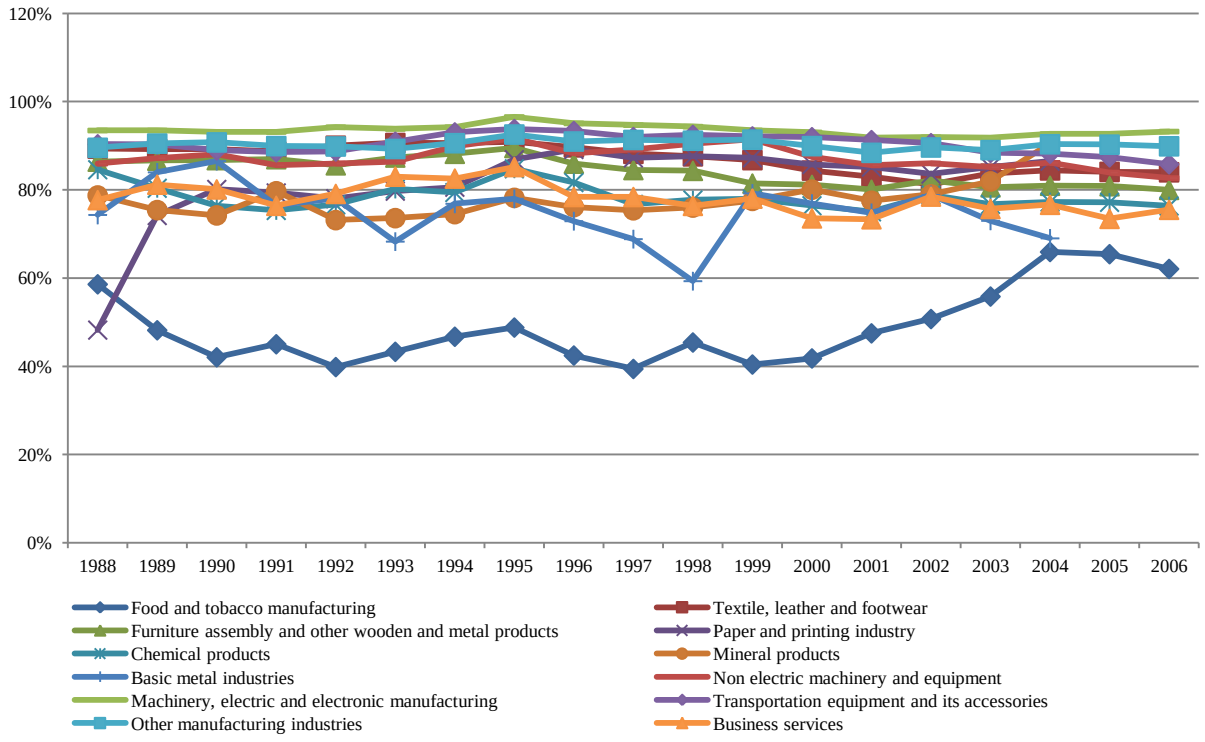
Figure (3): Share of domestic intermediate inputs and imported intermediate inputs in the total intermediate inputs used by the maquiladora.



Source: Authors' calculation based on INEGI (2001, 2005) from 1988 to 2004 and INEGI's official web site (BIE) from 2005 to 2006.
Note: this information in this graph was derived from the series expressed in constant Mexican prices of 1993.

At the level of manufacturing sectors, the dominance of imported inputs in total intermediate inputs does not change that much either. Figure (4) tells that in most of the manufacturing sectors more than 80% of the inputs are imported and that the use of domestic inputs does not seem to be increasing at all. The manufacturing sectors that on average used more imported inputs as a percentage of total inputs are "Machinery, Electric and electronic manufacturing" (94%), "Transportation equipment" (91%), "Other manufacturing sectors" (91%), "Textile, leather and footwear" (88%), "Non-electrical machinery" (88%) and "Wood product manufacturing" (85%). Those that used on average a bit less of imported inputs as a percentage of their total inputs are "Paper and printing industry" (81%), "Chemical products" (80%), "Services" (80%), "Mineral products" (78%), "Basic metal industries" (75%). The only manufacturing sector that has relied more on domestic inputs is the "Food and tobacco manufacturing" with an average of 50% of domestic inputs as a percentage of total inputs. Nonetheless, as can be observed in figure (4), from 1999 onwards the "Food and tobacco manufacturing" has progressively increased its use of imported inputs.

Figure (4) : Ratio of imported intermediate inputs to total intermediate inputs in the maquiladora industry per manufacturing sector



Source: Authors' calculation based on INEGI (2001, 2005) from 1988 to 2004 and INEGI's official web site (BIE) from 2005 to 2006.
Note: this information in this graph was derived from the series expressed in constant Mexican prices of 1993.

The information provided in this sub-section can be a first approximation for testing our first set of hypotheses (H1.a and H1.b) that were posited in the literature review. As the reader may remember, our first set of hypothesis indicated that the levels of DVA (and those for the productive linkages) will largely differ across industrial sectors. Our reasoning basically expected high to medium levels of DVA in the more complex manufacturing sectors (second and third generation of maquiladoras) and low levels in the more traditional manufacturing sectors (first generation of maquiladoras). This same reasoning was also expected for the case of productive linkages. From the data here presented, we infer that the

more complex manufacturing sectors might be the ones that show the lowest level of DVA (and thus of productive linkages) as they are the ones that have used on average less domestic inputs over time. This is the case of "Machinery, Electric and electronic manufacturing" "Transportation equipment", "Other manufacturing sectors7" and "Non-electrical machinery". So far, the only complex manufacturing sectors that might indeed present somehow high levels of DVA and of productive linkages are the "Chemical industry" and "Business services" because they used on average 20% of domestic inputs as percentage of total inputs.

On the other hand, apparently, some traditional manufacturing sectors might be adding medium to low levels of DVA in maquiladora industry. This is the case of "Mineral products", "Basic metal industries" and "Wood and product manufacturing and furniture" which add on average more than 20% of domestic inputs and "Food and tobacco manufacturing" which is the sector with the highest use of domestic inputs. The traditional manufacturing sectors that follow our second hypotheses (low levels of DVA) are "Textile, leather and footwear" and "Paper and Printing industries" with an average of less than 12% of domestic inputs.

These first results, however, are not yet final because we still have to evaluate this data by means of the proposed formulas presented in section 3. In the meantime, we have a first approximation to what might be our final results which shall be further confirmed or denied by the modified index of VS posited by our research.

5.3 Gross value added of maquiladora.

In section 4.2.2, we described that, according to INEGI (2010), gross value added (GVA) means the production costs that arise during the intermediate consumption of maquiladora firms. It includes the sum of wage bill, net taxes on subsidies from production and the gross operating surplus. From this section, we will see that the concept that accounts for the bulk of GVA is the one of the wage bill, which basically means the cost of labor (INEGI, 2001; 2005)

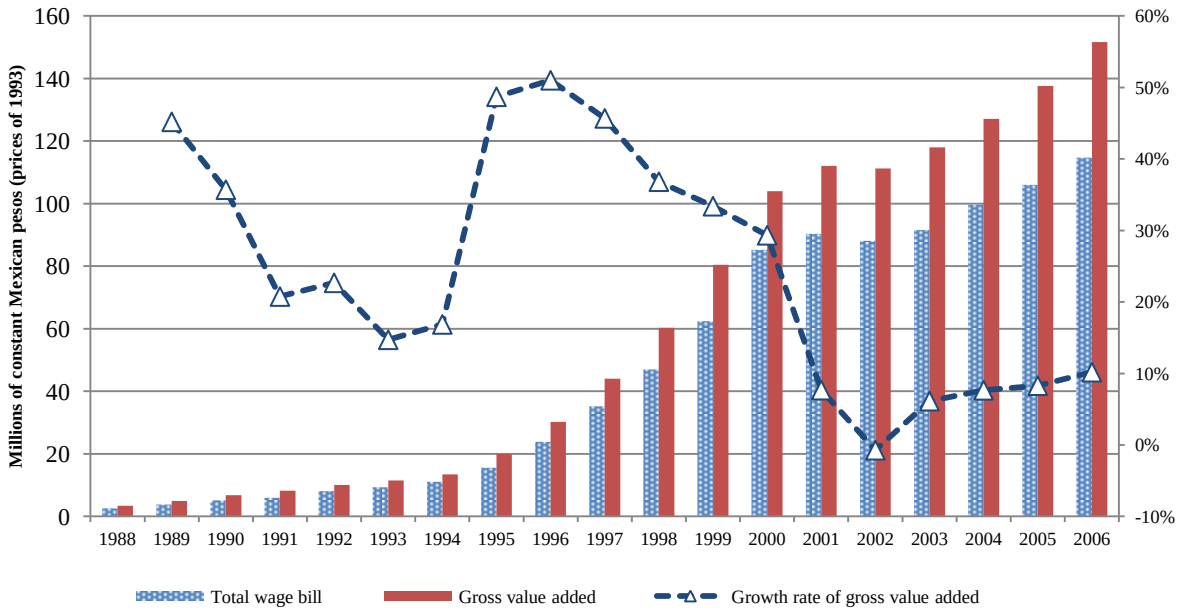
In this part, it is important to mention that the GVA measured by INEGI differs from our proposed measure of DVA in that our measure will solely focus in the total amount of domestic inputs embodied in the production to be exported by the maquiladora. On the other hand, as the reader may notice, INEGI's measure of gross value added focuses in the cost associated to intermediate production of maquiladora which, as previously mentioned, it mainly implies the cost of labor. Nevertheless, this measure of GVA provided by INEGI is also useful for research purposes because it can give us an idea of the use of other domestic resources (not only intermediate inputs) employed by the maquiladora.

Figure (5) introduces INEGI's measure of GVA and the wage bill in the maquiladora industry which are presented in millions of Mexican pesos of 1993 and described on the left-hand side axis.. In this figure, it can be observed that, as described by INEGI (2001, 2005), wage bill accounted by itself with an average of 78% of the GVA in maquiladora industry. This situation is quite important for further analysis of GVA because it tell us that we are basically analyzing the growth of wage bill in the maquiladora

[7] "Other manufacturing sectors" will be here classified within the category of more complex manufacturing sectors because according to INEGI (2001, 2005) they include, among other things, goods with important technological content: medical and photographic devices.

To better understand the dynamics of GVA we can also focus on its growth rates. Therefore, the right hand side axis of figure (5) also presents the growth rate of maquiladora's industry gross value added. In such a graph, we see that prior to NAFTA the growth rate of GVA was decreasing. Then, after this agreement was implemented, a boom in GVA was observed as it reached growth rates of more than 45 percent8. Finally, from 1998 onwards the growth rate of GVA faced a continuous downward trend which reached its lowest level in 2002 (-0.7%). The growth rate of maquiladora slightly recovered in the next years but it has not going beyond the growth rates observed before 2000.

Figure (5): Wage Bill and Gross Value Added in the maquiladora industry



Source: Authors' calculation based on INEGI (2001, 2005) from 1988 to 2004 and INEGI's official web site (BIE) from 2005 to 2006.

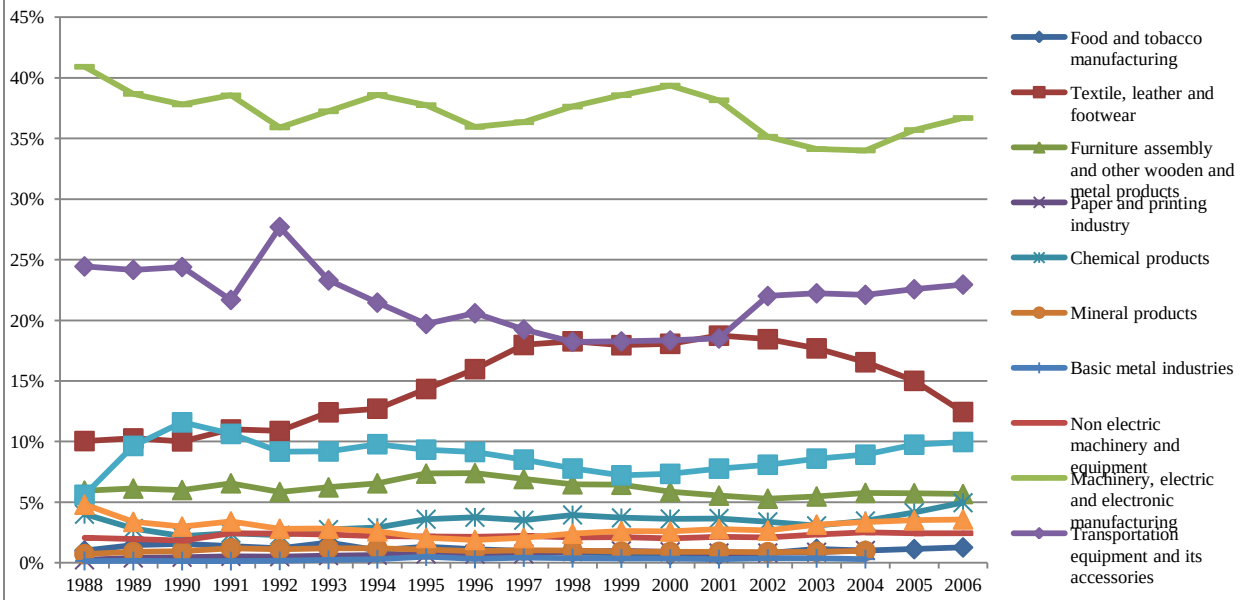
The participation of manufacturing sectors in the total GVA of maquiladora per years is presented in figure (6). This graph basically shows that the shares of GVA per manufacturing sectors have changed very little over time. It is important to notice that the differences in shares of GVA across manufacturing sectors are solely associated to differences in the scale of production. Therefore, if "Machinery and electronic equipment" has a higher share of GVA than "Textile, leather and footwear" it is simply because the first produces more than the second. One important conclusion also derived from this graph and from the analysis of previous paragraphs is that since "Machinery, electric and electronic manufacturing", "Transportation equipment", "Textiles" and "Other manufacturing products" are the ones with the highest share in GVA they must also be the ones with highest expenditure in labor (wage bill).

The information provided in this section can be a first approximation for testing our second set of hypotheses. That is because, as previously mentioned, the level of GVA can give us an idea about the use of other domestic resources that are not only intermediate goods. In our second set of hypotheses,

[8] In this case, and unlike figure (1), we decided not to exclude in figure (5) the aforementioned boom in GVA created by NAFTA. The main reason to exclude in figure (1) the boom in production triggered by NAFTA was due to the fact that including it might lead to an overestimation of the results in terms of gross production. Nevertheless, we do not see this situation as a pressing concern in the case of figure (5) because the boom in GVA was perceived during several years (1994-1998) while that of gross production was only seen in 1995.

which was divided among 3 sub-hypotheses, we expected low levels of DVA in the late 1980s for most of the manufacturing sectors (H2.a), higher levels of DVA for an increasing number of manufacturing sectors during the early and late 1990s (H2.b) and, very few industries with high levels of DVA by the mid-2000s (H2.c). From the analysis in figure (5), we can see that the tendency described in second set of hypotheses might be seen at the industry level (the whole maquiladora industry) as there was a decreasing growth rate prior to NAFTA, a boom after the agreement and yet another decreasing tendency by the early and mid-2000s.

Figure (6): Participation of manufacturing sectors in the value added for maquiladora industry per year



Source: Authors' calculation based on INEGI (2001, 2005) from 1988 to 2004 and INEGI's official web site (BIE) from 2005 to 2006.
Note: this information in this graph was derived from the series expressed in constant Mexican prices of 1993.

Nevertheless, our second set of hypotheses does not seem to hold in the case of each manufacturing sector. Figure (6) describes a rather constant tendency with very few significant changes in the share of GVA per manufacturing sector. The only sector that is remarkably increasing its share in GVA is "Other manufacturing sectors" from 2001 onwards. From 1994 to 2001, the "Textile industry" also increased but its share has been continuously decreasing since 2002.

In this context, it can be seen that maquiladora has changed its use of other domestic resources (mainly labor and not including intermediate inputs) in two different ways. On the one hand, the external shock of 1994 (NAFTA) increased the level of GVA in the maquiladora industry as a whole. Such a situation basically means that more people were hired in the maquiladoras as a result of NAFTA. On the other hand, the external shocks of 2001 (China and the economic crisis in the US) decreased the GVA in the maquiladora industry (less people were hired). Notwithstanding this upward and downward trend in the GVA of the maquiladora industry as a whole, the participation in GVA from each manufacturing might not have been seriously affected by those external shocks. For instance, NAFTA triggered an expansion in the GVA of the whole maquiladora from 13 million of Mexican pesos in 1994 to 105 million in 2000 but the share of GVA across manufacturing sectors did not change that much during all those years (see figure 6).

Such a situation might tell us that the levels of DVA might also not be changing the way we proposed in our second hypothesis. This was the tendency observed in the case of other domestic resources (mainly labor). But in order to reject our second hypothesis we still need to test the case in which we are interested the most (domestic intermediate inputs).

5.4. Exports and imports of maquiladora.

Finally, the last sub-section to be analyzed is the one that describes the exports and imports of the maquiladora industry. Table (1) presents an analysis with regard to the level of exports, imports, trade balance and total trade from maquiladora industry described in millions of dollars. The information is not presented in Mexican pesos because this was the only information for our research which was not retrieved from INEGI but from the Central Bank of Mexico (BANXICO). Such table basically confirms the previous findings of this section. Low levels of exports and imports before NAFTA (1994), an important boom after 1995 and then a deceleration on these levels from 2001 to 2003 and then a slight recovery. To our view, the most important finding from that table is the fact that the maquiladora industry as a whole has shown a continuous surplus on their trade balance over the years. Nevertheless, further attention must be paid to this level of trade balance. If we consider that the main imports of maquiladora are intermediate inputs and that all the production of maquiladora is for export, the trade balance here reported might also give us an idea about the amount of domestic inputs employed by the maquiladora. According to our calculations (not presented here but easily derived from table 1), the ratio of imports to exports of maquiladora has an average of 78% during the period of 1991 to 2006. In this context, such data does nothing but confirming the rather low use of domestic inputs.

Table (1)

Exports and imports of maquiladora (millions of dollars)

	Exports	Imports	Trade balance	Total trade (Export + Imports)
1991	15,8	11,8	4,1	27,6
1992	18,7	13,9	4,7	32,6
1993	21,9	16,4	5,4	38,3
1994	26,3	20,5	5,8	46,7
1995	31,1	26,2	4,9	57,3
1996	36,9	30,5	6,4	67,4
1997	45,2	36,3	8,8	81,5
1998	53,1	42,6	10,5	95,6
1999	63,9	50,4	13,4	114,3
2000	79,5	61,7	17,8	141,2
2001	76,9	57,6	19,3	134,5
2002	78,1	59,3	18,8	137,4
2003	77,5	59,1	18,4	136,5
2004	87,0	67,7	19,2	154,7
2005	97,4	75,7	21,7	173,1
2006	111,8	87,5	24,3	199,3

Source: Authors' calculation based on the balance of payments reported BANXICO.

The participation of manufacturing sectors in the total exports and imports from maquiladora industry is presented in figures A.1 and A.2 at the appendix of this research. Those figures are placed in the appendix because they simply confirm that the industries that produce (export) the most are the ones that also import the most. One more time, the ones with the highest share in the total exports and imports are the "Machinery and electronic manufacturing", "Transportation equipment", "Other manufacturing" and "Textiles" while the rest of manufacturing sectors present shares which are lower than 5%.

5.6. Conclusion from this section.

In this whole section, we conducted an analysis of descriptive statistics for the type data we are going to use for constructing IOT. This data will also be the basis for implementing our modified version of the index of VS. Therefore, from this section we develop the following ideas. We infer that most of the more complex manufacturing sectors are the ones that accounted for the bulk of the production of maquiladora. Likewise, we also see that the more complex manufacturing sectors have a rather small use of domestic inputs and that this use of domestic inputs has changed very little over time. On the other hand, we also see that some traditional manufacturing sectors are the ones that use more domestic inputs in their production. Finally, an important remark that this analysis yielded was the important expenditure of maquiladora firms on labor. This last remark also confirms that the maquiladora uses a lot of labor. All these findings must be considered by our research when we develop our final analysis.

Having presented our main data, methodology and descriptive statistics, it is time for our research to move forward and present our main results. That should be the objective of the following section.

6. Main results and discussion.

This section discusses and presents the main results of our research. Such analysis will be divided in three subsections. Our first subsection will study the average levels of DVA and productive linkage in the maquiladora industry as a whole and in our 12 manufacturing sectors. Those average levels from 1988 to 2006 are here studied in order to facilitate the testing of our first set of hypotheses (H1.a and H1b). On the other hand, the second subsection will study the evolution over the years of the levels of DVA and of the levels of productive linkages. We present our results in this form in an attempt to match the ideas of our second set of hypotheses (H2.a, H2.b and H2.c). Finally, section three will provide an additional analysis of labor qualification and productivity. This last analysis, which can be easily derived from the data we have been working with, will let us further confirm or deny the existence of a process of IU according to the situation described by our results.

6.1 Average levels of DVA and of productive linkages from 1988 to 2006.

Table (2) presents the average results for the indexes of the total level of DVA ($\mathrm{TDVA}^{\mathrm{maq}}$), the direct level of domestic value added ($\mathrm{DDVA}^{\mathrm{maq}}$), and the indirect level of DVA ($\mathrm{IDVA}^{\mathrm{maq}}$) in the maquiladora industry. It is important to notice that such a table classifies our 12 manufacturing sectors according to their level of technological complexity as proposed by Giuliani et al. (2005). In line with our methodology, the first two columns of table (2), the ones that indicate the average levels of $\mathrm{TDVA}^{\mathrm{maq}}$ and $\mathrm{DDVA}^{\mathrm{maq}}$, will be the basis for studying the average levels of DVA in the maquiladora as a whole

and across manufacturing sectors. Similarly, the last column of table (2), the one studying $\mathrm{IDVA}^{\mathrm{maq}}$, will be the basis for the analysis of productive linkages. With this background information in mind, let us start with the final analysis of the levels of DVA and productive linkages that can lead us to evaluate our hypotheses.

6.1.1 Average levels of DVA in the maquiladora as whole and across manufacturing sectors.

The first thing to see from table (2) is that the levels of DVA for the maquiladora industry as a whole are rather small. When measured by the total effect, the DVA reports on average 0.21 and, when measured by the direct effect, the data is of 0.22. On the other hand, from that table we can also see that, as initially proposed in hypothesis H1.a, the level of DVA does differ between manufacturing sectors. We observe that, with few remarkable exceptions, the traditional manufacturing sectors add low levels of DVA. Nonetheless, unlike our expectations, we also see that not all the complex manufacturing sectors add on average medium to high levels of DVA.

Let us first analyze the case of the traditional sectors. The upper section of table (2) shows that most of the traditional manufacturing sectors add on average low levels of DVA in the exports of maquiladora. That is mainly because of the fact that, with few exceptions, the indexes of $\mathrm{TDVA}^{\mathrm{maq}}$ and $\mathrm{DDVA}^{\mathrm{maq}}$ registered data which is lower than 0.37. Apparently, the only traditional manufacturing sector that added high levels of DVA in terms of the index of $\mathrm{TTDVA}^{\mathrm{maq}}$ and $\mathrm{DDVA}^{\mathrm{maq}}$ is the "food and tobacco manufacturing sector". In fact, this sector might be regarded as the one that added on average the highest level of DVA in the whole maquiladora industry, going far beyond the data registered by most of the more complex manufacturing sectors (see the lower section of table 2). Nevertheless, to our view, this observed high level of DVA in the "food and tobacco manufacturing sector" is of limited importance for the process of IU in the maquiladora industry. As discussed during the section of descriptive statistics of this research, we inferred that the average participation of this sector in the total production of maquiladora industry is less than 2%. Furthermore, even when these indexes of $\mathrm{TDVA}^{\mathrm{maq}}$ and $\mathrm{DDVA}^{\mathrm{maq}}$ confirm that "food and tobacco manufacturing" used an important amount of domestic inputs (50% with respect to the total intermediate inputs, according to section 5.2) those inputs were not processed with highly complex technological procedures. The labor intensive characteristics of this sector can account for this issue. Highly complex technological procedures are the ones required to foster industrial development given the current context of increasing competition in global production networks. This type of technology is by far not widely observed in the "food and tobacco industry", so their high levels of DVA are of limited importance

Table (2):
Average levels of DVA across manufacturing sectors of maquiladora (1988-2006).

Traditional manufacturing sectors	$\mathrm{TDVA}^{\mathrm{maq}}$	$\mathrm{DDVA}^{\mathrm{maq}}$	$\mathrm{IDVA}^{\mathrm{maq}}$
Food and tobacco manufacturing	0,53	0,62	0,91
Textile, leather and footwear	0,28	0,30	0,98
Furniture assembly and other wooden and metal products	0,33	0,36	0,98
Paper and printing industry	0,28	0,30	0,98
Mineral products	0,33	0,37	0,97
Basic metal industries	0,29	0,32	0,97
More complex manufacturing sectors	$\mathrm{TDVA}^{\mathrm{maq}}$	$\mathrm{DDVA}^{\mathrm{maq}}$	$\mathrm{IDVA}^{\mathrm{maq}}$

Chemical products	0,45	0,51	0,93
Non electric machinery and equipment	0,24	0,26	0,98
Machinery, electric and electronic manufacturing	0,16	0,17	0,99
Transportation equipment and its accessories	0,22	0,23	0,99
Other manufacturing industries	0,24	0,25	0,98
Business Services	0,43	0,45	0,98
Whole maquiladora industry	0,21	0,22	0,99

Source: Authors' calculation.

This limited relevance of the high level of DVA observed in the "food and tobacco manufacturing sector" can be further confirmed by taking a look to table (3). Table (3) shows the average levels of gross production, domestic value added and foreign value added expressed in constant Mexican pesos of 1993 during our period of study. Following our proposed methodology in section 3.1, in this table the data for domestic value added and foreign value added expressed in constant Mexican pesos of 1993 was obtained by multiplying the index of $\mathrm{TDVA}^{\mathrm{maq}}$ and $\mathrm{TDVS}^{\mathrm{maq}}$ times the level of gross production per manufacturing sector respectively. From such outcome, we see that the average level of DVA in the food manufacturing sector was of 1.46 million of constant Mexican pesos, a level which is rather low if we compare it to the average gross production in the whole maquiladora industry (451.7 million of constant Mexican pesos).

Nonetheless, table (3) also let us know that, when expressed in constant Mexican pesos, there are other traditional manufacturing sector that added on average high levels of domestic value added. This is the case of "Textile, leather and footwear" and "Furniture assembly". Such a situation, however, is mainly related to the size of these industries. This is especially true in the case of the textile sector as this is one of the sectors with the highest participation in the gross production of maquiladora (for instance in figure 2 it showed an average participation of 10%).

As for the rest of traditional manufacturing sectors presented in table (2), we see medium to low average levels of DVA. This is the case of "Paper and printing", "Mineral" and "Basic metal industries". Such a tendency of low to medium levels was first seen in section 5.2 when we analyzed the intermediate consumption from these industries and saw an average domestic consumption of 20% for these traditional sectors. Despite this situation, table (3) indicates that when those low to medium levels of DVA are expressed in constant Mexican pesos they all become rather small when compared to the gross production of maquiladora and the data reported by the more complex manufacturing sectors.

Table (3) Average levels of Gross production, domestic and foreign value added in constant Mexican pesos of 1993 (1988-2006)

Traditional manufacturing sectors	Gross production	Domestic value added	Foreign value added
Food and tobacco manufacturing	2,74	1,46	1,29
Textile, leather and footwear	49,43	13,63	35,80
Furniture assembly and other wooden and metal products	19,35	6,32	13,03
Paper and printing industry	2,65	0,75	1,90

Mineral products	4,71	1,58	3,13
Basic metal industries	1,31	0,38	0,93
More complex manufacturing sectors	Gross production	Domestic value added	Foreign value added
Chemical products	11,69	5,21	6,48
Non electric machinery and equipment	9,35	2,27	7,07
Machinery, electric and electronic manufacturing	230,80	36,54	194,27
Transportation equipment and its accessories	81,06	18,04	63,02
Other manufacturing industries	30,91	7,39	23,52
Business services	7,72	3,28	4,44
Whole maquiladora industry	451,72	94,79	356,93

Source: Authors' calculation.

In this context, we can infer that the more traditional manufacturing add in general low levels of DVA. According to the upper section of table (2), they report low to medium levels of DVA in terms of the indexes of $\mathrm{TDVA}^{\mathrm{maq}}$ and $\mathrm{DDVA}^{\mathrm{maq}}$. Nevertheless, when such indexes are transformed into constant Mexican pesos in table (3), by multiplying them by their level of gross production, the levels of DVA become rather small. Such small levels are mainly associated to the small shares that most of the traditional manufacturing sectors have in the total production of maquiladora. The only traditional manufacturing sector with relatively high levels of DVA (both expressed in terms of the indexes and in constant Mexican pesos) is the "Textile, leather and footwear sector".

In the case of the more complex manufacturing sectors, we observe that most of them add low levels of DVA. In the bottom part of table (2), it can be seen that with the exception of "Chemical products" and "Business services", the rest of more complex manufacturing sectors add low levels of DVA since their observed indexes of $\mathrm{TDVA}^{\mathrm{maq}}$ and $\mathrm{DDVA}^{\mathrm{maq}}$ are lower than 0.26. According to table (3), these levels of DVA for the more complex manufacturing sectors increase when expressed in constant Mexican pesos of 1993. Notwithstanding this situation, to our view, these levels of DVA are still small not only if we compare them to the average domestic value added in the maquiladora industry (94.7 million constant Mexican pesos according to table 3), but also if we compare those to the average foreign value added and gross production of maquiladora (356 and 451 million of constant Mexican pesos respectively).

The more complex manufacturing sectors that our research identified as having the lowest levels of DVA are also the sectors with the highest share of participation in maquiladora's gross production. According to the analysis in section 5.1, those were "Machinery, electric and electronic manufacturing", "Transportation equipment" and "Other manufacturing industries". Likewise, we can also see that the other more complex manufacturing sectors that we identify with the highest level of DVA ("Chemical products" and "Services") are among the sectors with the lowest share in the gross production of maquiladora (see figure 2 and table 2). This situation basically leads us to the idea that the most important manufacturing sectors in the maquiladora have offered very few opportunities for triggering a process of IU.

6.1.2 Average levels productive linkages in the maquiladora as whole and across manufacturing sectors.

In order to have sufficient information for evaluating our first set of hypothesis, we need to study our measure of productive linkages. As proposed in section 3.1, inferring a certain level of productive linkages between maquiladora firms and domestic suppliers implies multiplying the index of indirect level of domestic value added ($\mathrm{IDVA}^{\mathrm{maq}}$) times the total level of domestic inputs used by the maquiladora. The outcome of this should give us a value in Mexican pesos of 1993 that only indicates the intermediate inputs of domestic origin demanded by the maquiladora. This information must be reported in average levels in order to test the remaining part of our first hypothesis (H1.b), which expected high to medium levels of productive linkages in the more complex manufacturing sectors and low in the more traditional ones during the whole period of study.

For illustration purposes, our measure of productive linkages is presented in the second column of table (4). Productive linkages are described in that table as the domestic inputs used by local suppliers in the intermediate production to be sold to the maquiladora industry. In table (4), however, we also included two other columns. The first column of table (4), from left to right, presents the average level in constant Mexican pesos of domestic intermediate inputs used by the maquiladora and produced by domestic suppliers. The third column, on the other hand, indicates the average level of imported inputs used by domestic supplier in the intermediate consumption to be sold to the maquiladora. We decided to include this first and third column along with our measure of productive linkages in order to indicate the dominance of domestic inputs in the production of domestic inputs to be used by the maquiladora. As can be seen in that table, unlike maquiladora industry, the domestic suppliers use an important amount of domestic inputs during their production. In most of the cases, and as can be confirmed in the last column of table (2) the percentage of domestic inputs is higher than 0.9.

Nonetheless, we have to bear in mind the level of productive linkages between these domestic suppliers and the maquiladora industry must be considered as infinitely small. From the second column of table (4), we see that the maquiladora industry as a whole bought on average 39.13 million of pure domestic inputs from domestic suppliers. But, on the other hand, during the same period, this industry bought on average 351millions of imported inputs (INEGI, 2001; 2005). This situation indicates the existence of small productive linkages from the maquiladora with domestic suppliers that produce with important local content.

The tendency within the manufacturing sectors of maquiladora in terms of productive linkages is the following. We indeed see low levels of productive linkages in the more traditional manufacturing, if these are compared to the average level of productive linkages (most of them will report a value in Mexican pesos which will be lower than 39.1). The textile industry is the only sector showing the highest level of productive linkages in the traditional manufacturing sectors. To our view, that situation is also associated to important participation of the textile industry in the total gross production of maquiladora.

On the other hand, we see that more complex manufacturing present low levels of productive linkages. “Machinery, electric and electronic manufacturing” and “Transportation equipment and its accessories” show high average levels of productive linkages in terms of our proposed measure and when they are expressed in Mexican pesos of 1993. In spite of this context, we believe that if they are among the top buyers of domestic inputs from domestic suppliers it is mainly because they are the

sectors with the highest share of in the gross production and not because they are determined to foster more industrial interactions (productive linkages) with local producers. This is the reason why we believe their expected productive linkages must be considered as rather low.

Table (4): Average levels of productive linkages in constant Mexican pesos of 1993 (1988-2006)

Traditional manufacturing sectors	Intermediate inputs produced by domestic suppliers	Domestic inputs used by domestic suppliers]	Imported inputs used by domestic suppliers
Food and tobacco manufacturing	0,97	0,89	0,08
Textile, leather and footwear	5,95	5,81	0,15
Furniture assembly and other wooden and metal products	2,84	2,78	0,07
Paper and printing industry	0,30	0,29	0,01
Mineral products	0,58	0,56	0,02
Basic metal industries	0,32	0,31	0,01
More complex manufacturing sectors	**Intermediate inputs produced by domestic suppliers**	**Domestic inputs used by domestic suppliers]**	**Imported inputs used by domestic suppliers**
Chemical products	2,14	1,99	0,14
Non electric machinery and equipment	1,10	1,08	0,02
Machinery, electric and electronic manufacturing	14,56	14,42	0,15
Transportation equipment and its accessories	7,00	6,92	0,08
Other manufacturing industries	2,53	2,49	0,04
Services	1,42	1,39	0,03
Whole maquiladora industry	39,71	39,13	0,59

Source: Authors' calculation.

All and all, we consider that we have gathered sufficient information to completely test our first set of hypotheses. In line with our previously described results, we see that (with very few exceptions) the traditional manufacturing sectors do add on average low levels of DVA as initially proposed in hypothesis H1.a. At this issue the most remarkable exception is that of the "textile sector" which added on average 14 million of constant Mexican pesos to its gross production. On the other, and unlike our expectations also set in hypothesis H1.a, most of the more complex manufacturing sectors do not add high to medium levels of DVA because all of them presented data with truly low levels. "Chemical products" and "Services" are the only complex manufacturing sectors that added on average relatively medium levels of DVA. Nonetheless, the importance and possible impact for IU in the maquiladora

industry of these two sectors is limited given their limited participation in the total production of this industry.

As for the case of the productive linkages, we have elements to indicate that, unlike our hypothesis H1.b, not only are the traditional manufacturing sectors the ones with small levels of productive linkages but also the more complex ones. In general, there were on average low levels of productive linkages between all the manufacturing sectors of maquiladora. Having presented all this information, our research decides to reject our first hypothesis. These were the results for testing our first set of hypotheses which mainly deal with the expected average levels of DVA and productive linkages. Now, it is time to analyze their expected evolution over the years and thus time to evaluate our second set of hypotheses.

6.2 Evolution of DVA and productive linkages from 1988 to 2006.

6.2.1 Evolution of DVA in the maquiladora as whole and across manufacturing sectors.

Figure (7) describes the evolution over the years of the index of $\mathrm{TDVA}^{\mathrm{maq}}$ presented in equation (8) for the maquiladora industry as a whole9. In such figure, we can infer the following trend. In general, we see that level of DVA (as describe by the index of $\mathrm{TDVA}^{\mathrm{maq}}$) remains rather low (below 0.25) during the whole period of study. In the late 1980s, we see an increasing trend which enabled the maquiladora industry to reach its highest level of DVA in history (0.24). During the early 1990s, a downward trend is observed. This downward trend (that lasted 3 years) finally led to the lowest level of DVA for the maquiladora in 1995, one year after the implementation of NAFTA. Afterwards, in the late 1990s, the maquiladora progressively increased its level of DVA, going from 0.14 in 1995 to 0.23 in 2000. Nevertheless, it is in 2002 (one year after the industrial emergence of China) when the most detrimental shock for the evolution of DVA in the maquiladora is observed since, from 2002 onwards, we see five years of a continuous decline in DVA, a situation that by the mid-2000s had not been finished.

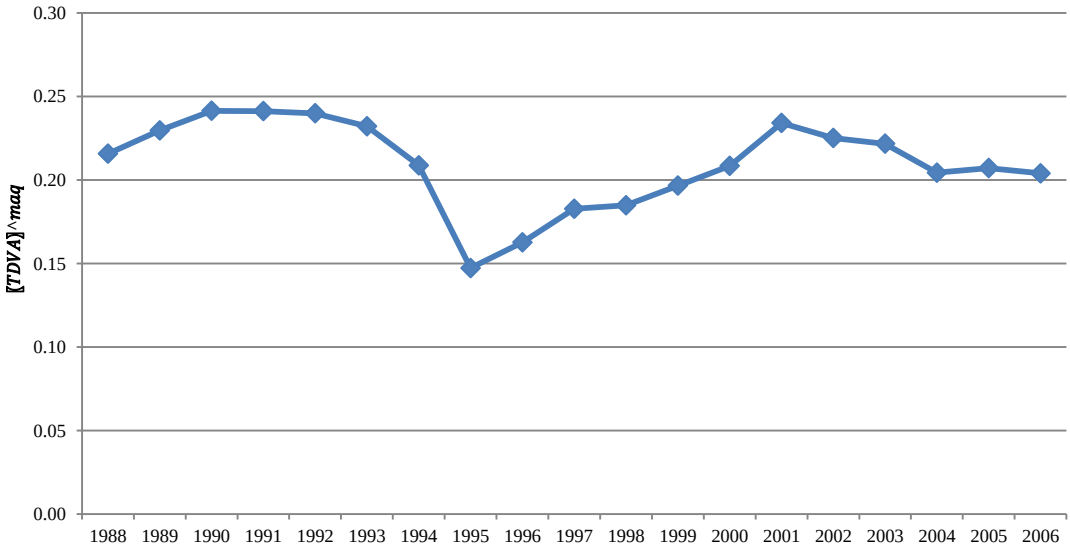
From this previous analysis, we infer the following reasoning. The maquiladora as a whole has been seriously impacted in their levels of DVA by two external shock: the implementation of NAFTA and the industrial emergence China. Both of these external shocks provoked a reduction in the levels of DVA in the maquiladora industry. The maquiladora was able to recover after the boom in imported intermediate consumption triggered by NAFTA (by 2000 it was able to reach the levels of DVA registered during the early 1990s). Nonetheless, the maquiladora was not yet able to recover at all from the boom in imports from China observed in 2001.

At this point of the analysis, we can compare the results presented in figure (7) with the results presented in figure (5). This comparison is relevant, because the first figure presents data for our measure of DVA, while the latter describes INEGI's measure of GVA. As discussed in section 5.3, the external shock of 1994 (NAFTA) increased the level of GVA in the maquiladora industry as a whole while, on the other hand, the external shocks of 2001 (China and the economic crisis in the US) decreased the GVA in the maquiladora industry. In that same section, we indicated that an increase in GVA and a

[9] In this part of the analysis, it is important to mention that during the whole sub-section 6.2 the basis for analyzing the levels of DVA will only be the index of $TDVA^{maq}$. In sub-section 6.1, we relied on the indexes of $TDVA^{maq}$ and $DDVA^{maq}$to infer the levels of DVA in the maquiladora industry as a whole and across manufacturing sectors. Nonetheless, in this sub-section we decided not to use the index of $DDVA^{maq}$because it reports roughly the same tendency as the index of $TDVA^{maq}$.The results for the case of $DDVA^{maq}$are, nonetheless, available upon request.

decrease in GVA basically meant that more and less people were hired respectively, given the fact that GVA mainly includes the concept of wage bill.

Figure (7): Evolution of DVA in the maquiladora industry as a whole.



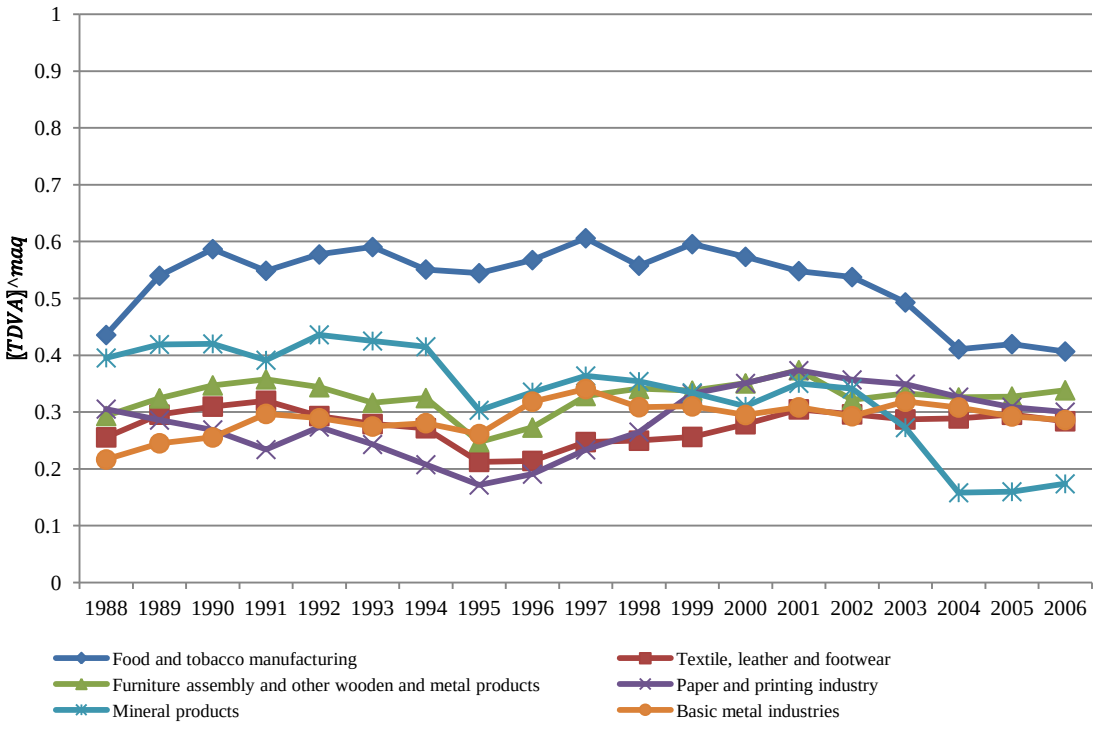
Source: Authors' calculation

Figure (7), on the other hand, states that the external shock of 1994 increased the level of DVA until the late 1990s and that the external shock of 2001 decreased DVA from that year onwards. To our view, the aforementioned differences observed between the trend described in figure (7) and the one explained in figure (5) can be explained by the following idea. The increasing amount of workers that were hired as a result of NAFTA in figure (5) help to achieve higher levels of DVA presented during the late 1990s in figure (7). Although higher levels of DVA are largely driven by domestic inputs, it is important to mention that they can also involve, to some extent, the use of other domestic resources such as labor. Therefore, if the maquiladora also shows a downward trend in their levels of DVA from 2001 onwards in figure (7) that is also because less labor was being used during that period as described by figure (5).

On the other hand, and more importantly, the tendency observed in figure (7) is not related to the ideas we posited during our second set of hypotheses. As the reader may remember, our second hypothesis posited low levels of DVA during the late 1980s (H2.a), higher levels of DVA during the 1990s (H2.b) and medium to low levels by the early and mid-2000s (H2.c). Our described results in terms of the whole maquiladora industry indicate other scenario: medium to low levels of DVA during the late 1980s, lower levels in DVA by the mid-1990s and an upward trend by the late 1990s and finally, a continuous decline with low levels of DVA during the first five years in the 2000s. Nevertheless, at this stage of the analysis, we have to bear in mind that the previously described tendency in figure (7) represents the tendency of the maquiladora as a whole and not necessarily that of the manufacturing sectors. The tendency in manufacturing sectors was the basis of our second set of hypotheses and thus, we must now describe the observed trend of DVA in those sectors over the years. One more time, in order to match our analysis to the ideas presented in our second set of hypotheses, we will classify our manufacturing sectors in traditional and more complex according to Giuliani et al. (2005).

Figure (8) presents the evolution of $TDVA^{maq}$ over the years from the more traditional manufacturing sectors. In general, with slight variations, the traditional manufacturing sectors added low to medium levels of DVA during the whole period of study. From this figure, we see a traditional sector, "the food and tobacco manufacturing", that added high levels of DVA during most of the years. As previously discussed, the possible impact that this sector might have in IU should be regarded as of limited importance given their limited participation in the gross production of maquiladora (see section 5.1).On the other hand, the most important thing to notice from this figure (8) is that the levels of DVA in most of the traditional sectors were affected by NAFTA but not by the industrial emergence of China. In 1995, the implementation of NAFTA reduced the medium levels of DVA added by "Furniture", "Textile", "Paper" and "Basic metals" due to an increasing consumption of intermediate inputs as documented in table (1) of section 5.2. Nonetheless, such sectors were able to recover from 1996 onwards and, even resisted the increasing imports from China in 2001, by not reducing their level of DVA. As previously mentioned, the most relevant case to bear in mind is that of "Textile sector" since this is the only of the more traditional manufacturing sectors that have had over the years an important participation in the gross production of maquiladora.

Figure (8): Evolution of DVA in the more traditional manufacturing sectors



Source: Authors' calculation

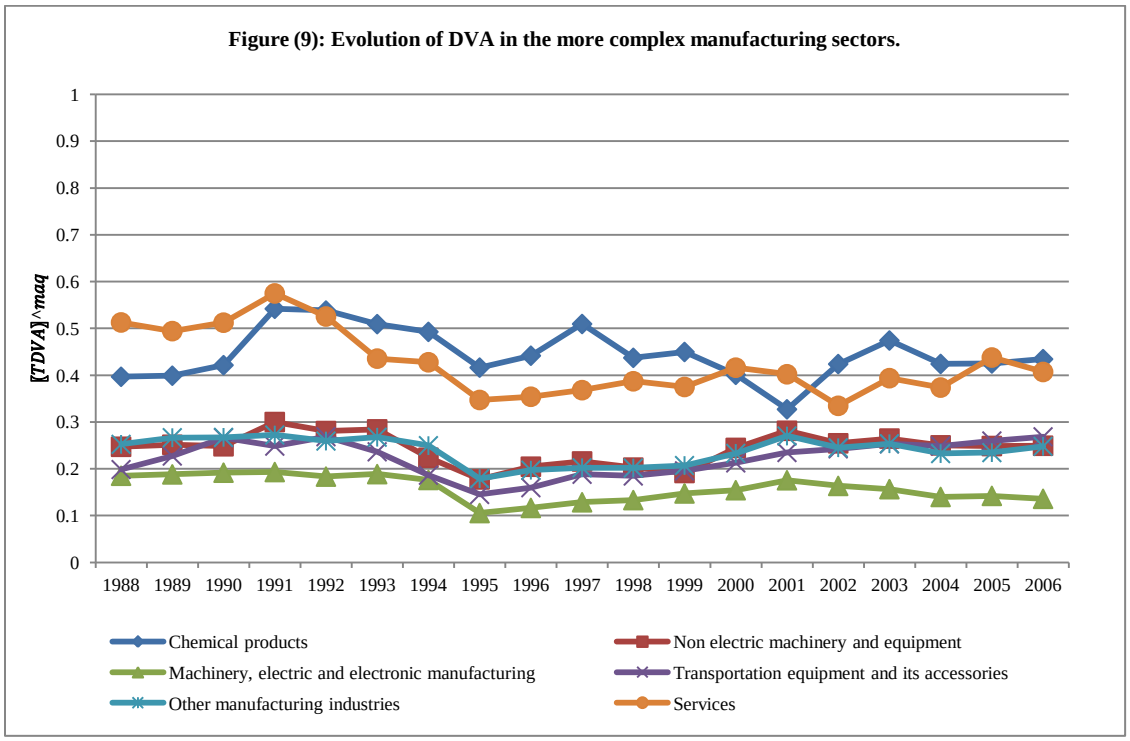
In general, the trend of DVA for the more traditional sectors over the years can be described as follows. Medium to low levels of DVA by the late 1990s, a decline in these levels by 1994 and a continuous upward trend which was not severely affected by the industrial emergence of China.

On the other hand, the trend for the more complex manufacturing sectors is completely different from the trend of the more traditional sectors discussed in the last paragraph. Figure (9)

describes the evolution of $TDVA^{maq}$ in the more complex manufacturing sectors from 1988 to 2006. As commented in section 6.1, one more time we have sectors with high levels of DVA but with small participation in the gross production of maquiladora (Business services and Chemical products). Likewise, we have sectors with low to medium levels of DVA that have important levels of participation in the gross production of maquiladora (Other manufacturing goods, Transportation equipment, Machinery, electric and electronic manufacturing) . Where the situation becomes different to what we have been previously seeing (and where we find another difference with respect to traditional manufacturing sectors) is in the case of the observed trend of DVA over the years.

Unlike the trend of DVA from the traditional manufacturing sectors (figure 8), the more complex manufacturing sectors have had a sharp decline in their levels of DVA since 1994 but have not been able to fully recover until 2006. Moreover, the industrial emergence of China in 2001 stopped their slight recover (which was observed after the implementation of NAFTA) and even worsened the levels of DVA to a point where most of the sectors have not been able to achieve the levels registered during the early 1990s. This is the case of "Other manufacturing", "Machinery, electric and electronic equipment", "Transportation" and "Non electric machinery". Given that the first three industries account for an important amount of the gross production of maquiladora (see section 5.1), they largely drive the trend in the whole manufacturing industry. This means that the tendency of DVA for these three first sectors and the one of the maquiladora as a whole must be roughly the same. From these results we develop the following idea. To our view, the fact that the more complex manufacturing sectors have not been able to fully recover after the external shock of 2001must be related to the fact that the competition from China has limited the possibilities for achieving higher levels of DVA in these sectors. China has done this because its emergence as a global manufacturer has reduced the number of firms and the amount of production in the maquiladora as a whole (Dussel Peters, 2005; Gallagher et al., 2008). Therefore, this contraction can also be associated to our classification of complex manufacturing sectors since, according to our results, they largely drive the production in maquiladora industry.

Figure (9): Evolution of DVA in the more complex manufacturing sectors.



Source: Author's calculation

In general, the evolution of DVA for the more complex manufacturing sectors is described as follows. Medium to low levels of DVA during the late 1980s, a decrease in DVA by the mid-1990s and a limited recovery by the late 1990s further worsened by emergence of China (a continuous decline with low levels of DVA during the first five years in the 2000s).

6.2.2 Evolution of productive linkages in the maquiladora as whole and across manufacturing sectors.

Finally, to conclude the analysis of this subsection and have enough information for testing our second set of hypotheses we need to evaluate the existence of productive linkages in the maquiladora as a whole and between manufacturing sectors. Table (5) presents our measure of productive linkages as discussed in section 3.1. From that table, we can see that most of the traditional and more complex manufacturing sectors of maquiladora have small levels of interaction (productive linkages) with domestic suppliers. This situation holds, if we compare this "pure domestic intermediate consumption" (domestic inputs with no imported inputs included) presented in table (5) to the total levels of imported intermediate consumption discussed in section 5.2. The only remarkable situation to be commented is the apparent increasing existence of productive linkages in the "Textile", "Furniture assembly", "Transportation equipment" and "Machinery" sectors.

As can be seen in table (5), from 1988 to 1993 the aforementioned sectors maintain low levels of productive linkages. Nevertheless, the data for each of those sectors drastically changed after the implementation of NAFTA since "Textile" changed from 1.51 million of constant Mexican pesos in 1994 to 11.36 in 2006, the "Furniture sector" from 0.59 to 8.12, "Machinery" from 1.90 to 38.91 and "Transportation" from 1.28 to 24 respectively, all of them during the same period. At the same time, the maquiladora as whole also drastically increased its use of "pure domestic inputs" as it changed from 5.97 to 111 million of Mexican period from 1994 to 2006. This situation indicates that the most important manufacturing sectors of maquiladora have increased their use of ""pure domestic inputs" and thus they might have created to some extent productive linkages. To our view, these productive linkages exist but they are still of limited importance if we compare them with the interaction of maquiladora with the rest of the world in terms of more and more imported intermediate inputs (see figure 3 in section 5.2). In general, the observed trend of productive linkages in maquiladora as a whole and for the most important manufacturing sectors is the following. Low levels of productive linkages during the late 1980s and a progressive upward trend from 1994 onwards. Nonetheless, these productive linkages are rather small given the size of the total production of maquiladora industry.

At this point of our analysis, we have the required information and data for testing our second set of hypothesis. Hypothesis H2.a (posited in section 2.2.1) expected low levels of DVA and of productive linkages in most of the sectors in maquiladora industry given the restrictive framework that prevailed in most of that decade. Our results indicate that, unlike our expectations, in most of the manufacturing sectors the levels of DVA were relatively medium and that the levels of productive linkages were low indeed. To our view, this situation means that prior to the external shocks of NAFTA and the industrial emergence of China, the maquiladora was using some medium level of domestic inputs which were not increasing during the late 1980 and early 1990s because none of the maquiladora sectors had yet faced a challenging situation for the domestic industry. By challenging situation, we understand the boom in imports triggered by the aforementioned external shocks. In this context, and by relying on these pieces of information, we must reject hypothesis H2.a.

Following the same stream ideas, in section 2.2.2 we posited other sub-hypothesis (H2.b). Here, we posited an increasing number of manufacturing sectors showing higher levels of DVA and of productive linkages given the implementation of NAFTA and its associated first important boom in the production of maquiladora. Our results showed, however, that all the manufacturing sectors did not show higher levels of DVA but suffered instead a decline in their levels of DVA as a result of NAFTA. This decline was due to the fact that, according to our analysis and descriptive statistics, NAFTA not only implied a boom in production but also a boom in imports.

Table (5): Productive linkages in the maquiladora industry expressed in constant Mexican pesos of 1993.

Traditional manufacturing sectors

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Food and tobacco manufacturing	0,06	0,12	0,18	0,22	0,27	0,29	0,23	0,37	0,63	0,74	0,85	1,11	1,29	1,16	1,20	1,87	1,55	1,83	2,97
Textile, leather and footwear	0,16	0,21	0,27	0,36	0,43	0,56	0,64	1,51	2,73	4,01	5,90	7,99	11,50	11,79	13,63	12,80	12,39	11,77	11,36
Furniture assembly and other wooden and metal products	0,14	0,19	0,25	0,35	0,39	0,46	0,59	0,98	1,70	2,12	2,78	3,69	4,72	4,76	4,23	4,80	5,79	6,62	8,12
Paper and printing industry	0,02	0,02	0,03	0,03	0,04	0,05	0,05	0,09	0,15	0,18	0,31	0,39	0,48	0,43	0,44	0,50	0,65	0,75	0,93
Mineral products	0,01	0,03	0,04	0,05	0,07	0,09	0,11	0,24	0,30	0,41	0,55	0,70	0,82	0,82	0,74	1,06	1,16	1,46	2,09
Basic metal industries	0,00	0,01	0,01	0,01	0,01	0,05	0,04	0,13	0,18	0,29	0,94	0,22	0,29	0,33	0,36	0,50	0,62	0,78	1,04

More complex manufacturing sectors

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Chemical products	0,07	0,10	0,12	0,15	0,17	0,22	0,27	0,51	0,95	1,36	1,88	2,38	3,27	3,73	3,17	3,32	4,18	5,26	7,07
Non electric machinery and equipment	0,06	0,06	0,07	0,11	0,15	0,15	0,17	0,27	0,56	0,66	0,78	0,97	1,39	1,54	1,74	2,14	2,43	3,18	4,07
Machinery, electric and electronic manufacturing	0,56	0,75	1,04	1,26	1,24	1,54	1,90	2,99	6,09	8,58	12,62	18,09	24,53	26,41	26,69	30,74	33,55	36,11	38,91
Transportation equipment and its accessories	0,56	0,62	0,77	1,01	1,32	1,17	1,28	2,24	3,35	4,57	5,58	7,20	8,36	8,59	10,67	14,72	16,74	18,66	23,98
Other manufacturing industries	0,09	0,17	0,27	0,33	0,38	0,45	0,52	0,93	1,57	1,92	2,49	2,82	3,81	4,10	4,29	4,94	5,30	6,08	6,75
Business services	0,05	0,05	0,06	0,07	0,08	0,11	0,12	0,18	0,46	0,67	1,12	1,53	2,18	2,84	2,80	2,94	3,54	3,46	3,99
Whole maquiladora industry	1,79	2,35	3,15	4,00	4,59	5,17	5,97	10,53	18,82	25,69	36,02	47,34	62,97	66,74	70,28	80,64	88,24	96,35	111,89

Source: Authors' calculation.

Such a situation becomes even more noteworthy if we consider that response of the manufacturing sectors after NAFTA largely differed across them. While the more traditional sectors were able to recover the medium to low levels of DVA observed during the late 1980, the more complex manufacturing showed very few signs of a continuous recovery. In the case of the productive linkages, according to our measure, those indeed seemed to increase but that increase was of limited relevance given the small amount of domestic inputs used by the maquiladora. In this context, we infer that NAFTA meant for all the manufacturing sectors an increasing use of imported inputs and thus, lower and not higher levels of DVA and of productive linkages as we initially believed. In this background context, we have sufficient information to rejects hypothesis H2.b.

Lastly, section 2.2.3 was the basis for hypothesis H2.c that dealt with the evolution of maquiladora in the early and mid-2000s. There, we stated that very few manufacturing sectors were going to show high levels of DVA (and high levels of productive linkages) while a large amount of manufacturing sector were to present medium to low levels. In general, we indeed see very few manufacturing sectors showing higher levels of DVA in this period. These are two complex sectors (business services and chemical products) and one traditional (food and tobacco manufacturing). On the other hand, we also see a large amount of sectors adding low levels which are not mainly traditional sectors but that also include more complex sectors. Finally, as for the productive linkages, we see higher levels of "pure domestic intermediate consumption" which is, nonetheless, still outperformed by the imported consumption of maquiladora. With this information in mind, we must also reject hypothesis H2.c because the tendency set in such hypothesis is not seen in the manufacturing sectors we initially believed.

Finally, before concluding the analysis of this section it is well worth comparing our results to those achieved by other researchers that followed a similar methodology for measuring the value added of maquiladora industry. This is the case of the research prepared by De La Cruz et al. (2011). Those authors prepared a measure for the level of foreign value added of maquiladora industry. They followed the methodology proposed by Koopman et al. (2008),that computes domestic and foreign content in the case of processing exports, and used the same maquiladora IOT of 2003 that our research employed. Our results described in section 6.1 and section 6.2 and the results presented by De La Cruz et al. (2011) coincide in the following idea. Those authors and our research indicate that the sectors with the lowest levels of DVA (an thus the ones with the highest levels of foreign value added) are also the ones with the highest share in the total production of maquiladora. According to De La Cruz et al. (2011), the sectors that present this tendency are peripheral equipment, audio and video equipment, communications equipment, semiconductor and other electronic components, and electrical equipment. The aforementioned sectors can be easily embodied in the sector of "Machinery, electric and electronic manufacturing" that we regarded as the one with the highest share in the production of maquiladora and also one of the sectors with the lowest level of DVA.

Notwithstanding this similarity in results, our results in terms of foreign value added are higher than the ones presented by De La Cruz et al. (2011). For instance, De La Cruz et al. (2011) indicated that, on average, Mexico's manufacturing exports have a level of foreign value added of about 66 percent in 2003. According to figure (7) our measure of DVA for 2003 was of 0.22 (which means 22%). If the remaining part of this percentage of DVA is foreign value added then, our research proposes an average level of foreign value added of 0.78 (78%) which is higher than that of De La Cruz et al. (2011). This situation might lead us to the idea that the aforementioned authors are underestimating the level of foreign value added and, conversely, overestimating the level of DVA. Such a problem of overestimating of DVA was one of the main justifications presented in section 3.1 for implementing the modified

version of the index of VS proposed by Yang et al. (2010). In light of the previous situation, we can conclude that our measure correctly fixes this problem.

If compare this level to our average level of DVA for the maquiladora as a whole presented in table (2), we will see that our measure is indeed lower (0.21). Nevertheless, before concluding that our research is underestimating the level of DVA in maquiladora industry an important remark must be taken into account. Those authors are mainly relying on the maquiladora IOT of 2003, and thus when they refer to an average level they are referring to the level considering all their manufacturing sectors in 2003.

So far, on the basis of section 6.1 and section 6.2, our research can infer the existence of very few signs of industrial upgrading that are not mainly present in the more complex manufacturing sectors. Likewise, we can also posit the existence of rather limited productive linkages that, along with the medium to low levels of DVA, might have not triggered a real process of IU at all. This is the outcome described by our modified measure of VS and the formulas we derived from that index. Nevertheless, before concluding that the maquiladora as whole and between manufacturing sectors has achieved few signs of industrial upgrading, we can conduct additional analysis. This additional analysis, that is to be developed on the basis of the data this research used, may further confirm the existence (or the lack thereof) of the aforementioned limited signs of IU. Conducting that study will be the objective of the last sub-section and that shall be the part where whole analysis of IU concludes.

6.3 Analysis of labor qualification and measures of productivity.

The level of skills from the working force that is employed by the maquiladora (labor qualification) as a well as the efficiency by which the manufacturing goods are being produced (productivity) are also additional measures to be considered in order to infer a process of IU. According to Azadegan and Wagner (2011), the process of IU requires the continued development of new skills alongside mastery of existing responsibilities. Firms using IU need to constantly improve their knowledge base by tapping into, developing and retaining skilled human resources (Ernst and Kim, 2002). At the same time, higher productivity can also be regarded as an additional outcome of the process of IU, as moving from simple to more complicated tasks calls for a higher level of efficiency.

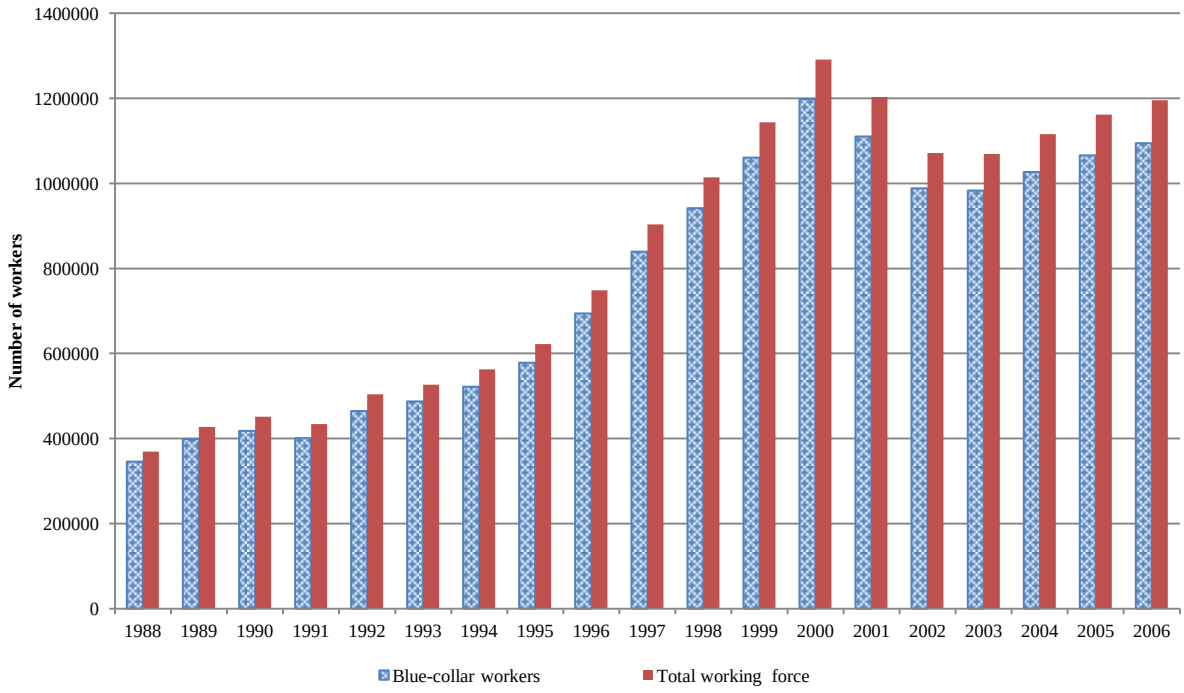
On the basis of the data we used for constructing IOTs, we can also conduct analysis for determining the observed levels of labor qualification and productivity of maquiladora over the years. INEGI (2001, 2005) classified the labor force of maquiladora in terms of their levels of skills. According to the methodology described by INEGI (2010), “Personal ocupado”, i.e. the total working force, can be disaggregated in “obreros”, i.e. blue-collar workers, and “personal administrativo”, i.e. white-collar workers. In this last document presented by INEGI, blue-collar workers are understood as the working force directly involved in the production process of maquiladora, while the remaining working force (white-collar workers) is the one that develops the administrative procedures of those firms. To our view, this type of data is a good indication of the levels of labor of qualification in maquiladora since the working force directly involved in the production of maquiladora is generally regarded as being low qualified (Carrillo, 2007).

On the other hand, with information provided by INEGI, we can also provide a measure for the levels of productivity. In fact, INEGI (2001, 2005) provide their own measure of productivity which is ratio of the reported levels of “gross value added” to the levels of total working force in maquiladora

industry. We consider this measure as being quite useful for our research since it can give us an idea as to how efficient this industry has been in producing manufactuirng goods over the years.

Having discussed these issues, we can now present the results of our additional analysis of labor qualification and productivity. Let us first analyze the case of labor qualification. In line with the ideas presented by Ernst and Kim (2002), in order to infer a process of IU, described by higher levels of labor qualification, we must observe a downward trend in the share of "obreros" (blue-collar workers) in the total working force of maquiladora as higher skills are being needed in the production process. Figure (10) describes the share of "blue-collar workers" in the total working force of maquiladora industry as a whole. As can be seen, during our period of study, the share of blue-collar workers accounts for more than 90% in the total working force of maquiladora industry. This dominance of blue-collar workers can also be seen in the case of each of our 12 manufacturing sectors, as the average participation of those workers in the total working force per manufacturing sector is more than 90% (see figure A.3 in the appendix). This whole situation does nothing but confirming that there must be few signs of IU in the maquiladora industry because this industry has not employed workers with a higher level of qualification (white-collar workers) over the years.

Figure (10): Blue collar workers and total working force in themaquiladora industy as a whole (1988-2006).



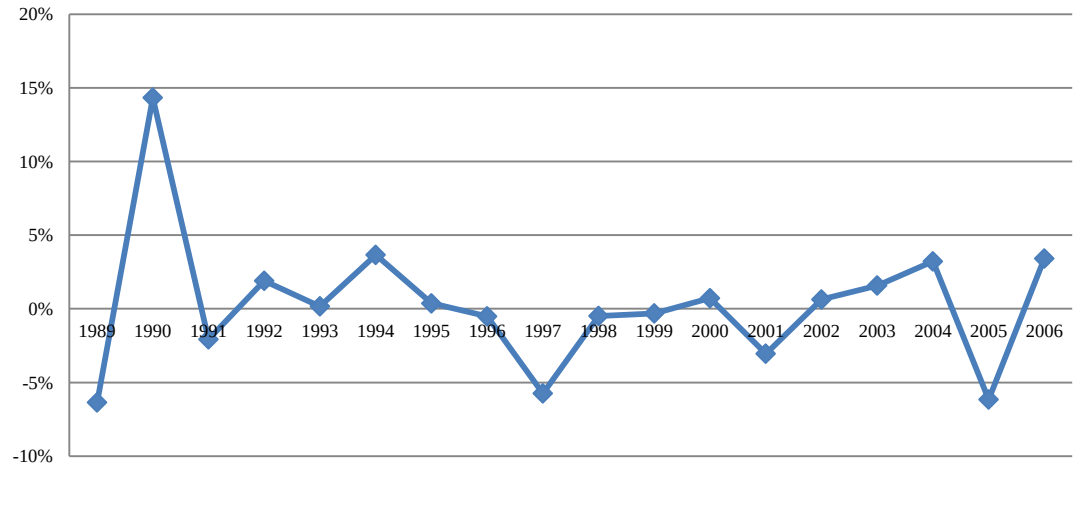
Source: Authors' calculation

Now we present the results for our measure of productivity. Figure (11) indicates the productivity growth rate of the maquiladora industry as a whole during our period of study according to the measure provided by INEGI (2001, 2005). From such figure, we can infer that the productivity growth rate in maquiladora has remained rather low. In general, with very few exceptions, the productivity growth rate has remained below 5% from 1991 to 2006. The implementation of NAFTA only represented a growth

rate of 3.66% with respect to the previous yearsm which has been the highest during years here analyzed.

The trend in productivity growth rate across manufacturing sectors in the maquiladora industry is relatively similar. Figure (A.4) and figure (A.5) in the appendix of this research show the evolution in productivity growth rate of the more traditional manufacturing sectors and in the more complex sectors respectively. In such figures, it can be seen that boom in productivity triggered by NAFTA was observed in all of the manufacturing sectors. Nevertheless, and similar to the tendency of the maquiladora industry as whole, the productivity growth rate in most of the sector has been showing a continuous decline. One more time, the only particular exceptions to this downward trend are the case of "Food and tobacco manufacturing", "Basic metal industries" and "Chemical", all of them with a rather low participation in the gross production of maquiladora industry. Similarly, the low levels of productivity growth rate in "Machinery", "Transportation" and "Other manufacturing sectors" are the ones that drive the low level of productivity growth rate in the maquiladora since those sectors account for the highest share in the gross production of this industry. To our view, this continuous decline in productivity growth rate indicates the limited implementation of technological improvements in the more complex manufacturing sectors. According to figure (11), (A.4) and (A.5) this decline gets deeper from 2001, so it can also be argued that the industrial emergence of China further worsened the decline in productivity of maquiladora.

Figure (11): Growth rate of productivity in maquiladora's gross production (INEGI's measure)



Source: Authors' calculation

In this whole context, we see that from 1988 to 2006 the maquiladora industry has not used progressively more highly qualified workers (white-collar workers) and has not increased its productivity growth. Such tendencies are seen in the maquiladora industry as a whole and across its manufacturing sectors. Therefore, this additional analysis of section 6.3 further confirmed the previous findings of section 6.1 and section 6.2: the fact that the maquiladora has achieved very few signs of a process of IU from 1988 to 2006. With this idea in mind, it is now time to provide the final conclusion of our research.

7. Conclusion.

The main objective of this research was to find an answer for the following research questions: what has been the evolution of DVA in the manufacturing sectors of maquiladora industry? Are there any productive linkages between maquiladoras and domestic suppliers that foster increasing levels of DVA?. Finding an answer for these questions would allow us to further confirm the existence (or the lack thereof) of a process of IU in the Mexican maquiladora industry as previous research has pointed it out (Carrillo and Zarate, 2009).

On the basis of an extensive literature review that dealt with the theoretical implications of IU and the historical evolution of maquiladora industry, we also developed several hypotheses. The first set of hypotheses (H1.a and H1.B) expected on average low levels of DVA and of productive linkages in the more traditional manufacturing sectors, while the opposite situation was expected in the more complex ones. On the other hand, the second set of hypotheses (H2.a, H2.b and H2.c) expected low to medium levels of DVA in the late 1980s, higher levels in the mid and late 1990s, and few sectors with high levels by the mid-2000s. The same analogy was expected in the case of productive linkages.

To evaluate all the aforementioned issues, we constructed maquiladora IOTs for a rather long period of time that covered the years from 1988 to 2006. We constructed those IOT by drawing upon methodology and data provided by the Mexican Statistical office and the Central Bank of Mexico. Those IOTs would allow us to implement indexes of VS that, on their modified versions, evaluate the existence of levels of DVA and of productive linkages for the maquiladora industry as whole and across manufacturing sectors.

Our main results show the maquiladora as whole and across most of their manufacturing sectors show very low levels of DVA and of productive linkages. Our first set of hypotheses was rejected because we saw that not all the traditional manufacturing sectors had low levels of DVA (and of productive linkages) and that not all the complex sectors had high levels of DVA (and of productive linkages). We were able to identify sectors with high levels of DVA that were both located in the more traditional and complex sectors. Nonetheless, the possible impact on IU of the sectors we found with high levels of DVA is not relevant given that they were also identified as being the ones with low levels of participation in the total production of maquiladora. This was the case of chemicals, Business Services and Food and tobacco manufacturing among others. From this stream of ideas, we derive the following reasoning. Being a highly complex manufacturing sector in the maquiladora industry does not necessarily ensure the existence of high levels of technology that might trigger higher levels of DVA and productive linkages. To our view, the fact that most of the more complex manufacturing sector in the maquiladora fail to add higher levels of DVA is related to the fact that their productive process does imply high levels of technology but that this productive process and this technology is still performed abroad. The complex manufacturing sectors operating in the Mexican maquiladora industry may have technology but that is still of limited relevance for fostering a process of IU. The technology that they possess might have been simply implemented to make more efficient their labor intensive activities (assembly).

On the other hand, our results also rejected our second set of hypotheses. The levels of DVA and of productive linkages were medium during the late 1980s. These levels further declined during the mid-1990s. Finally, some manufacturing sectors achieved higher levels of DVA and of productive linkages with respect to the previous years. The sectors we are referring to were two complex sectors (business services and chemical products) and one traditional (food and tobacco manufacturing). From these

outcomes, we infer the following ideas. The levels of DVA and of productive linkages were medium during the late 1980s because the maquiladora industry had not yet faced a challenging situation in terms of increasing imports or higher level of competition. The maquiladora could rely on a higher level of domestic inputs because there were no pressure to improve the quality of its production with imported inputs that were more efficiently produced. During the mid-199s, the signing of NAFTA opened the US market for an increasing amount of manufacturing goods produced in Mexico. This was a challenging situation for the maquiladora as it had to cover the requirements of the World's biggest market. Therefore, the boom in production triggered by NAFTA also meant a boom in imported inputs that aimed at meeting the high requirements of the US market at the expense of demanding less domestic inputs. Finally, the industrial emergence of China further declined the level of DVA and of productive linkages in most of the manufacturing sectors with very few of them being able to show progressively higher levels.

With this background information, we now provide an answer for our research questions. As for our first research question, we can posit that the evolution of DVA in the Mexican maquiladora industry has been cyclical. The external shocks of 1994 and 2001have deterred the existence of a continuous upward trend in DVA. These two external shocks have meant a reduction in the levels of DVA. According to figure (7), the DVA in maquiladora as a whole decreased in 1994. Later on the maquiladora was able to recover from the shock of 1994, as it achieved by the late 1990s similar levels to the ones observed by the early 1990s. Nonetheless, in 2001 the maquiladora suffered another decrease from which it had not been able to recover by the mid-2000s. This situation meant that the slight recovery of the late 1990s turned into a continuous downward trend in the forthcoming years. In our viewpoint, this cyclical tendency that we are observing in the maquiladora as a whole has its origin in the tendency of its manufacturing sectors. That is mainly because the sectors that drive the maquiladora industry (some of the more complex manufacturing sectors) are the ones that show this same tendency (see figure 9). This cyclical tendency was also confirmed by our additional analysis in terms of productivity (see figure 11 and figure A.5).

On the other hand, regarding our second research question, we believe that there have been very few signs of productive linkages between domestic supplier and the manufacturing producers in the maquiladora industry. That was mainly because our measure of productive linkages (the level of domestic inputs produced by domestic suppliers for the maquiladora) was found to be rather low. As we have been continuously arguing throughout this research, the main reason for the small consumption of domestic inputs is the rather excessive use of imported inputs. To our view, the use of domestic inputs has remained remarkably low not only because of the tariff exemptions for imported goods historically provided by the maquiladora program. There must be another reason for this issue. After all, and as documented in section 2.2.2 of our literature review, the Mexican government has extended the benefit of maquiladora to the producer of those domestic inputs (domestic suppliers) as of 2001. Furthermore, those domestic suppliers may even offer additional advantages for the maquiladora industry, such as closer geographical proximity, that may reduce transportation costs. It is in this context that we believe that the main reason why the domestic suppliers have developed low productive linkages is related to the quality of the inputs that they produce. This problem has been pointed out by previous research. For instance, Wilson (1992) indicated that many Mexican producers cannot meet the quality, quantity or timeless needs of the maquiladora plants, despite continuous attempts of the Mexican government to foster a continuous interaction between both types of producers during the early and late 1990s. As discussed by our research, the support of the Mexican government has even increased in terms of providing more and more tariff exemptions to domestic suppliers. Nonetheless, given the small levels of

productive linkages that we observed in this research, we argue that the situation of the domestic suppliers described by Wilson (1992) has not changed that much in the last years.

Taking this whole context into account the final conclusion of our research is that the Mexican maquiladora industry has achieved very few signs of a process of IU since our measures of DVA and productive linkages show these results. Some signs of IU (higher levels of DVA and of productive linkages) were seen in the late 1980s and late 1990s. Nonetheless, these were discouraged by the external shocks of NAFTA and the industrial emergence of China. We also believe that few signs of IU must be inferred from 1988 to 2006 because the manufacturing sectors that have shown such relatively high levels of DVA and of productive linkages are of limited importance in the maquiladora industry.

All and all, we believe that the key for fostering a continuous upward trend for DVA and productive linkages, and thus more and more signs of IU, is fostering a higher use of inputs domestic inputs for the sectors in the maquiladora industry that have the highest share in total production. The Mexican government has provided a great amount of tax incentives for the domestic suppliers. This idea has simply not worked out. The domestic inputs need to be produced with higher quality. Therefore good idea may be that the government should help domestic suppliers in acquiring more complex technology. The way by which this objective may be achieved is by means of subsidies to these domestic producers Such endeavor looks rather challenging and expensive. Nonetheless, in our viewpoint, this is only feasible way by which the Mexican maquiladora industry can achieve higher levels of efficiency given the current context of competition and its observed performance in the last years.

References.

Azadegan A. & Wagner S.M. (2011), "Industrial Upgrading, Exploitative Innovations and Explorative Innovations", *International Journal of Production Economics*, (130), pp. 54-65.

Brown, F., & Domínguez, L. (1989). "Nuevas Tecnologías en la Industria Maquiladora de Exportación", *Comercio Exterior* 39 (3).

Buitelaar, R.M. and R. Padilla Pérez (2000), "Maquila, Economic Reform and Corporate Strategies", *World Development* Vol. 28, No. 9, pp. 1627-1642.

Capdevielle M., Corona J.M. and Hernández, C. (2000), "Production System and Technological Patterns", in Cimoli, M. (Ed.) Developing Innovation Systems. México in a Global Context, Ed. Continum.

Carrillo, J., & Hualde, A. (1997) "Maquiladoras de Tercera Generación. El caso de Delphi-General Motors", *El Colegio de la Frontera Norte (COLEF*), México.

Carrillo J., Mortimore M. and Alonso Estrada J. (1999). "Competitividad y Mercado de Trabajo. Empresas de Autopartes y Televisores en México", *Universidad Autónoma de Ciudad Juárez/ UAM – Iztapalapa. Plaza y Valdés*.

Carrillo, J. (2004), "Principales estadísticas de la industria maquiladora. Encuesta sobre aprendizaje tecnológico y escalamiento industrial", *El Colegio de la Frontera Norte*, Tijuana.

Carrillo, J. (2007), "La Industria Maquiladora en México: ¿Evolución o Agotamiento?", *Comercio Exterior,* vol. 57, núm. 8.

Carrillo, J. and Zarate R. (2009), "The Evolution of Maquiladora Best Practices", *Journal of Business Ethics* , no. 88, pp. 335-348.

Contreras, O.F. and Munguia L.F. (2007), "Evolución de las Maquiladoras en México. Política Industrial y Aprendizaje Tecnólogico", *Region y Sociedad*, vol. XIX, pp. 72-87.

De La Cruz J., R. Koopman, Z. Wang. and S. Wei. (2011), "Estimating Foreign Value Added in Mexico's Manufacturing Sector", *United States International Trade Commission, Columbia University, CEPR and NBER*, pp. 1-33.

Dussel, J.J. Palacios, G. Woo (eds.), (2003), La Industria Electrónica en México: Problemática, Perspectiva y Propuestas, *Universidad de Guadalajara, Mexico.*

Dussel Peters, E. (2005), "Economic Opportunities and Challenges Posed By China for Mexico and Central America", *German Development Institute (DIE), Studies Series, Bonn.*

Ernst, D. and Kim, L. (2002) 'Global production networks, knowledge diffusion, and local capability formation', *Research Policy*, 31, 1417-1429.

Gallagher, K. P., J. C. Moreno-Brid and R. Porzecanski (2008) "The dynamism of Mexican exports: Lost in (Chinese) translation?," *World Development* vol. 36, no. 8, pp. 1365–1320.

Gallagher, K. and Shafaeddin, M. (2010),"Policies for industrial learning in China and Mexico", *Technology in Society,* Vol. 32, Issue 2, pp. 81-99.

Gereffi, G. (1999), "International Trade and Industrial Upgrading in the Apparel Commodity Chain", *Journal of International Economics*, Vol. 48, pp. 37-70.

Gereffi, G. and R. Kaplinsky (eds.) (2001). The Value of Value Chains: Spreading the Gains from Globalisation. Special issue of the IDS Bulletin 32, 3.

Giuliani E., Pietrobelli C. and Rabelloti, R. (2005), "Upgrading in Global Value Chains: Lessons from Latin American Clusters", *World Development*, Vol. 33, No. 4, pp.549-573.

González, A. (1990), *El Desarrollo de la Inversión Extranjera en México. SEGUMEX: Reseña anual de la industria maquiladora*, Thomas Madison, México DF.

Hummels, D., J. Ishii and K.M. Yi (2001), "The Nature and Growth of Vertical Specialization in World Trade", *Journal of International Economics*, vol. 54, pp. 75-96.

Humphrey J. & Schmitz H. (2000). Does Local Co-operation Matter? Evidence from Industrial Clusters in South Asia and Latin America*. Oxford Development Studies*. Vol. 28 (3),323-336.

Humphrey J. and H. Schmitz (2002), "How Does Insertion in Global Value Chains Affect Upgrading in Industrial Clusters", *Regional Studies*, Vol. 36, Issue 9, pp. 1-16

INEGI (2001), "La Producción, Salarios, Empleo y Productividad de la Industria Maquiladora de Exportación; Total Nacional (1988-2000)", *Sistema de Cuentas Nacionales de México*, Instituto Nacional de Estadística e Informática, México, pp. 1-115.

_____ (2005), "La Producción, Salarios, Empleo y Productividad de la Industria Maquiladora de Exportación; Total Nacional (1999-2004)", *Sistema de Cuentas Nacionales de México,* Instituto Nacional de Estadística e Informática, México, pp. 1-109.

_____ (2006), "Matriz de Insumo Producto de México 2003: Clasificación SCIAN 2002", *Sistema de Cuentas Nacionales de México*, Dirección General de Estadísticas Económicas, Dirección General Adjunta de Cuentas Nacionales, , Instituto Nacional de Estadística e Informática, México, pp. 1-64.

_____ (2010), "La Producción, Salarios, Empleo y Productividad de la Industria Maquiladora de Exportación, Total Nacional; Metodología", *Sistema de Cuentas Nacionales de México,* Instituto Nacional de Estadística e Informática, México, pp. 1-7.

_____, (2011), "Estadística Mensual Sobre Establecimientos Manufactureros con Programa IMMEX, Cifras Durante Marzo de 2011". *Comunicado No. 247-11*. Instituto Nacional de Estadística y Geografía, Aguascalientes, México.

Javorcik, B. S., W. Keller and J. Tybout, (2008) "Openness and Industrial Response in a Wal-Mart World: A Case Study of Mexican Soaps, Detergents and Surfactant Producers" *World Economy* 31(12), p. 1558-1580.

Junius, T. and Oosterhaven, J. (2003), "The solution of updating or regionalizing a matrix with both positive and negative entries", Economic Systems Research, 15, pp. 87–96

Koopman, R., Wang, Z. and Wei, S.-J. (2008) "How much of Chinese exports is really made in China? Assessing domestic value-added when processing trade is pervasive", NBER Working Paper 14109, http://www.nber.org/papers/w14109.

Mexico, Government of (1989). *Decreto para el Fomento y la Operación de la Industria Maquiladora de Exportación. Diario Oficial de la Federación.*

Nelson, R.R. and Pack, H. (1999), "The Asian Miracle and Modern Growth Theory", *The Economic Journal*, Vol. 109, No. 457, pp. 416-436.

Polanyi, M.(1967) "The Growth of Science in Society." *Minerva,* 5(4), pp. 533-545.

Ruiz Durán C., Piore M. and Schrank A. (2005), "Los Retos para el Desarrollo de la Industria del Software", *Comercio Exterior*, Vol. 55, no. 9, pp. 743-755

Sargent J. and Mathews L. (2006), "The drivers of the evolution/upgrading in Mexico's maquiladoras: How important is subsidiary initiative?", *Journal of World Business* (41), pp. 233-246.

Sargent, J. and Mathews, L. (2008), "Capital Intensity, Technology Intensity, and Skill Development in Post China/WTO Maquiladoras", World Development, Vol. 36, Issue 4, April 2008, Pages 541–559.

Sargent, J. and Mathews, L. (2009), "China versus Mexico in the Global EPZ Industry: Maquiladoras, FDI Quality, and Plant Mortality", *World Development*, Volume 37, Issue 6, June 2009, Pages 1069-1082.

Schmitz, H. (1995), "Collective Efficiency: Growth Path for Small Scale Industry", *Journal of Development Studies*, Vol. 31, No.4.

Stone, R. (1961), "Multiple classifications in social accounting". *Bulletin del'Institut International de Statistique*, 1962, 39, pp. 215-233.

Stone, R. and Brown, A. (1962), *A Computable Model of Economic Growth (A Programme for Growth)*. London: Chapman & Hall.

Urias, H. (1978), "La Industria Maquiladora: Evolución Reciente y Perspectivas." *Comercio Exterior* 28 (4).

Verhoogen, E. A. (2008): "Trade, Quality Upgrading and Wage Inequality in the Mexican Manufacturing Sector," *Quarterly Journal of Economics*, 123(2).

Wilson, P.A. (1992), *Exports and Local Development: Mexico's New Maquiladora*, University of Texas Press, pp. 161.

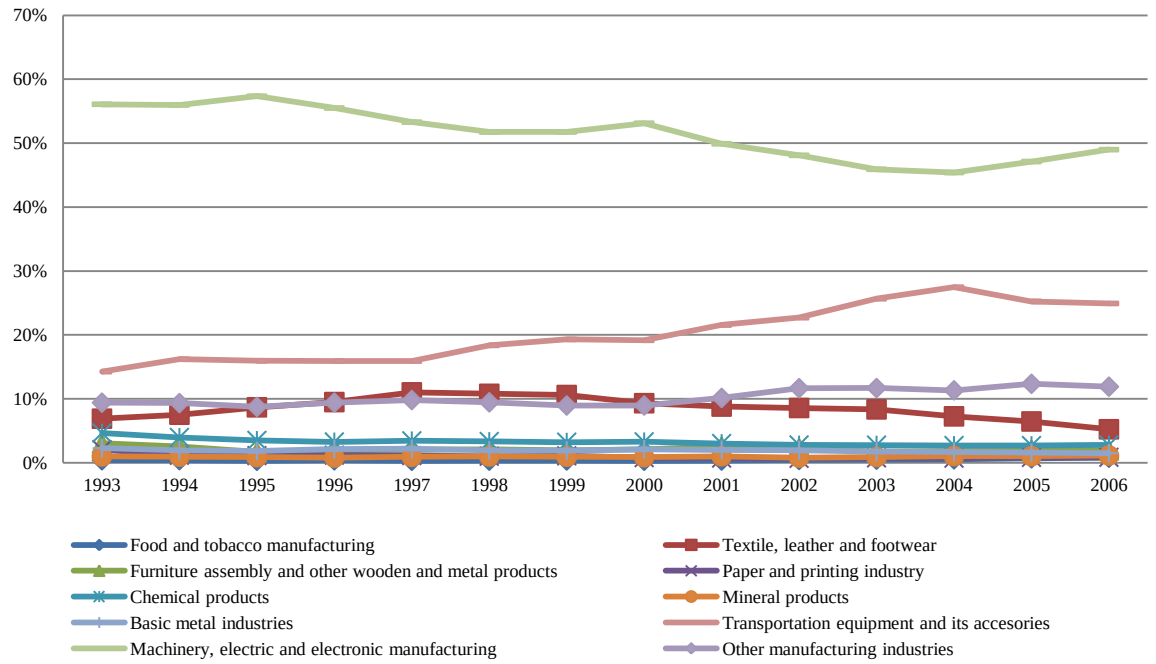
Yang C., Dietzenbacher E., Pei J., Chen X., Zhu K. and Tang Z. (2010), "The Bias in Measuring Vertical Specialization", under revision for *Journal of Comparative Economics*.

APPENDIX

Table (A.1). Classification for maquiladora manufacturing sectors according to INEGI and BANXICO

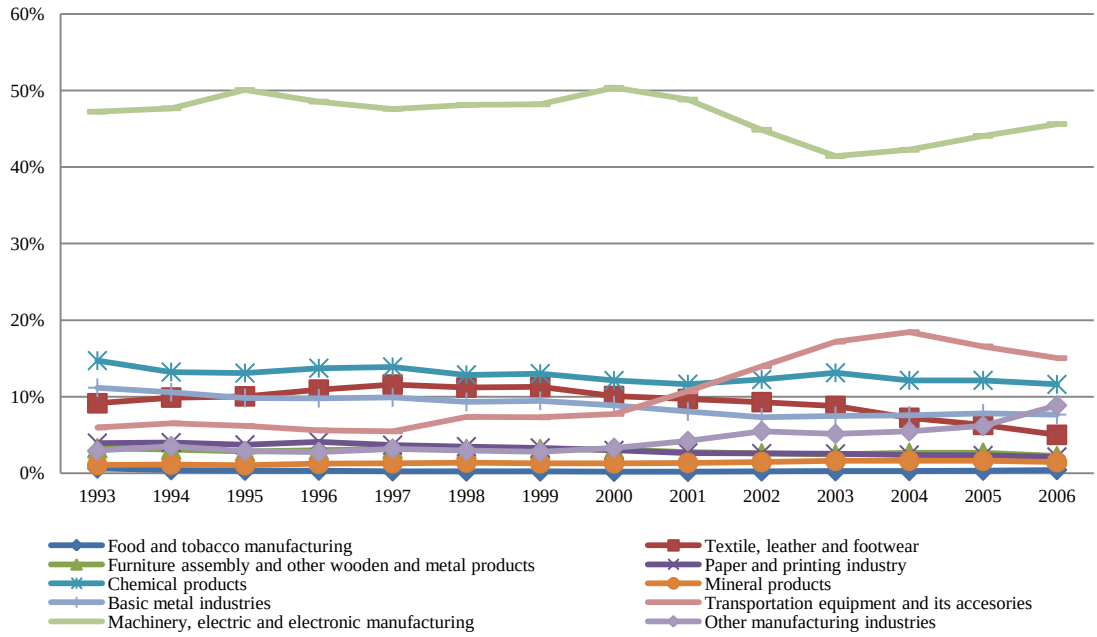
Number	Final manufacturing classification used by our research	Manufacturing sectors reported by INEGI at the Bank of Economic Information (BIE)	Manufacturing sectors reported by INEGI (2001, 2005) according to the Codificator for the National Accounting System of Mexico of 1993	Manufacturing sectors reported by BANXICO according to the Harmonized System
1	**Food and tobacco manufacturing**	1.Food and tobacco manufacturing	11 Meat and Dairy 12 Fruit and Vegetable 19 Other type of food 22 Soft Drinks and Water 23 Tobacco	01 05 09 13 17 21 02 06 10 14 18 22 03 07 11 15 19 23 04 08 12 16 20 24
2	**Textile, leather and footwear**	2. Textile goods 3. Apparel, leather and related products	24 Fiber Spinning 25 Yarns and Fabrics Fibers 26 Other textile industries 27 Clothes 28 Leather and Footwear	41 53 57 61 65 50 54 58 62 66 51 55 59 63 67 52 56 60 64
3	**Furniture assembly and other wooden and metal products**	4. Furniture assembly and other wooden and metal products	29 Sawmills, plywood and panels 30 Other Wood Products and Cork 48 Metal furniture 49 Structural Metal Product 50 Other metal products, except machinery	42 46 79 43 47 81 44 75 83 45 78
4	**Paper and printing industry**	N.A.	31 Paper and Paperboard 32 Printing and Publishing	48 49
5	**Chemical products**	5. Chemicals products	33 Oil and Derivatives 35 Basic Chemistry 37 Synthetic Resins and chemical fibers 38 Pharmaceutical products 39 Soaps, Detergents and Cosmetics 40 Other Chemical products 41Rubber products 42 Plastic items	26 30 34 38 27 31 35 39 28 32 36 40 29 33 37
6	**Mineral products**	N.A.	43 Glass and Glass Products 45 Non-metallic mineral products	68 70 69 71
7	**Basic metal industries**	N.A.	46 Manufacture of basic iron and steel 47 Basic Industries of Nonferrous Metals	72 80 73 74 76
8	**Transportation equipment and its accessories**	6. Transportation equipment and its accessories	57 Bodywork, Engines, Parts and Accessories for Motor Vehicles 58 Equipment and transport material	84 89 86 87 88
9	**Non electric machinery and equipment**	7. Assembly of equipment and tools (non-electric)	51 Non-electric machinery and equipment	82
10	**Machinery, electric and electronic manufacturing**	8. Machinery and equipment manufacturing 9. Electric and electronic accessories	54 Electronic Equipment and Devices 55 Electrical Equipment	85
11	**Other manufacturing industries**	10. Toys and sporting goods 11. Other manufacturing goods	59 Other manufacturing industries	90 94 98 91 95 92 96 93 97
12	**Business services**	12. Services.	68 Professional Services 71 Leisure Services 72 Other services	N.A.

Figure (A.1): Participation of manufacturing sectors in the total exports of maquiladora industry*



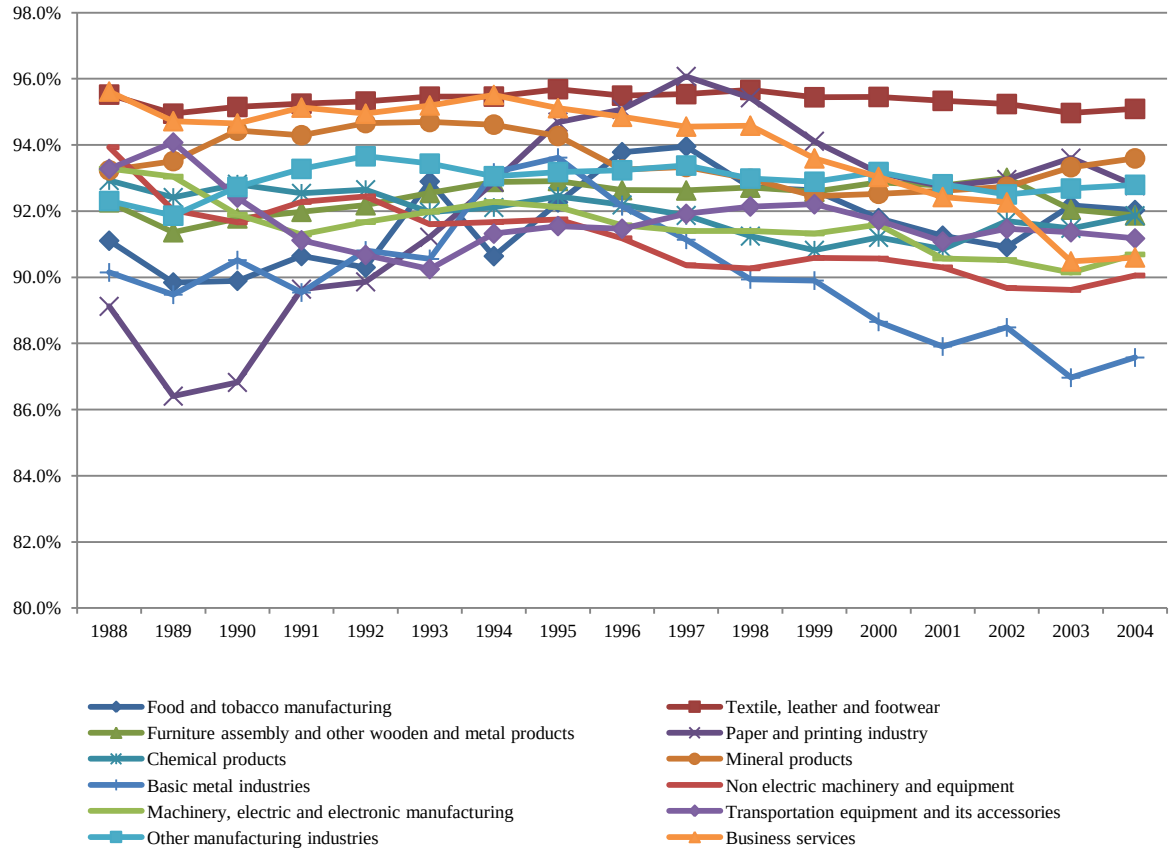
Source: Authors' calculation based on the balance of payments reported BANXICO.
*In this case, data is not reported for "Non electrical machinery equipment" and "Business services" because BANXICO did not provide specific information for studying these sectors.

Figure (A.2): Participation of manufacturing sectors in the total imports of maquiladora industry



Source: Authors' calculation based on the balance of payments reported BANXICO.
*In this case, data is not reported for "Non electrical machinery equipment" and "Business services" because BANXICO did not provide specific information for studying these sectors.

Figure (A.3): Share of blue-collar worker in the total working force of maquiladora per manufacturing sector.



Source: Authors' calculation

Table (A.2): Evolution of productivity levels in the maquiladora industry.

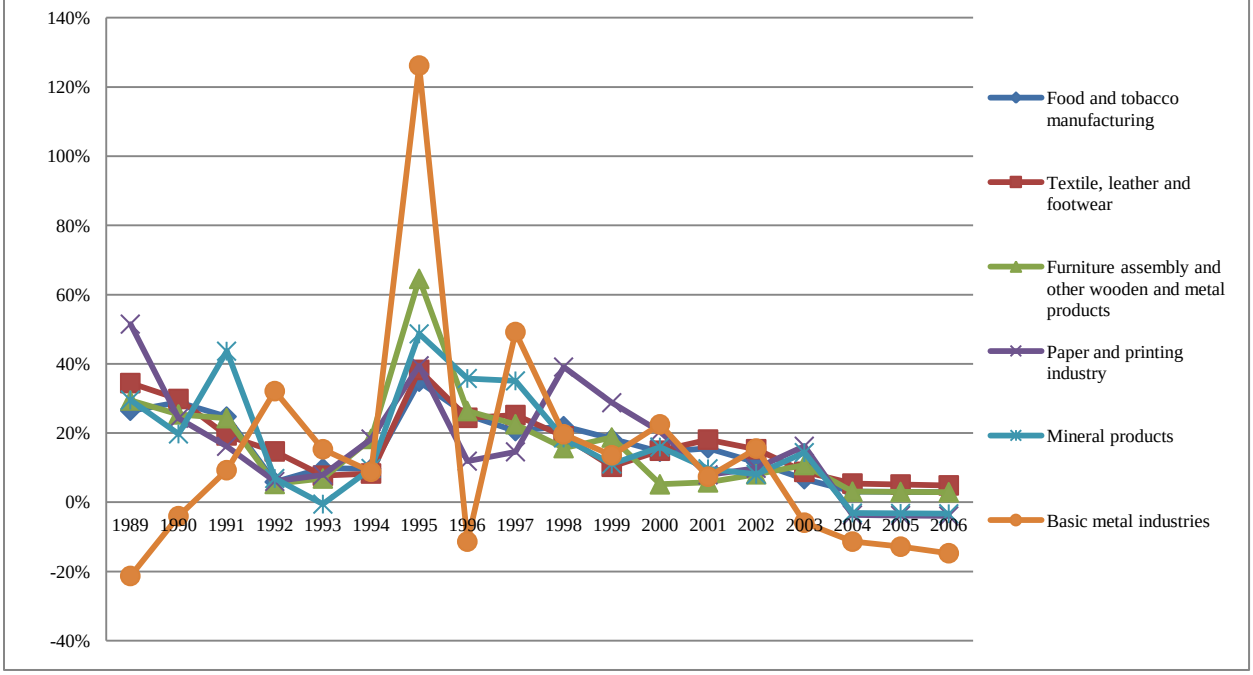
Traditional manufacturing sectors

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Food and tobacco manufacturing	9.22	11.66	15.03	18.75	19.84	21.79	23.90	32.23	40.33	48.62	59.31	70.19	80.43	92.98	103.71	110.62	114.01	117.41	120.80
Textile, leather and footwear	6.29	8.46	10.98	13.10	15.02	16.18	17.52	24.22	30.13	37.72	44.90	49.50	56.87	67.17	77.46	84.26	88.80	93.35	97.89
Furniture assembly and other wooden and metal products	8.94	11.57	14.50	18.02	18.98	20.28	23.99	39.48	49.88	61.13	70.70	83.92	88.27	93.34	100.88	111.73	115.15	118.58	122.00
Paper and printing industry	7.53	11.41	14.17	16.46	17.45	18.83	22.27	31.05	34.74	39.80	55.35	71.27	85.81	92.60	101.69	118.15	113.80	109.46	105.12
Mineral products	7.64	9.90	11.85	17.02	18.19	18.09	19.85	29.51	40.07	54.12	64.17	71.26	82.62	90.60	97.90	111.94	108.45	104.96	101.47
Basic metal industries	19.34	15.22	14.61	15.96	21.09	24.31	26.46	59.84	53.03	79.12	94.66	107.51	131.70	141.43	163.36	153.71	136.21	118.72	101.23

More complex manufacturing sectors

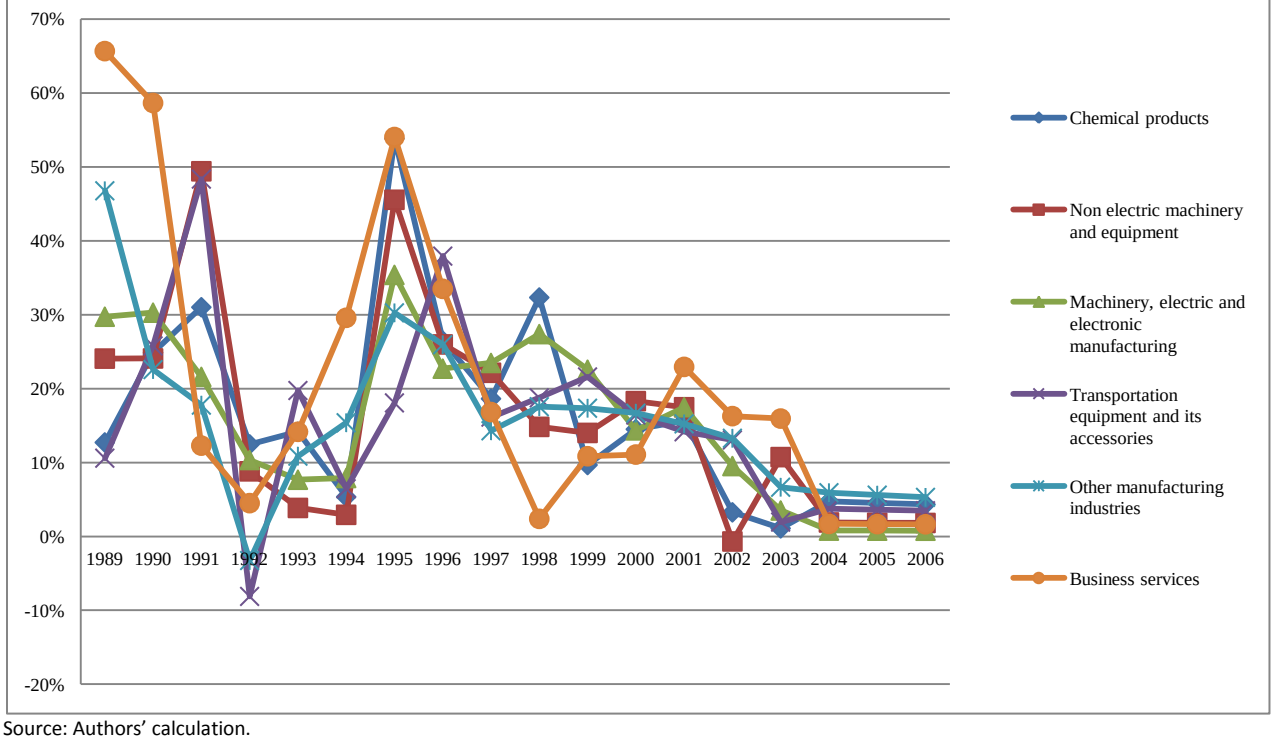
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Chemical products	9.62	10.84	13.54	17.74	19.95	22.78	24.00	36.92	46.70	55.40	73.32	80.41	92.08	106.48	109.95	111.16	116.44	121.72	126.99
Non electric machinery and equipment	11.49	14.26	17.69	26.43	28.76	29.87	30.75	44.75	56.38	68.88	79.09	90.17	106.68	125.33	124.48	137.85	140.46	143.07	145.69
Machinery, electric and electronic manufacturing	9.76	12.66	16.50	20.06	22.14	23.84	25.72	34.83	42.74	52.77	67.22	82.39	94.22	110.70	121.25	125.51	126.50	127.49	128.49
Transportation equipment and its accessories	11.45	12.66	15.93	23.63	21.72	26.01	27.69	32.69	45.09	52.38	62.20	75.63	88.06	100.53	113.66	115.87	120.21	124.55	128.89
Other manufacturing industries	9.30	13.66	16.74	19.71	19.07	21.15	24.40	31.78	40.03	45.76	53.79	63.12	73.65	84.88	96.15	102.56	108.63	114.71	120.78
Business services	17.97	29.78	47.25	53.06	55.45	63.30	82.03	126.38	168.72	197.12	201.82	223.74	248.54	305.57	355.33	412.01	419.02	426.03	433.05
Maquiladora industry as whole	9.32	11.70	15.04	18.87	19.95	21.90	23.96	32.21	40.43	48.76	59.46	70.33	80.53	93.10	103.77	110.37	113.89	115.49	122.61

Figure (A.4): Evolution of productivity growth rate in the more traditional manufacturing sectors (1989-2006).



Source: Authors' calculation.

Figure (A.5): Evolution of the productivity growth rate in the more complex manufacturing sectors (1989-2006).



Source: Authors' calculation.