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Global Value Chains in Mexico: A Historical Perspective*

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Abstract: This paper performs a historical analysis of Mexico's insertion into Global Value Chains (GVCs) and links it to the notion of competition underlying traditional theoretical models of international trade. In contrast with existing studies, it uses both new analytical tools pertaining to the GVC literature and tools based on the traditional notion of comparative advantage. This combination allows identifying three periods: (i) since NAFTA's signature until 2001, Mexico deepened its insertion into GVCs and reallocated resources to the production of more skilled-intensive goods; (ii) this higher GVC participation vanished when China entered the WTO; and (iii) since the second half of the 2000s, Mexico recovered the ground lost due to higher integration in the automotive sector and a reallocation of resources to the production of more unskilled-intensive goods, likely generated by an efficient response to competition with China. Hence, Mexico used two different models of GVC insertion entailing production processes with different characteristics in terms of skill-usage.
Keywords: Global Value Chains, NAFTA, Skill intensity
JEL Classification: F11, F15, F16

Resumen: Este documento realiza un análisis histórico de la inserción mexicana en las Cadenas Globales de Valor (CGV) y lo liga a la noción de competencia que subyace a los modelos teóricos tradicionales de comercio internacional. A diferencia de estudios existentes, combina herramientas analíticas modernas de la literatura de CGV con herramientas basadas en la noción tradicional de ventaja comparativa. Esta combinación permite identificar tres períodos: (i) desde la firma del NAFTA hasta 2001, México profundizó su participación en las CGV y reasignó recursos hacia industrias más intensivas en capital humano; (ii) esta mayor participación desapareció con la entrada de China a la OMC en 2001; y (iii) desde la segunda mitad de los 2000, México recuperó el terreno perdido por una mayor integración en el sector automotriz y una reasignación de recursos hacia industrias menos intensivas en capital humano, probablemente generadas como respuesta eficiente a la competencia con China. Por tanto, México usó dos modelos de inserción a las CGV, caracterizados por procesos productivos divergentes respecto al uso de capital humano.
Palabras Clave: Cadenas Globales de Valor, NAFTA, Capital humano

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1. Introduction

The current political-economic environment threatens the trade liberalization processes initiated decades ago. As noted in policy and academic communities, the widespread imposition of trade barriers currently remains an important risk, so that rises in unilateral trade restrictions could result in further retaliatory measures, and this can launch an unprecedented trade war (Ossa, 2014; World Bank, 2017). Indeed, while other times in contemporaneous history featured widespread sentiments anti-trade, such as the interwar period, the fact that the current environment features Global Value Chains (GVCs) implies that a new wave of protectionism can trigger significantly larger effects than in the past. Since GVCs fragmented the production process around the world, intermediates currently cross borders multiple times through the stages of production (Feenstra, 1998; Hummels, Ishii and Yi, 2001; Fally, 2011; Antràs et al., 2012). In this context, the effects of trade barriers can cascade along the supply chain triggering amplifying impacts (Yi, 2003; Diakantoni et al., 2017; World Bank, 2017).

Beyond its potential to amplify the effects of trade barriers, the fragmentation of the production process entailed by GVCs created a need for new analytical and measurement tools. In the new GVC world, countries specialize in specific stages of production and not only in final goods, implying that the traditional concept of comparative advantage is no longer sufficient to understand patterns of trade flows. Regarding the need for new measurement tools, it stems from the fact that countries import and re-export goods and thus gross exports currently embed large amounts of foreign value added. That is, gross flows are no longer informative on a country's degree of participation in international trade or on the amount of national income this trade generates.

A final but important characteristic of GVCs is that in this new world Mexico has been called to play a predominant role. Several of its characteristics place Mexico in a privileged position to exploit GVCs. Due to its geographical proximity with the U.S., the prevalence of its multiple trade agreements, its potential comparative advantage in unskilled labor-intensive stages, and a long tradition of policy actions favoring sectors that are particularly prone to industrial fragmentation, e.g., automotive and *maquiladora* sectors, Mexico has been called to play an important role in the GVC world.

In light of Mexico's privileged position to exploit GVCs, and particularly of the current situation that could impose barriers and disrupt chains, this paper performs an empirical investigation that is relevant both for a historical analysis and for understanding the current political-economic environment. In particular, the paper takes a historical perspective to study Mexico's insertion into GVCs. In contrast with existing literature, it complements the use of tools based on the traditional concept of comparative advantage with new analytical tools proposed in the new GVC literature (for a review on different tools, see Section 2). In doing so, the paper focuses on two hypothesis that were referred to in the context of the structural change in Mexican trade of the mid- to end-2000s. Specifically, it explores how much of the potential recovery of Mexico in global markets was driven by the automotive sector and how much by changes in China's fundamentals.

Regarding the new analytical tools, the paper applies the measures of upstreamness proposed by Fally (2011), Antràs et al. (2012) and Chor, Manova and Yu (2014) to the Mexican case by following the same two steps they follow: (i) using the Mexican Input-Output (IO) table, the paper constructs measures of upstreamness at the industry-level; and then (ii) it combines these industry-level indicators with data on trade flows to construct measures that reflect the average upstreamness of Mexican exports on one side and Mexican imports on the other. These measures are computed as weighted averages of the industry-level indicators of upstreamness in which the weight received by each industry depends on its importance in total trade. An interesting point of these measures is that because they combine industry-level indicators with information on trade flows, their construction requires merging two datasets recorded under different classifications.

The two measures of average upstreamness indicate the number of stages away from final demand at which Mexican exports and imports enter as an input in the production process. Moreover, as noted in Chor, Manova and Yu (2014), provided that imports are more upstream than exports, a negative difference between the average upstreamness of exports and imports indicates that a country imports goods that are processed into different stages and, then, re-exported. Furthermore, in this case, the difference is an estimate of the number of stages that imported goods go through before being re-exported.

Thus, since the Mexican process features these characteristics, the paper interprets the above-mentioned difference as an indicator of Mexico's insertion into GVCs: as argued by Chor, Manova and Yu (2014), a larger value of the difference indicates that a wider range of GVCs is domestically performed. This is consistent with but does not necessarily imply that more domestic value added is being created. Nonetheless, in this regard it is important to note that our results are consistent with those obtained by Aguirre, Cardozo and Tobal (forthcoming) with a more direct measure of value added. Hence, implicitly, these studies contribute to the literature by providing further and external validity to GVC measures used in the literature for the case of Mexico.

Regarding the tools based on the traditional comparative advantage concept, the paper uses them to characterize the Mexican insertion in terms of the skill intensity implied by the production process underlying trade flows. Characterizing this process in terms of skill intensity enables us to subsequently use traditional models of trade in linking the results to Mexico's unskilled-labor abundance relative to its trading partners and the rest of the world. Furthermore, the intuition underlying these models of trade will allow explaining how changes in Mexico's contribution to the GVCs relate to global competition with China.

In characterizing Mexico's insertion in terms of skill intensity, the paper contributes to the literature by constructing new indicators of the average human capital intensity for exports and imports. To this end, it uses two steps that resemble those taken for the upstreamness measures: (i) using the data of Nunn and Trefler (2013), it constructs measures of skill intensity at the industry-level; then (ii) it combines them with data on trade flows to create measures of human capital intensity for exports and imports. Precisely, these measures are weighted averages of the industry-level indicators of human capital intensity in which the weight received by each industry depends on its importance in total trade. Just as for the upstreamness measures, since the human capital intensity indicators combine industry-level measures with data on trade flows, their construction requires merging two datasets recorded under different classification systems.

Furthermore, also just as in the case of upstreamness, we use differences between exports and imports. In particular, following the intuition that falls out of traditional factor-proportion models of trade, the paper uses the difference between the average skill intensity of exports and imports to infer specialization patterns. For instance, it interprets the fact that skill intensity is higher for imports than for exports as an indication that an economy specializes in relatively unskilled intensive goods. By the same token, a rise in the above-mentioned difference is interpreted as an indication that in a given economy resources are being relocated to the production of relatively less skill-intensive goods.

An additional contribution of this paper relates to the fact that the construction of the upstreamness and skill intensity indicators requires merging datasets that are recorded under different classifications, the Mexican North American Industry Classification System (SCIAN) and the Mexican Import and Export General Tariff Act (TIGIE). While there is for Mexico a correspondence table linking the two classifications, this table is available only for the period beginning in 2007. Moreover, using this table to analyze historical data generates a considerable amount of information loss. Thus, the paper constructs a new historical bridge between SCIAN and TIGIE. This bridge uses as one of its inputs an algorithm developed in Pierce and Schott (2012) and allows capturing more than 90% of trade flows for each year within 1993-2006.

In contrast, a drawback of the new bridge is that it involves some arbitrary choices regarding the manner in which some codes in the TIGIE and SCIAN classifications are linked. While we provide robustness to both the bridge and the paper's results through different strategies in generating these links, we acknowledge that some degree of arbitrariness remains (for details, see Section 4 and Appendix A). Notwithstanding, we still believe that the link makes a contribution since it can be used by other researchers in the scientific community, particularly in Mexico, to undertake historical empirical studies at the intersection between labor economics and trade.

The results show that there are three clearly identifiable periods regarding Mexico's insertion into GVCs. During the first period, beginning immediately after the signature of North American Free Trade Agreement (NAFTA), the number of GVC stages produced in Mexico increased, suggesting that NAFTA fostered participation in production chains. During the second period, beginning in 2001, there was a reduction in the number of stages performed in Mexico. The fact that this reduction coincides with China's entry into the WTO suggests that global competition with the economy may have contributed to reduce the slice of the GVCs that Mexico produces.

During the third period, which begins in the mid- to end-2000s, the number of stages performed in Mexico has increased again. That is, Mexico's contribution to the GVCs seems to have recovered some of the ground it had lost with China's entry into the WTO, generating a structural change in Mexican trade patterns. In this regard, consistent with the abovementioned hypothesis on the role of the automotive sector, the results suggest that the Mexican recovery is partially explained by its outstanding performance in this sector, in which the number of domestically-produced stages in the GVCs has also increased since the mid-2000s.

Regarding the characterization of the insertion process, the results surprisingly show that the exact same three periods identified in the upstreamness analysis are relevant for understanding specialization patterns in Mexico. During the first period, beginning after NAFTA, the difference between the average skill-intensity of Mexican exports and imports decreased, suggesting that NAFTA not only increased the number of stages produced in Mexico, but also shifted resources towards the production of relatively skilled-intensive industries. In the second period, this difference remained relatively constant, suggesting that the reduction in the number of stages was not related to resource relocations between skilled and unskilled goods. Finally, the third period, beginning in the mid-/end-2000s, the difference between the skill-intensity of exports and imports increased. This suggests that the rise in the number of GVC stages produced in Mexico during this period, the period of structural change in trade patterns, associates with a stronger specialization of Mexico towards relatively less skilled-intensive industries.

Interestingly, the results regarding the changes in specialization are robust to using completely different methodologies and data. Consistent with these results, an additional analysis at the industry-level shows that, while relatively skilled-intensive industries increased their trade balance in 1995-2001 and reduced it in 2006-2017, relatively unskilled-intensive industries reduced their balance in the first period and increased it iver the second one. Moreover, employing the methodology of Aguirre, Cardozo and Tobal (forthcoming) and the World Input-Output database (WIOD), the paper shows that the Mexican value added embedded in U.S. manufacturing consumption of skilled-intensive industries increased relative to that of unskilled-intensive ones over 1995-2001, but decreased over 2006-2014. These two results suggest that NAFTA induced Mexico to specialize in the production of the relatively skill-intensive goods but, since mid-2000s, resources seem to have shifted towards relatively unskilled-intensive industries.

Finally, the comparison between the average skill intensity of Mexican and Chinese trade flows reveals interesting results. Based on the specialization indicator, the paper distinguishes two periods in the Chinese process of insertion into GVCs. In the first period, beginning in 2001, the difference between the average skill-intensity of its exports and imports increased; China's insertion into the WTO seemed to have induced a resource relocation towards unskilled-intensive industries in this economy. This is reassuring because this economy should have in principle had a comparative advantage in these industries in 2001. Furthermore, this is the same type of industries in which Mexico had a comparative advantage, indicating that the two countries were global competitors at the time. To be more precise, the specialization indicator takes the exact same value for China as for Mexico exactly in 2006, suggesting that the similarity in the goods produced by the economies, and thus the competition between them, peaked in this year.

Interestingly, this is exactly the same year in which the third period we have identified for Mexico begins; that is, the same moment in which Mexico begins relocating resources towards relatively less skilled-intensive industries. This is arguably consistent with the idea that global competition between the two countries has shaped not only Mexico's insertion into GVCs but also its specialization patterns. That is, while China's entry into the WTO reduced Mexico's insertion into GVCs, this loss seems to have induced a resource relocation in Mexico towards industries in which the Asian economy did not have a comparative advantage. In turn, this allowed Mexico to integrate back in GVCs.

The remainder of the paper is organized as follows. Section 2 reviews the literature measuring a country's contribution to the GVCs. Section 3 describes the data and Section 4 presents the methodology and results for the upstreamness analysis. Section 5 presents the methodology and results for the human capital intensity analysis. Section 6 compares the experiences of Mexico and China on GVC integration, and explores the hypothesis that the process of Mexican insertion have been shaped by the competition with the Asian country. Finally, Section 7 concludes.

2. Measuring Contributions to GVCs with an Emphasis on Mexico

This section reviews the literature dealing with different estimates of a country's insertion into GVCs. For illustration purposes, this literature is divided into three strands, depending on the type of measure considered and on the type of data used to construct it. The first strand builds measures of GVC participation only with data on international trade; the second strand builds measures of GVC integration with a single data source, either domestic or global IO tables; finally, the third strand builds measures of integration by using a combination of international trade data and domestic IO tables.

In approximating a country's degree of insertion into GVCs, the first strand of the literature relies on the premise that fragmentation generates intra-industry trade in intermediate goods between countries. The idea is that these countries may exchange intermediate goods for intermediate goods both of which, at sufficiently high aggregation levels, fall in the same industry classification. Under this premise, the greater a country's intra-industry trade relative to its inter-industry trade is, the more integrated this country is in international production networks (see Fukao, Ishido and Ito, 2003; Blyde, Volpe and Molina, 2014). Thus, following this logic, this first strand approximates GVC participation by constructing indexes of intra-industry trade.[1]

The second strand measures a country's insertion into GVCs by calculating the amounts of foreign and domestic value added (FVA and DVA, respectively) embedded in its exports, and uses data from domestic IO or Global ICIO tables to infer these amounts (see Hummels, Ishii and Yi, 2001 and Koopman, Wang and Wei, 2008). For instance, Hummels, Ishii and Yi (2001) estimate the FVA embedded in an exports unit by using the share of intermediate inputs over gross output. For the case of Mexico, De La Cruz et al. (2011) measure the DVA embedded in total manufacturing and processing exports (i.e., those under the *Maquiladora* and PITEX programs) for 2000, 2003 and 2006. They show that the DVA embedded in manufacturing and processing exports is of 27%-36% and of 21%-28%, respectively, depending on the aggregation level considered. With a similar methodology, Fujii and Cervantes (2013) estimate that DVA in Mexico equaled 27% and 15% in manufacturing and processing exports in 2003.

The second strand also comprises papers using Global ICIO tables based on Global Trade Analysis Project (GTAP) models and the WIOD (e.g., Stehrer, Foster and de Vries, 2010; Daudin, Rifflart and Schweisguth, 2011 and Johnson and Noguera, 2012). The advantage is that these tables track, for each sector/industry and each country, bilateral shipments of gross output for final demand and intermediate use separately, enabling researchers to account for complex production linkages between countries; e.g., the fact that one country imports inputs from another to produce final goods that are consumed in a third country. For Mexico, Blyde, Volpe and Molina (2014) use Global ICIO tables and show that the DVA embedded in exports equaled 56% in 2003.[2]

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[1] For instance, Blyde, Volpe and Molina (2014) construct its intra-industry trade index employing the Grubel-Lloyd index which measures the relative importance of intra-industry trade in a particular product/industry.

[2] Additionally, Blyde, Volpe and Molina (2014) use the IMMEX census generated by the National Institute of Statistics and Geography (INEGI) to estimate the DVA embedded in processing exports in Mexico over July 2007-January 2013. This census provides basic information for all the plants that benefit from the *Maquiladora* and PITEX programs, including the DVA in the exports of each establishment. The country-level DVA embodied in total processing exports is then computed as a weighted average of the share of DVA of the establishments over their processing exports, using

More recently, Aguirre, Cardozo and Tobal (forthcoming) use the WIOD to perform an empirical study that, just as this paper does, takes a historical perspective on the Mexican insertion into GVCs. Using the WIOD, they estimate the Mexican value added embedded in U.S. manufacturing consumption.[3] Based on their estimates, they identify three periods: (i) a period beginning after NAFTA in which the Mexican valued added embedded in U.S. manufacturing consumption increased; i.e., in which Mexico's participation in GVCs increased; (ii) a period starting in 2001, when China's entered the WTO, in which the Mexican value added decreased; and (iii) a period beginning in the mid- to end-2000s in which this value added began to recover. These are the exact same periods we identify in the present paper by using different data and a different methodology. Thus, in this sense, Aguirre, Cardozo and Tobal (forthcoming) provide external validity to the results obtained in this paper.

Finally, the third strand combines data on domestic IO tables with data on trade (see Fally, 2011; Antràs et al., 2012; and Chor, Manova and Yu, 2014). Domestic IO tables allow computing measures of upstreamness that reflect the average position of each industry on the production chain; i.e., its average distance from final consumer. Then, these industry-level measures are combined with trade data in calculating the average position of a country's exports and imports. By subtracting the latter position from the former position, one can estimate the production stages in GVCs that are produced in the country, which are in turn indicative of the degree to which it participates in GVCs.[4] Using these measures, Chor, Manova and Yu (2014) show that China has been steadily increasing its GVC contribution over 1992-2011. For Mexico, this is the first paper of the third strand of the literature that investigates upstreamness of exports and imports.

3. Data

3.1 Upstreamness Information and New Historical Bridge

The measures of upstreamness calculated in Section 4, which approximate for the number of production stages in the GVCs that are produced in Mexico, involve the use of two

the participation of each establishment processing exports in total processing exports of the country. They document a decline in the DVA embedded in processing exports, from about 18% in July 2007 to about 15% in January 2015.

[3] Aguirre, Cardozo and Tobal (forthcoming) use two versions of the WIOD. The first version comprises trade transactions of 41 countries and 35 sectors mostly at the 2-digit level of ISIC Rev. 3 from 1995 to 2011. The second version enlarges the sample to 44 countries and 56 sectors at the 2-digit level of ISIC Rev. 4 from 2000 to 2014.

[4] As explained in Section 4, the average position of exports (imports) is computed as a weighted average of the industry-level upstreamness measures using export (import) flows as weights.

information types: (i) data on Mexican IO tables enabling us to construct measures of upstreamness at the industry-level; and (ii) industry-level data on Mexican exports and imports. These two types of information are gathered in datasets that are assembled by Bank of Mexico (the country's central bank) and the National Institute of Statistics and Geography (INEGI). We will use this information, and when comparing our results to the Chinese case, we will also use the outcomes obtained by Chor, Manova and Yu (2014).

The dataset assembled by Bank of Mexico provides information on the U.S. dollar value of Mexican imports and exports, on the tax-identifier code of the corresponding exporting or importing firm, on whether the firm participated in the *Maquiladora* program implemented by the government for at least one year over 1993-2006, and on the origin-destination country of the international trade flows. Our analysis will be constrained to manufacturing goods. Moreover, for the purpose of the present study, it is important to note that these flows are classified under the 6-digit TIGIE classification code. The data coming from the Mexican IO table were retrieved from INEGI and provide information on the inter-industrial flows of goods and services in the domestic economy for 262 industries corresponding to 2008. Importantly, these inter-industrial flows are reported according to the SCIAN classification aggregated at the 4-digit level.

As noted above, the construction of the upstreamness measures requires merging data on international trade flows that are reported according to the 6-digit level TIGIE classification with data on inter-industrial flows that are reported according to the 4-digit level SCIAN classification. The facts that these two information types are reported under different product classifications and that, at the same time, Mexico, i.e., INEGI-Ministry of Economy, does not count with correspondence tables enabling to map them for any year before 2007 imposed significant challenges to the data merging process and, therefore, to the construction of the upstreamness measures we present. Generally speaking, it is fair to say that the lack of correspondence tables to bridge the TIGIE and the SCIAN classifications has precluded researchers from undertaking empirical studies at the intersection between trade and other fields of economics in Mexico.

In confronting this challenge, one could use the 2007 table to map the two information types for every year over the period preceding 2007; that is, from 1993 to 2006. Nonetheless, the problem is that this strategy yields a considerably large set of TIGIE categories that cannot be mapped to any SCIAN category; thus, it generates an information loss of about 40% of the data contained in our trade database over 1993-2006. Having this in mind, the present paper takes a different avenue by constructing a completely new bridge between the TIGIE and the SCIAN classifications for the period 1993-2006. For 2007-2017, the paper uses the correspondence tables provided by INEGI-Ministry of Economy.

This new bridge between TIGIE and SCIAN classifications allows analyzing more than 90% of trade flows for each year between 1993 and 2006. Thus, they will enable to extend Bank of Mexico's database on trade flows recorded under the SCIAN classification for this period and not to circumscribe to data series beginning in 2007, which are the only series that could be obtained by using the existent correspondence tables provided by INEGI-Ministry of Economy. The extended database could be used at Bank of Mexico to undertake complementary analytical exercises and not only for the purposes of the present paper. Moreover, our impression is that this new bridge can also be used by other researchers in the scientific community, particularly in Mexico, to undertake empirical studies combining industrial data with trade flow information.

In constructing the new historical bridge, the paper relies on three facts: (i) the product categories in the TIGIE classification at the 6-digit level are the same as those in the harmonized system (HS) classification at the 6-digit level, i.e., these classifications coincide; (ii) the SCIAN classification at the 4-digit level coincides with the North American Industry Classification System (NAICS) at the 4-digit level;[5] and (iii) while there are not correspondence tables between HS and the NAICS provided by official institutions, a recent paper by Pierce and Schott (2012) develops an algorithm linking the 10-digit level HS classification to the 6-digit level NAICS classification for the U.S.

Taking these facts into account, we construct our new historical bridge between the 6-digit level TIGIE and the 4-digit level SCIAN classifications by using Pierce and Schott's work (2012). We accomplish this task by using facts (i) and (ii) to have our trade data classified under the 6-digit level HS classification and our IO data classified under the 4-digit level NAICS classification. Then, having these two data types, we link them through

[5] There are a few industries in SCIAN and NAICS classifications that are only consistent at higher aggregation levels. In particular, *Credit Intermediation and Related Activities* (code 522 in SCIAN), *Waste Management and Remediation Services* (code 562 in SCIAN), *Personal and Laundry Services* (code 812 in SCIAN) and *Religious, Grantmaking, Civic, Professional, and Similar Organizations* (code 813 in SCIAN) industries are comparable at the 3-digit level; and *Utilities* (code 22 in SCIAN), *Wholesale Trade* (code 43 in SCIAN), *Retail Trade* (code 46 in SCIAN) and *Public Administration* (code 93 in SCIAN) industries are comparable at the 2-digit level. However, neither of these industries involves the production of tangible goods and, therefore, they are not mapped to any product category of 6-digit HS.

a new correspondence we obtain by considering only the first 6 digits in Pierce and Schott's (2012) 10-digit HS classification and only the first four digits in their 6-digit level NAICS classification. This yields a mapping between the 6-digit level HS and the 4-digit level NAICS classifications we use to link our trade with our IO data and, ultimately, to construct the new historical bridge between TIGIE and SCIAN (for further details, see Appendix A).

In discussing the characteristics of the new historical bridge, it is important to explain one of its main flaws. As we use Pierce and Schott (2012) to derive the HS-NAICS correspondence, some 6-digit HS codes end up corresponding to more than one 4-digit NAICS category, and this in turn implies that we must use a subjective criterion to allocate these codes. Thus, we provide robustness to the new historical bridge and our empirical results by taking two different strategies.

To understand the first strategy, used in the main body text, it is useful to begin with Pierce and Schott's correspondence (2012) and to focus first on the whole 10 digits for the HS classification but only on the first four digits for the 6-digit NAICS classification. Then, taking these digit-level classifications into account, we perform the allocation so that we distribute the flows recorded in each 6-digit level HS code by assigning relative weights to each 4-digit NAICS category on the basis of the proportion of 10-digit level HS codes that fall in this category (for details and graphical representation of the procedure, see Appendix A). As a robustness check, we take a second strategy in which, regardless of the above-mentioned relative weights, we distribute the traded flows recorded in each 6-digit level HS uniformly across the corresponding SCIAN categories (see Appendix A). The results suggest that the manner in which the above-mentioned HS codes are distributed across SCIAN categories does not alter either significantly the allocation among codes or the paper's qualitative results (see Appendix F).

3.2 Data for Human Capital Intensity Analysis

As noted below, Section 4 will study changes in Mexico's insertion into GVCs. Then, given that different levels of human capital intensity in production yield different implications for the skill premium and thus for schooling returns, Section 5 will characterize this insertion in terms of the human capital intensity of the underlying production process. Importantly, in undertaking this analysis, the paper relies on the skill-intensity measures mentioned in the introduction and, thus, relies on two information types: (i) industry-level data on Mexican exports and imports; and (ii) the industry-level data on unskilled and skilled wages used by Nunn and Trefler to construct their skill-intensity measures. While the former data are assembled by Bank of Mexico as noted above, the latter data are provided by Nunn and Trefler (2013) in a general dataset on labor market outcomes.

The dataset on Mexican exports and imports has been already presented in the previous subsection. As for the labor market dataset provided by Nunn and Trefler (2013), it reports data on production worker and total wages for the U.S.[6] These data are reported at the industry-level for 338 manufacturing industries in 2005 and classified according to the 6-digit level NAICS categorization. Given that the construction of the skill-intensity indicators requires merging these two information types, we will go through a data merging process that is similar to one we have described above for the upstreamness measures. In particular, using the correspondence table between the 6-digit level TIGIE and the 4-digit NAICS classifications we have created, we aggregate Nunn and Trefler's information (2013) into the 4-digit category and link the ensuing information with the data on trade flows contained in Bank of Mexico's dataset.

Moreover, the skill-intensity analysis of Section 5 goes beyond the industry-level measures of Nunn and Trefler (2013). As noted below, that section performs two additional exercises in which it uses the WIOD methodology employed by Aguirre, Cardozo and Tobal (forthcoming) and additional data from OECD ICIO tables, respectively, to investigate whether the outcomes obtained with the Nunn and Trefler indicators (2013) are corroborated with a different methodology and different data, for the case of the skill intensity results. To perform these additional exercises, we had to merge Nunn and Trefler's (2013) skill-intensity measures classified under the 4-digit level NAICS classification with data from the WIOD and the OECD ICIO tables, both of which are based on the 2-digit ISIC Rev. 3 classification. Ultimately, the goal was to count with skill-intensity measures enabling us to classify the industries considered in the WIOD and the OECD ICIO tables into high skill- and low skill-intensive industries.

Nonetheless, there is not a correspondence table that links directly the 4-digit level NAICS classification to the 2-digit level ISIC Rev. 3 categorization. Thus, we were confronted with the need of linking these classifications indirectly through several middle

[6] Data available at https://scholar.harvard.edu/nunn/pages/data-0.

stages. This data merging process can be readily summarized in two big steps. The first stage comprises the following middle steps enabling us to go from 4-digit level NAICS to 4-digit ISIC Rev. 3: (i) starting from the 4-digit level NAICS classification, we use the 6-digit level version; (ii) using the 6-digit NAICS/4-digit ISIC Rev. 4 correspondence table; then (iii) the 4-digit ISIC Rev. 4/4-digit ISIC Rev. 3.1 table; and then (iv) the 4-digit ISIC Rev. 3.1/4-digit ISIC Rev. 3 correspondence tables from UN Comtrade. In the second step, the 6-digit NAICS/4-digit ISIC Rev. 3 table is aggregated to the 4-digit NAICS /2-digit ISIC Rev. 3 level, enabling us to obtain the desired link.

Once we had the 4-digit NAICS/2-digit ISIC Rev. 3 correspondence table, we were able to redefine Nunn and Trefler's measures (2013) on the spectrum of industries considered in the 2-digit ISIC Rev. 3 classification. Yet, an additional step was required to finally link these 2-digit ISIC Rev. 3 skill-intensity measures to the industries considered in the WIOD and the OECD ICIO tables. Indeed, each of the categories considered in the WIOD groups multiple of the industries considered in the 2-digit ISIC Rev. 3 classification. Thus, we assigned a skill-intensity value to each of the categories in the WIOD by taking an average over all of the 2-digit ISIC Rev. 3 categories comprised in this category. To assign a skill-intensity value to each industry in the OECD tables, we follow a similar strategy.

In this context, those industries in the WIOD and OECD ICIO with a skill intensity above the mean were classified as high skill-intensive industries and those with a value below the mean were classified as low skill-intensive industries. This procedure allowed classifying 23 out of the 35 industries of the WIOD and OECD ICIO tables. The remaining industries were classified by using information on the years of education at the worker level available at the National Survey on Employment and Occupation (ENOE) reported by INEGI. In particular, under this criterion, an industry was classified as being high skill-intensive if at least 50% of their workers had at least 8 years of education, and classified as low skill-intensive otherwise.

4. Upstreamness: Approximating Insertion into Global Value Chains

4.1 Methodology

In a GVC world countries must be no longer thought of as having a comparative advantage only in the production of final goods; instead, given that the production is globally fragmented, they must be thought of as having a comparative advantage in stages of the production process. Following this logic, a country's integration into GVCs can be linked to the nature and number of production stages it produces. In this context, the present paper constructs indicators of the amount of production stages that are produced in Mexico by using the measures of upstreamness proposed by Fally (2011), Antràs et al. (2012) and Chor, Manova and Yu (2014).

The estimate of the amount of GVC stages that are domestically-produced will be calculated in two steps. In the first step, the paper will use the Mexican IO table described in Section 3 to construct measures of upstreamness disaggregated at the industry-level. In the second step, these measures will be combined with trade data to calculate the average position of Mexican exports and imports and, ultimately, to estimate the amount of stages that are domestically-produced.

In the first step, our point of departure in constructing the industry-level measures of upstreamness is the basic IO identity. According to this identity, gross output in an industry i can be decomposed into final use and intermediate use. In an economy with N industries, this decomposition is written as

$$Y_i = F_i + \sum_{j=1}^{N} d_{ij} F_j + \sum_{j=1}^{N} \sum_{k=1}^{N} d_{ik} d_{kj} F_j + \cdots \quad (1)$$

where Y_i denotes gross output in industry i; F_i refers to the final use of Y_i, i.e., its use for consumption and investment; and d_{ij} is the direct requirement coefficient of industry j from industry i, i.e., the amount of output from industry i directly required to produce a unit of output in industry j. The sum of the second, third and final terms in the right hand side of Equation (1) represents the intermediate use of Y_i; i.e., its use as an input in other industries. Importantly, all of the coefficients considered in this equation have a direct empirical counterpart with data arising from the Mexican IO table.

Moreover, as one multiplies each of the terms in the right hand side of Equation (1) by its "distance" from final use, i.e., the amount of stages away it is from final consumer, and then divides it by Y_i, one obtains an expression reflecting the average position of industry i in the production chain; that is, the level of upstreamness of industry i. Denoting this level by U_i, this expression can be written as follows

$$U_i = 1 \cdot \frac{F_i}{Y_i} + 2 \cdot \frac{\sum_{j=1}^{N} d_{ij} F_j}{Y_i} + 3 \cdot \frac{\sum_{j=1}^{N} \sum_{k=1}^{N} d_{ik} d_{kj} F_j}{Y_i} + \ldots \quad (2)$$

As noted above, the coefficients in this expression have a direct empirical counterpart in Mexican IO tables. Nonetheless, in the context of an open economy with inventories, some corrections are required, and thus the direct requirement coefficient of industry j from industry i (d_{ij}) cannot be directly obtained from the data. In particular, consider a situation in which a fraction of the inputs used by Y_j are imported from a foreign industry i. In this situation, these imported inputs would be included in the empirical counterpart of d_{ij}, and thus it would be overestimated for the purpose of our study. A similar argument can be built to consider inventories in the afore-mentioned correction.[7] Thus, following Fally (2011), Antràs et al. (2012) and Chor, Manova and Yu (2014), we correct the value of d_{ij} obtained from the IO tables by scaling it with $\frac{Y_i}{Y_i - X_i + M_i - NI_i}$, where X_i, M_i and NI_i are, respectively, exports, imports and net change in inventories of industry i.

Regarding Equation (2), note that U_i is a weighted average of the number of stages away from final demand at which Y_i enters as an input in production. In this sense, a value of U_i that is closer to 1, for instance, reflects that Y_i enters as an input at a position that is relatively close to final use (i.e. consumption or investment), while higher values of U_i indicates that Y_i goes on average through several stages of the production process before being invested or consumed. In other words, the higher the value of U_i is, the more upstream Y_i is located in the production chain.

To illustrate this link between U_i and the upstreamness of industry i, let us consider two polar cases; i.e., *Animal Slaughtering and Processing* and *Semiconductors and Other Electronic Components*. Since the *Animal Slaughtering and Processing* industry comprises establishments that are mainly engaged in preparing processed meats and meat byproducts, i.e., mainly final goods, it is located relatively downstream in the production chain. In contrast, the *Semiconductors and Other Electronic Components* industry produces mainly intermediate goods, such microprocessors, electronic connectors and resistors which are, in turn, used for producing a variety of electronic devices, among

[7] The potential bias in the computation of d_{ij} arises from three sources. First, because the inter-industrial flows reported in the Mexican IO table do not distinguish between domestic and international exchanges, d_{ij} will be computed employing total input purchases by industry j of industry i's output, regardless of these purchases are made to domestic or foreign producers. This will tend to overstate d_{ij}. Second, the computation of d_{ij} will not include the amount of domestic industry i's output used as an input by industry j abroad, which would tend to understate d_{ij}. Third, reductions in inventories are included in input purchases of industry i's output by industry j. This will tend to overstate d_{ij}. Note that the open-economy and inventories adjustment proposed by Fally (2011), Antràs et al. (2012) and Chor, Manova and Yu (2014), $Y_i/(Y_i - X_i + M_i - NI_i)$, is intended to consider the potential bias in d_{ij}; d_{ij} falls as imports of industry i's output increase and/or accumulated inventories fall, and it increases as the exports of industry i's output increase.

computers and microwaves stand out. Thus, in this sense, one can argue that the *Semiconductors and Other Electronic Components* industry is located relatively upstream and should, thus, receive a higher upstreamness value (U_i) than *Animal Slaughtering and Processing*. Indeed, while *Semiconductors and Other Electronic Components* receives a value of 3.8, *Animal Slaughtering and Processing* receives a value of 1.2, indicating that this industry enters about 1 stage before final use.

Having obtained the industry-level measures of upstreamness by going through the first step, we proceed with the second step in which we calculate the average position of Mexican exports and imports. Thus, we combine the industry-level measures of upstreamness U_i with the data on trade flows and calculate for exports and imports separately the following weighted averages

$$U_{Mex,t}^{X} = \sum_{i=1}^{N} \left(\frac{X_{Mex,i,t}}{X_{Mex,t}}\right) U_i \; ; \; U_{Mex,t}^{M} = \sum_{i=1}^{N} \left(\frac{M_{Mex,i,t}}{M_{Mex,t}}\right) U_i \qquad (3)$$

where $U_{Mex,t}^{X}$ and $U_{Mex,t}^{M}$ are the average upstreamness (i.e., position) of Mexican exports and imports in year *t*, respectively; and $\frac{X_{Mex,i,t}}{X_{Mex,t}}$ and $\frac{M_{Mex,i,t}}{M_{Mex,t}}$ are the shares of exports and imports of industry i over total exports and imports in the same year. For future reference, note in (3) that, given that U_i measures do not vary over time, changes in $U_{Mex,t}^{X}$ and $U_{Mex,t}^{M}$ are a pure reflection of changes in the composition of export and import shares; e.g., an increase in $U_{Mex,t}^{X}$ reflects a change in the composition of exports indicating that Mexico started to export relatively more goods located upstream and relatively less goods located downstream. That is, changes in $U_{Mex,t}^{X}$ and $U_{Mex,t}^{M}$ indicate that the production process shifts resources to industries that are relatively more or less upstream.

Finally, we use the average position of Mexican exports and imports to derive the estimate of the number of production stages that are domestically-produced. Using Equation (3), we write

$$U_{Mex,t}^{XM} = U_{Mex,t}^{X} - U_{Mex,t}^{M} = \sum_{i=1}^{N} \left(\frac{X_{Mex,i,t}}{X_{Mex,t}}\right) U_i - \sum_{i=1}^{N} \left(\frac{M_{Mex,it}}{M_{Mex,t}}\right) U_i \qquad (4)$$

where $U_{Mex,t}^{XM}$ is the difference between the average upstreamness of Mexican export and imports. Negative values of $U_{Mex,t}^{XM}$ indicate that, on average, exports are less upstream than imports, providing an estimate of the average number of stages of the GVC that are performed in Mexico.[8] Thus, given that greater negative values for $U^{XM}_{Mex,t}$ indicate that the country executes more stages domestically, these greater negative values indicate a greater contribution to GVCs. Moreover, although $U^{XM}_{Mex,t}$ does not directly measure the value added generated by trade, it provides a reasonable approximation to it.[9] Indeed, the greater the number of production stages performed by Mexico is, the larger the range of productive activities that generate domestic income in this country and, thus, the higher the extent to which the country may benefit from GVC integration.[10]

4.2 Mexico's Insertion into Manufacturing GVCs

Figure 1 shows the average upstreamness of Mexican manufacturing exports and imports ($U^{X}_{Mex,t}$ and $U^{M}_{Mex,t}$ in Equation (3)) with a green solid curve and a green dotted curve, respectively. This figure shows that, while the position of manufacturing imports has remained relatively constant over time, the position of manufacturing exports exhibit substantial movement over time. An important implication is that time-variation in the difference between the curves, i.e., $U^{XM}_{Mex,t}$ our estimate for the number of stages produced in Mexico, is mostly driven by changes in the upstreamness of exports. Note also that Mexican exports have been persistently less upstream than Mexican manufacturing imports, indicating that the number of production stages mentioned above is positive.

This result is more clearly stated in Figure 2, which depicts the time-behavior of $U^{XM}_{Mex,t}$. Note in this figure that, depending on the value of this indicator and therefore on the extent to which Mexico is inserted into GVCs, there are three clearly identifiable periods. The first period begins immediately after NAFTA implementation and ends in 2001 with China's accession in the WTO. In this period our estimate for the number of stages of the GVCs that were produced in Mexico increased; i.e., $U^{XM}_{Mex,t}$ became higher in absolute terms. In other words, NAFTA might appear to have contributed to increase Mexico's contribution to GVCs.

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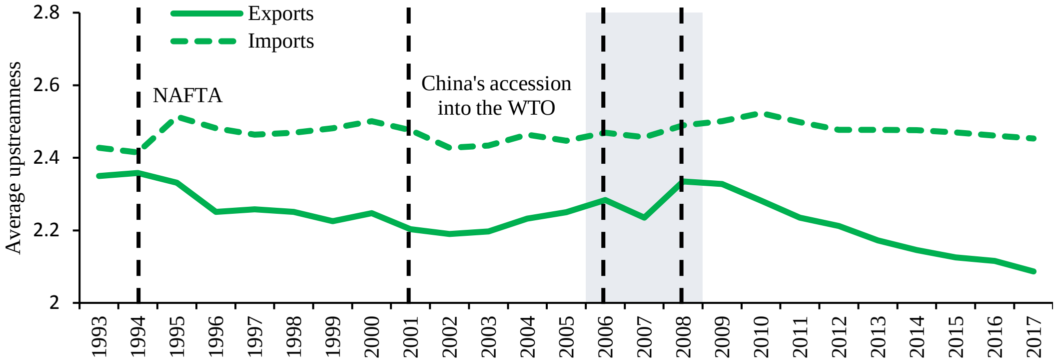
[8] Generally speaking, it is possible for exports to be more upstream than imports so that $U^{XM}_{Mex,t}$ is not always negative. For instance, countries that are rich in natural resources tend to export raw materials and to import final goods. In these countries, exports tend to be more upstream implying that $U^{XM}_{Mex,t}$ takes positive values. In these cases, the value of $U^{XM}_{Mex,t}$ cannot be interpreted as the number GVC stages that are domestically-produced.

[9] The results are robust to using more direct measures of value added as in Aguirre, Cardozo and Tobal (forthcoming).

[10] Notwithstanding, it is worth noting that the same number of stages domestically-produced may not generate the same domestic value added along the production chain; that is, the value added implied by a given number of stages at the beginning of the production process may not be the same as the value added implied by the same number of stages at the end of the process. Notwithstanding, when the average upstreamness of imports or the average upstreamness of exports remains relatively constant, a change in the $U^{XM}_{Mex,t}$ always indicate an increase in domestic value added.

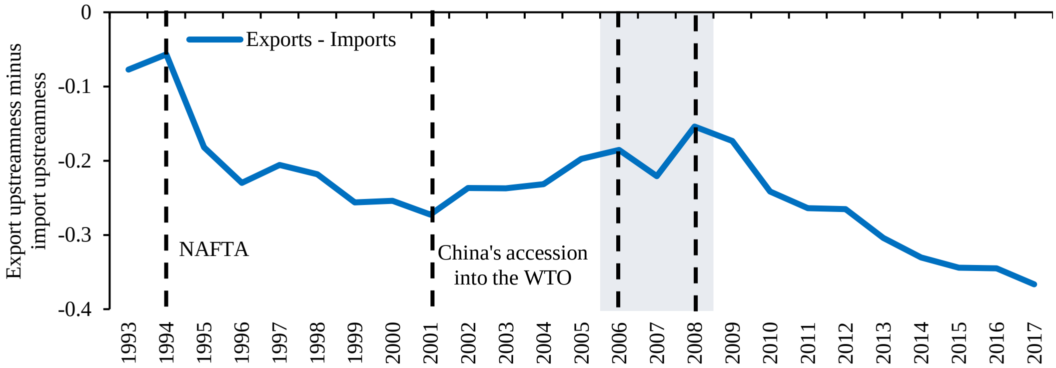
Figure 1. Average Upstreamness of Mexican Manufacturing Exports and Imports



Source: Own calculations with data from Bank of Mexico and National Institute of Statistics and Geography (INEGI). Notes: This figure depicts the average upstreamness levels of Mexican manufacturing exports (solid curve) and imports (dotted curve). These upstreamness levels are computed as weighted averages of industry-level measures of upstreamness using trade flows by industry as weights, as explained in detail in Subsection 4.1. The upstreamness measures for 2017 were computed employing accumulated trade flows from January to July of that year.

The second period clearly identifiable in Figure 2 begins in 2001 and finishes in the mid- to end-2000s. This period is characterized by a fall (in absolute terms) in the difference between the upstreamness of exports and imports ($U^{XM}_{Mex,t}$); i.e., by a reduction in the number of production stages carried out in the country. That is, Mexico's participation in GVCs declined over this period. The fact that this decline coincides with China's accession to the WTO suggests that global competition with this Asian economy may have contributed to reduce the slice of the GVCs produced in Mexico.[11]

Figure 2. Difference between Average Upstreamness of Mexican Manufacturing Exports and Imports



Source: Own calculations with data from Bank of Mexico and National Institute of Statistics and Geography (INEGI). Notes: This figure depicts the difference between the average upstreamness of Mexican manufacturing exports and imports, constructed as explained in detail in Subsection 4.1. The upstreamness measures for 2017 were computed employing accumulated trade flows from January to July of that year.

Finally, the third period goes from the mid- to end-2000s to 2017. During this period, the difference between the average upstreamness of manufacturing exports and imports

[11] This is consistent with Feenstra and Kee (2007) who argue that the implementation of U.S. tariff reductions for goods from China expanded the export variety of this last country, crowding out Mexico's product varieties in the U.S. market.

widens again, indicating a rise in the number of domestically-produced stages. That is, between the mid- to end- 2000s to 2017 Mexico seems to have recovered the ground had lost with China's entry to the WTO.[12] In explaining this recovery at least two facts have been mentioned: (i) the outstanding performance of the automotive and *maquiladora* sectors, whose production processes are prone to fragmentation; and (ii) recent changes in the Chinese fundamentals that may have triggered a resource relocation both in this economy and its direct competitors.

Finally, as noted above, it is worth mentioning that the fact that there have been three clearly identifiable periods regarding Mexico's insertion into GVCs is a result that has also been found by Aguirre, Cardozo and Tobal (forthcoming). When analyzing the Mexican value added embedded in U.S. consumption, they identify the exact same three periods we have presented above.

4.3 Industry Analysis

Consistent with the idea that Mexico has been called to play a predominant role in the new GVC arena, as noted above, this country has exhibited an outstanding trade performance precisely in those sectors in which the production process is particularly prone to be fragmented around the world.[13] Among these sectors, the automotive and *maquiladora* industries stand out.

Regarding the automotive industry, it has gone through a series of structural changes since the mid-1980s that, accompanied by strong regional patterns at operational level, made it a more global integrated industry (Lung, Van Tulder and Carillo, 2004; Dicken, 2005, 2007 and Evenett, Hoekman and Cattaneo, 2009). Within regions, most automotive companies move their assembly plants to locations with relatively low operating costs; i.e. to South U.S. and Mexico in North America, to Spain and Eastern Europe in Europe, and to South East Asia and China in Asia (Sturgeon and Van Biesebroeck, 2009). In this fragmentation process, several automotive firms relocated their assembly plants to

[12] The industry-level measures of upstreamness in manufacturing goes from a minimum value of 1, which corresponds to the *Automobiles and Trucks Manufacturing*, to a maximum value of 3.9, which corresponds to *Commercial and Service Industry Machinery*. Thus, the manufacturing production process is composed of 2.9 stages. As a percentage of this number, Mexico performed the 6.3% (2%) of the manufacturing GVCs in 1995 (1994), while by 2001 it performed the 9.4%. In 2006 (2008), this percentage reduced to 6.4% (5.3%), and it increased again to 12.7% in 2017.

[13] Proximity with the U.S. makes Mexico attractive for foreign firms. For instance, according to the OECD (2017), the average delivery time for products sent from China's east coast to the interior of the U.S. is about 3-4 weeks through its west coast and 4-6 weeks through its east coast. In contrast, for products sent from Mexico is less than 1 week. This advantage is more important in products with high transport costs, e.g. perishable, seasonal or bulky goods.

Mexico not only because of its relative low operating costs but also because of its privileged market access to the U.S. and a relatively high productivity level arising from a long tradition in car production.

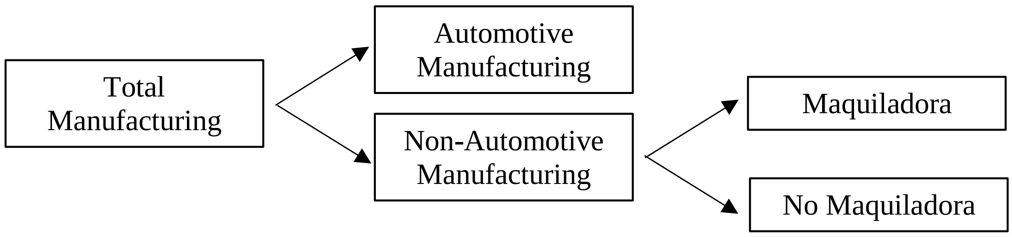
The number of assembly plants operating in Mexico and their production have more than doubled since 1994, going from eight plants producing nearly 1 million vehicles in that year to 22 plants producing over 2.2 million units in 2010 (Contreras, Carrillo and Alonso, 2012). Furthermore, according to the Mexican Association of the Automotive Industry (AMIA), by 2015, Mexico became the seventh largest manufacturer of vehicles in the world and the first of Latin America, and the fourth largest exporter in the world (Cuevas, 2016). These figures suggest that Mexico has been playing a predominant role in the automotive sector, which is particularly prone to industrial fragmentation, and thus representative of the GVC world.

At the same time, several figures make it hard to argue against the importance of GVCs for Mexico. Since its distinctive characteristics place it in a privileged position to integrate into GVCs, meaning that Mexico's integration is likely associated with efficiency gains, it is natural to think that this country's insertion into automotive GVCs contributed to increase its production levels and thus its income. Related to these points, Figure D.1 in Appendix D retrieves data from INEGI and, using these data, calculates the share of the automotive sector in GDP for Mexico. The figure shows that the share has been traditionally high, and that it has been increasing steadily since 2009; i.e., passing from 1.6 to 3.6 in 2017. Moreover, in terms of external balance, the exports of the automotive sector represented 25% of Mexico's total manufacturing exports in 2015, becoming an important sources of international reserves (AMIA and INEGI, 2015).

Beyond the automotive industry, the *maquiladora* sector is particularly representative of global fragmentation and thus of GVCs. Indeed, the term *maquiladoras* refers to firms that import components to assemble or process for subsequent export to the imports origin country. Notably, Mexico has also played a predominant role in the globally integrated *maquiladoras* industry, partially as a result of a long tradition of conducive policy actions. Since Mexico relaxed its restriction on foreign direct investment (FDI) in the 1980s, different government programs have granted fiscal and commercial benefits to *maquiladoras*, promoting the growth of the *maquiladora* sector, as well as its integration with the U.S. manufacturing industry (De La Cruz et al., 2011).[14] At the same time, the *maquiladora* sector has been particularly relevant to understand Mexico's performance to the extent that it has become an important source of employment, exports and international reserves (e.g., see Cañas, 2006).[15]

In summary, given that Mexico has been in a privileged position to integrate into GVCs and that the automotive and *maquiladoras* industries are especially prone to industrial fragmentation, one would think that these industries are important for its contribution to international production networks and for its economic performance.[16] Thus, the present subsection provides a detailed analysis of Mexico's insertion into GVCs for these two industries. This analysis is presented in Figure 3; i.e., we first present the analysis of the automotive sector, followed by the analysis of the *maquiladora* non-automotive sector.

Figure 3. Sector Structure



4.3.1 Automotive Industry

Following Figure 3, we begin with the automotive sector. Thus, we construct the upstreamness measures for Mexican automotive exports and imports (Figure D.2 in Appendix D shows the time-behavior of these measures). These measures are computed as explained in Subsection 4.1, but considering only the upstreamness indexes and the

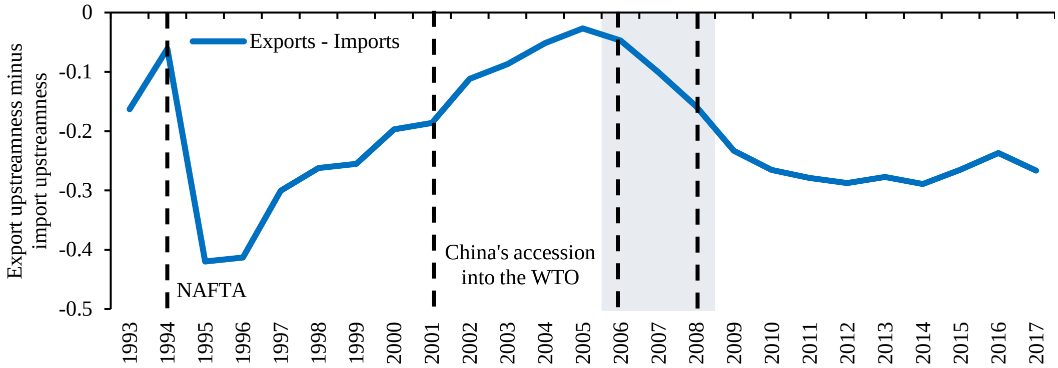
[14] The programs implemented by the U.S. and Mexico fostered the growth of *maquiladoras*. Initially, the U.S. allowed a preferential tariff treatment by which U.S. firms offshoring to Mexico paid duties on foreign value-added only, and the Mexican laws allowed for duty-free imports as long as the *maquiladora* output was exported back to the U.S. (Feenstra, Hanson and Swenson, 2000; De La Cruz, et al., 2011). However, this treatment ended with NAFTA, under which *maquiladoras* using non-NAFTA originating inputs to produce goods to export to the U.S. or Canada would have to pay Mexico's Most Favored Nation (MFN) import duties, while inputs from NAFTA countries would still be duty-free (De La Cruz et al., 2011). Since 2002, with the aim of maintaining competitiveness of the manufacturing sector, the Mexican government established programs that allowed participating companies to import eligible non-NAFTA inputs and capital equipment at rates either zero or 5%, and the *maquiladora* exports were exempted from the Value Added Tax and, upon complying with certain rules, from income and asset taxes (De La Cruz et al. (2011).

[15] For instance, according to Cañas (2006), by 2005 *maquiladora* exports represented nearly 50% of total exports and *maquiladora* employment represented 10% of total formal employment in Mexico.

[16] Given the close definitions of processing and *maquiladora* industries, in this paper we use both industries as analogous. Indeed, *maquiladoras* are foreign-owned, controlled or subcontracted manufacturing plants that process or assemble imported components for export (Cañas, 2006). Processing trade is the business activities in which the operating enterprise imports all or part of the raw or ancillary materials, spare parts, components, and packaging materials, and re-exports finished products after processing or assembling these materials/parts (Manova and Yu, 2016).

trade flows associated with industries conforming the automotive industry.[17] Having built the average upstreamness of exports and imports, we build our estimate of Mexico's insertion into GVCs by taking the difference between them, just as we have done in Subsection 4.2 for the entire manufacturing sector.

Figure 4. Difference between Average Upstreamness of Mexican Automotive Exports and Imports



Source: Own calculations with data from Bank of Mexico and National Institute of Statistics and Geography (INEGI). Notes: This figure depicts the difference between the average upstreamness of Mexican exports and imports in the automotive sector, constructed as explained in detail in Subsection 4.1, but considering only those industry-level measures of upstreamness and trade flows associated with the industries that conform the automotive sector; i.e., *Automobiles and Trucks Manufacturing*, *Motors Vehicles Bodies and Trailers*, and *Motor Vehicle Parts* industries. The upstreamness measures for 2017 were computed using accumulated trade flows from January to July of that year.

Figure 4 presents this difference and two conclusions can be drawn from this graph. First, just as in total manufacturing, the difference between the average upstreamness of exports and imports has been negative over the whole period. That is, automotive exports have been persistently less upstream than automotive imports. Second, three periods can be identified regarding Mexico's insertion into automotive GVCs. During the years immediately following NAFTA, there was an increase in the number of stages domestically-produced, suggesting the trade agreement deepened Mexico's insertion into GVCs. Nonetheless, this number of stages started to fall until the mid-2000s, when the trend reverted: since the mid-2000s Mexico increased its participation in GVCs in the automotive sector. In turn, this is consistent with the idea that, as noted by Solis (2015),

[17] Under the NAICS classification, the *Transportation Equipment* sector comprises the following eight industries: (i) *Automobiles and Trucks Manufacturing*; (ii) *Motor Vehicles Bodies and Trailers*; (iii) *Motor Vehicle Parts*; (iv) *Aerospace Product and Parts*; (v) *Railroad Equipment*; (vi) *Ship and Boat Building*; and (vii) *Other Transportation Equipment*. It is clearly evident that, from all these industries, only (i), (ii) and (ii) conform the Automotive Sector. Thus, we define the Automotive Sector as the sector comprising *Automobiles and Trucks Manufacturing*, *Motors Vehicles Bodies and Trailers*, and *Motor Vehicle Parts* industries.

part of Mexico's recovery in the mid- to end-2000s was at least partially driven by its performance in the automotive sector.[18]

In understanding these changes, note that, as shown in Figure D.2 of Appendix D, the time-variation in the indicator of Figure 4 is largely explained by variations in the upstreamness of imports. In turn, Table C.1 in Appendix C suggests that these changes can be largely explained by the time behavior of finished vehicles and auto parts. Specifically, the table shows that from 1994 to 1995 the share of imports of finished vehicles over total automotive imports decreased and the share of auto parts increased, raising the upstreamness of automotive imports and, thus, reducing the indicator in Figure 4. Similarly, over 1995-2006 the share of imports of finished vehicles increased and the share of auto parts dropped but, since 2006, the share of finished vehicles fell and that of auto parts rose, deepening Mexico's participation in GVCs again.

As for Figure 4, note that China's accession in the WTO does not seem to be particularly relevant for understanding the trade pattern thereby observed. This result most likely reflects that Mexico and China were not direct competitors in the automotive industry.

4.3.2 Non-automotive, Maquiladora Industry

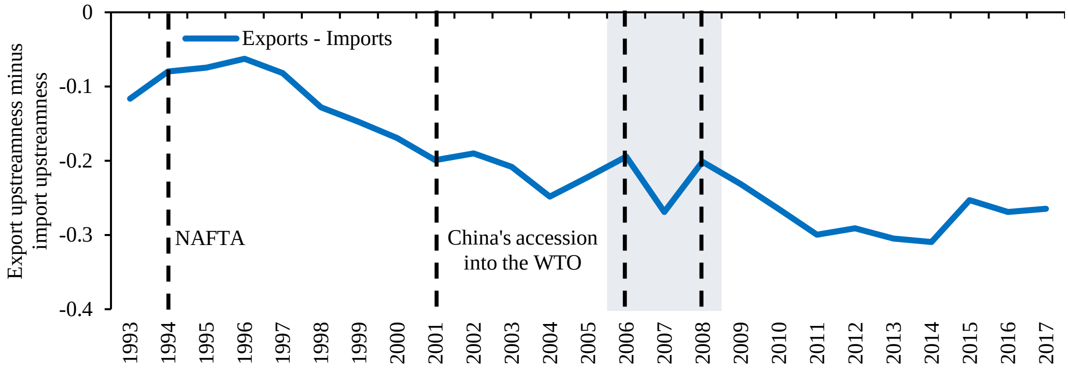
This subsection constructs measures of upstreamness for exports and imports in the non-automotive, *maquiladora* sector. These measures are constructed as weighted averages of industry-level measures of upstreamness by using trade flows by industry as weights, and by considering only the trade flows associated with firms that participated for at least a year in the *Maquiladora* program. Then, to approximate the participation of the Mexican *maquiladora* sector in non-automotive manufacturing GVCs, we compute the difference between the export and the import measures.

Figure 5 shows that, just as in total and automotive manufacturing, this difference takes negative values over the entire period; that is, the *maquiladora* exports were persistently more downstream than the imports. In turn, this is reassuring since it is what we would have expected considering the intrinsic nature of the *maquiladoras* process; i.e., the fact that they are manufacturing plants that process or assemble imported components for subsequent re-export. Importantly, note that the number of stages in non-automotive

[18] The industry-level measures of upstreamness associated with the industries conforming the automotive sector goes from a minimum value of 1, corresponding to *Automobiles and Trucks Manufacturing*, to a maximum value of 2, corresponding to *Motor Vehicle Parts*. Thus, the production process of the automotive sector comprises only 1 stage. As a percentage of this number, Mexico produced the 6.3% of the automotive GVC in 1994, and by 1996 it produced the 42.1%. This proportion decreased to 2.7% (4.8%) in 2005 (2006), and it recovered to 27.2% in 2017.

manufacturing GVCs produced by Mexican *maquiladora* sector increased steadily after NAFTA's implementation. That is, the range of activities in the GVCs performed by Mexican *maquiladoras* shows an increasing trend, with increases in most of the 25 year period following 1994; beyond the fall in the recent period (see Figure D.3 in Appendix D for upstreamness of exports and imports).[19]

Figure 5. Difference between Average Upstreamness of Mexican Non-Automotive Exports and Imports (*Maquiladora* Sector)



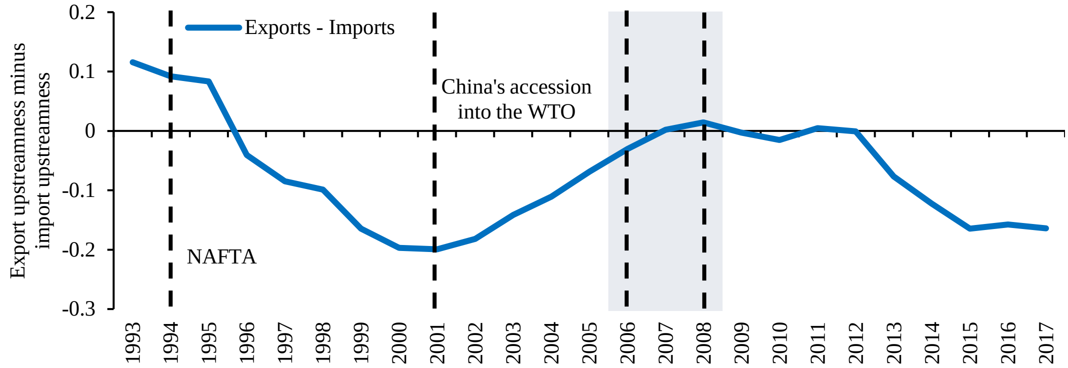
Source: Own calculations with data from Bank of Mexico and National Institute of Statistics and Geography (INEGI). Notes: This figure depicts the difference between the average upstreamness of Mexican exports and imports of the non-automotive, *maquiladora* sector, constructed as explained in detail in Subsection 4.1, but considering only trade flows of firms that participated at least one year between 1993 and 2006 in the *Maquiladora* program and excluding trade flows associated with the industries conforming the automotive sector; i.e., *Automobiles and Trucks Manufacturing, Motors Vehicles Bodies and Trailers*, and *Motor Vehicle Parts* industries.

Figure 6 explores the *non-maquiladora* industry. This figure shows that there are three remarkable periods concerning Mexico's insertion into GVCs. That is, three periods can be distinguished in the dynamics of the number of stages of non-automotive manufacturing GVCs domestically-produced by Mexican *non-maquiladoras*. This number of stages increased after NAFTA, it dropped after 2001, and increased again in the mid- to end-2000s. Among the three sectors we have studied in the present section, this is the first one for which the pattern is similar to the one we have observed for total manufacturing; i.e., in which the three identifiable periods are exactly the same. Furthermore, in line with total manufacturing and contrasting with the *maquiladora* case, the changes in the number of stages produced by *non-maquiladoras* are mainly driven by

[19] The industry-level measures of upstreamness associated with the industries conforming the manufacturing non-automotive sector goes from a minimum value of 1, which corresponds to the *Ship and Boat Manufacturing* industry, to a maximum value of 3.9, which corresponds to the *Commercial and Service Industry Machinery* industry. This implies that the production process of the non-automotive sector is composed of 2.9 stages. As a percentage of this number of stages, the slice of the non-automotive manufacturing GVCs produced by the Mexican *maquiladora* sector increased from 2.8% in 1994 to 9.2% in 2017.

changes in the average upstreamness of exports (see Appendix E for a detailed analysis of the insertion of the non-automotive, *non-maquiladora* sector into the GVCs).[20]

Figure 6. Difference between Average Upstreamness of Mexican Non-Automotive Exports and Imports (*Non-Maquiladora* Sector)



Source: Own calculations with data from Bank of Mexico and National Institute of Statistics and Geography (INEGI). Notes: This figure shows the difference between the average upstreamness of Mexican exports and imports for the non-automotive, *non-maquiladora* sector, constructed as explained in Subsection 4.1, but considering only trade flows of firms that did not participate between 1993 and 2006 in the *Maquiladora* program, and excluding trade flows associated with the industries of the automotive sector; i.e., *Automobiles and Trucks Manufacturing*, *Motors Vehicles Bodies and Trailers*, and *Motor Vehicle Parts*.

5. Human Capital Intensity: Characterizing the Insertion into GVCs

The previous section identified three periods regarding Mexico's insertion into GVCs over 1993-2017. To dig deeper into the reasons, the present section characterizes the insertion process in terms of the average human capital intensity implied by the underlying production process in each period. Among all choices, we opt for human capital intensity because this allows employing traditional models of international trade to associate the results with Mexico's unskilled-labor abundance relative to its trading partners and the rest of the world. Moreover, as it will become clear in the upcoming section, the intuition underlying these models will allow relating changes in Mexico's average position in GVCs to its competition in global markets with China.

5.1 Methodology

To characterize Mexico's insertion into GVCs, we construct measures of average skill-intensity (i.e., human capital intensity) for Mexican manufacturing exports and imports. To this end, we build weighted averages as we have done in Section 4 for the

[20] As noted in footnote 19, our industry-level measures of upstreamness imply that the production process in the manufacturing non-automotive sector comprises 2.9 stages. As a percentage of this number of stages, the slice of the manufacturing non-automotive GVCs performed by the Mexican *non-maquiladora* sector increased from 0% in 1994 (note that non-maquiladora exports were more upstream than imports in this year) to 6.9% in 2001, it reduced to 1.1% (0.5%) in 2006 (2008), and increased again to 5.7% in 2017.

upstreamness measures. In particular, we construct our measures of skill-intensity in two steps. In the first step, we build industry-level indicators of human capital intensity. In the second step, these indicators are combined with data on international trade disaggregated at the industry-level.

In the first step, we follow Nunn and Trefler (2013) and use data for U.S. manufacturing to compute the human capital intensity indicator for industry i (SI_i) as follows: [21]

$$SI_i = ln\left[\frac{npw_i}{tw_i}\right] \tag{5}$$

where npw_i and tw_i are non-production worker wages and total worker wages in industry i, respectively. Note in Equation (5) that SI_i takes values from zero to minus infinity.[22] Note also that the larger the value of SI_i is, i.e., the closer it is to zero, the higher the share of non-production worker wages over total wages is and therefore the more human capital-intensive industry i is.

In understanding the link between SI_i and human capital intensity, consider the industries of *Animal Slaughtering and Processing* and *Semiconductors and Other Electronic Components.* Since the first of these industries produces processed meats and meat byproducts, and thus involves activities not requiring high levels of educational attainment, it should be associated with a high negative value of SI_i. In contrast, *Semiconductors and Other Electronic Components* involves the production of intermediate goods whose manufacturing requires high levels of education, such as microprocessors, electronic connectors and resistors, and should therefore be associated with a smaller negative value of SI_i. Indeed, while *Animal Slaughtering and Processing* receives a value of SI_i equal to -1.48, the value received by *Semiconductors and Other Electronic Components* equals -0.52.

Having constructed the industry-level skill intensity indicators in the first step, in the second step we combine them with trade data to build the above-mentioned weighted averages. In performing this combination we merge the corresponding datasets by using the correspondence table between the TIGIE and the SCIAN classifications constructed

[21] See Section 3 for a description of the data used to construct the skill-intensity measures.
[22] In our sample of 85 U.S. manufacturing industries, SI_i takes a minimum value of -1.9, which corresponds to the *Automobiles and Trucks Manufacturing* industry, and a maximum value of -0.28, which corresponds to the industry of *Computer and Peripheral Equipment*. It is worth noting that, among those industries conforming the automotive sector, *Automobiles and Trucks Manufacturing* is the less skill-intensive one, i.e., it is less skill-intensive than the *Motors Vehicles Bodies and Trailers* and *Motor Vehicle Parts* industries (see the discussion at the end of this subsection).

in Section 3.[23] The weighted averages for exports and for imports are then constructed in the following manner:

$$SI_{Mex,t}^{X} = \sum_{i=1}^{N}\left(\frac{X_{Mex,i,t}}{X_{Mex,t}}\right)SI_i \;;\quad SI_{Mex,t}^{M} = \sum_{i=1}^{N}\left(\frac{M_{Mex,i,t}}{M_{Mex,t}}\right)SI_i \qquad (6)$$

where $SI_{Mex,t}^{X}$ and $SI_{Mex,t}^{M}$ are the average skill intensity embedded in Mexican manufacturing exports and imports in year t, respectively; $\frac{X_{Mex,i,t}}{X_{Mex,t}}$ and $\frac{M_{Mex,i,t}}{M_{Mex,t}}$ are the shares of industry i's exports and imports over total manufacturing exports and imports in year t, respectively. Note in (6) that $SI_{Mex,t}^{X}$ and $SI_{Mex,t}^{M}$ are weighted averages of the skill-intensity measures in which the relative weights are the export and import shares of the corresponding industries.

Using these measures, we take the same strategy as for the upstreamness measures. Specifically, we take the difference between the average skill-intensity in exports and imports and, in this manner, obtain an indicator of the average skill-intensity in the production process underlying Mexican trade flows. This indicator is written as follows:

$$SI_{Mex,t}^{XM} = SI_{Mex,t}^{X} - SI_{Mex,t}^{M} = \sum_{i=1}^{N}\left(\frac{X_{Mex,i,t}}{X_{Mex,t}} - \frac{M_{Mex,i,t}}{M_{Mex,t}}\right)SI_i \qquad (7)$$

where $SI_{Mex,t}^{XM}$ is the measure of skill-intensity. By indicating on the human capital intensity underlying production, $SI_{Mex,t}^{XM}$ informs on the type of goods in which the Mexican economy specializes. For instance, negative values of $SI_{Mex,t}^{XM}$ indicate that exports are less human capital intensive than imports, suggesting specialization in goods that are relatively unskilled-intensive.

Furthermore, since the industry level measures are invariant over time, time-variation in $SI_{Mex,t}^{XM}$ can only stem from changes in the composition of exports and imports. To better understand this point, it is useful to express Equation (7) in terms of its changes over time as follows:

$$\Delta SI_{Mex,t}^{XM} = \left(\sum_{i=1}^{N}\Delta\frac{X_{Mex,i,t}}{X_{Mex,t}} - \sum_{i=1}^{N}\Delta\frac{M_{Mex,i,t}}{M_{Mex,t}}\right)SI_i = \sum_{i=1}^{N}\Delta\left(\frac{X_{Mex,i,t}}{X_{Mex,t}} - \frac{M_{Mex,i,t}}{M_{Mex,t}}\right)SI_i \qquad (7')$$

[23] A similar procedure is followed by Yeaple (2003, 2006) to proxy skill and headquarter intensity. Yeaple (2003) uses the share of nonproduction workers in value added by industry (Midelfart-Knarvik, Overman and Venables, 2000) to construct a weighted average of the skill intensities at all U.S. multinational affiliates by industry. Yeaple (2006) uses the share of workers by industry that have at least a high-school education.

where Δ refers to change between t and $t-1$. Note that, since $\Delta\frac{X_{Mex,i,t}}{X_{Mex,t}}$ and $\Delta\frac{M_{Mex,i,t}}{M_{Mex,t}}$ are changes in shares, these changes must sum to zero over all industries ($\sum_{i=1}^{N}\Delta\frac{X_{Mex,i,t}}{X_{Mex,t}}=0$ and $\sum_{i=1}^{N}\Delta\frac{M_{Mex,i,t}}{M_{Mex,t}}=0$); thus, the term between brackets in the right hand-side of (7'), i.e., the sum of these changes must also be zero; i.e., $\sum_{i=1}^{N}\Delta(\frac{X_{Mex,i,t}}{X_{Mex,t}}-\frac{M_{Mex,i,t}}{M_{Mex,t}})=0$. The implication is that, when interpreting $\Delta SI_{Mex,t}^{XM}$, one should consider that they reflect variations in the production patterns underlying Mexican trade flows, and that industries for which $\Delta\left(\frac{X_{Mex,i,t}}{X_{Mex,t}}-\frac{M_{Mex,i,t}}{M_{Mex,t}}\right)$ is positive are those where domestic production is growing over domestic consumption, while industries for which $\Delta\left(\frac{X_{Mex,i,t}}{X_{Mex,t}}-\frac{M_{Mex,i,t}}{M_{Mex,t}}\right)$ is negative are those where domestic production is growing under domestic consumption. In this sense, one can argue that time-variation in $SI_{Mex,t}^{XM}$ reflects changes how Mexico allocates resources in the production of skilled-intensive and unskilled-intensive goods.

Since understanding the sources of time-variation in $SI_{Mex,t}^{XM}$ will be important for understanding the analysis in this section, we further illustrate the link between $\Delta SI_{Mex,t}^{XM}$ and resource relocation by referring to the automotive sector; in particular, the industries labeled *Automobiles and Trucks Manufacturing* and *Motor Vehicle Parts*. The industry *Automobiles and Trucks Manufacturing* comprises establishments primarily engaged in assembling complete motor vehicles and thus not require high levels of education. In contrast, *Motor Vehicle Parts* produces parts for motor vehicles whose manufacturing requires relatively higher levels of educational attainment; e.g., motor vehicle gasoline engines, engine parts, electrical and electronic equipment, brake systems, seats, seat belts and interior trimmings, and is thus relatively more skilled-intensive than *Automobiles and Trucks Manufacturing*. Indeed, while *Automobiles and Trucks Manufacturing* receives a value of SI_i equal to -1.90, *Motor Vehicle Parts* receives a value of -1.26.

Having these two industries in mind, let us consider a case in which, everything else equal, domestic resources shift from motor vehicle parts to finished motor vehicles. In terms of $\Delta SI_{Mex,t}^{XM}$, this resource relocation should generate the following changes: (i) due to the fall in the production of *Motor Vehicle Parts*, its share in total exports should fall relative to its share in total imports (i.e., $\frac{X_{Mex,i,t}}{X_{Mex,t}}-\frac{M_{Mex,i,t}}{M_{Mex,t}}$ decreases); and (ii) due to its increased production, the share of *Automobiles and Trucks* in total exports should increase relative to its share in total imports. Hence, as a result of these changes, the value of SI_i for *Automobiles and Trucks Manufacturing* will receive a higher relative weight in Equation (7) and the value of *Motor Vehicle Parts* will receive a smaller weight. Thus, since the former industry is less skill intensive than the latter, the value of $SI^{XM}_{Mex,t}$ will decrease, reflecting a resource relocation towards a less skilled-intensive industry.

5.2 Specialization of the Mexican Economy

This subsection characterizes Mexico's insertion into GVCs in terms of human capital use, using the methodology described in 5.1. For this purpose, Figure 7 shows the average skill-intensity of Mexican manufacturing exports and imports with green solid and green dotted curves, respectively. The difference between these curves ($SI^{XM}_{Mex,t}$) is depicted in Figure 8 and, as noted above, informs on the specialization of the Mexican economy.

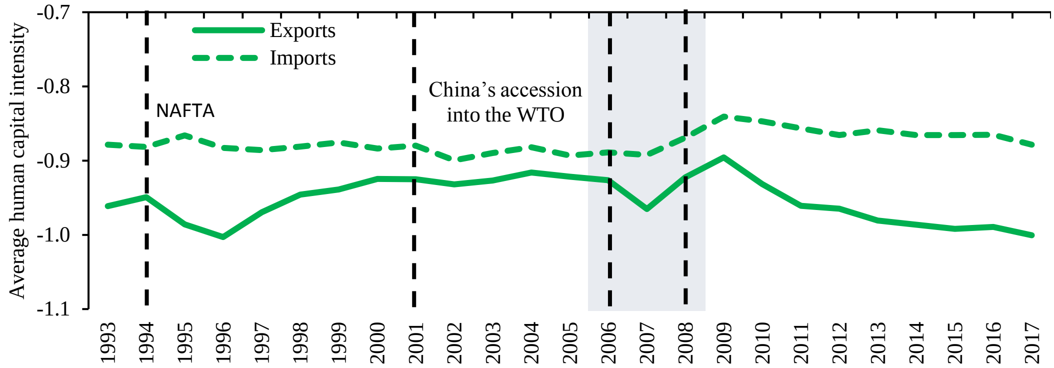
Two conclusions arise from Figures 7 and 8. First, Mexican manufacturing exports were persistently less human capital intensive than Mexican manufacturing imports; i.e., $SI^{XM}_{Mex,t}$ was negative over the whole period. This suggests that Mexico specialized in industries that are relatively less intensive in their use of human capital. Second, whereas the average human capital intensity of imports remained relatively constant over the entire period, the average human capital intensity of exports showed significant variation. This implies that the changes in specialization observed in Figure 8 are mainly explained by changes in the skill-intensity of exports.

Moreover, Figure 8 shows that three periods can be distinguished regarding Mexico's specialization (approximated by $SI^{XM}_{Mex,t}$): (i) a period beginning immediately after NAFTA; (ii) a period beginning in 2001, with China's accession to the WTO; and (iii) a period beginning in the mid- to end-2000s. Indeed, these are the exact same three periods we have identified when performing the upstreamness analysis. Interestingly, this implies that each of these periods can be characterized over the two dimensions; i.e., according to whether the country's insertion into GVCs increased or decreased and to whether the skill-intensity of the production patterns underlying its trade flows increased or decreased.

As for the first period, beginning after NAFTA and ending in 2001, the difference between the average skill intensity of Mexican manufacturing exports and imports decreased (in absolute terms). This suggests that NAFTA increased the number of stages of the GVCs produced in Mexico, raising its contribution to GVCs as argued in Section

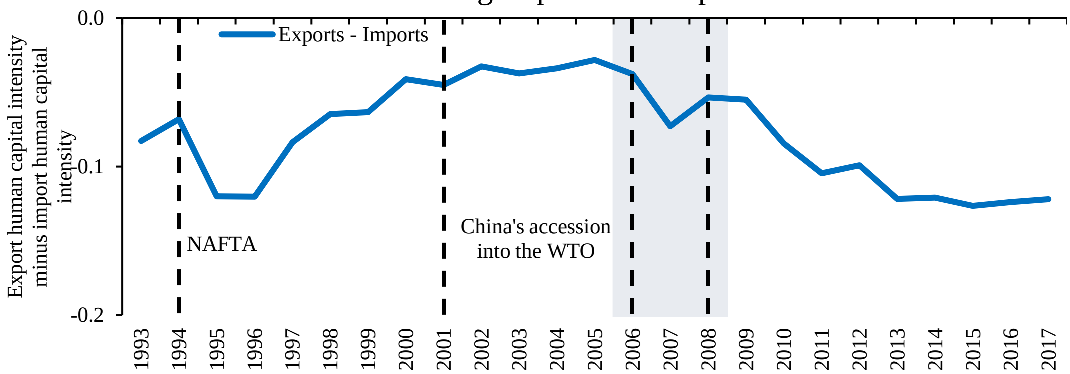
4, but also shifted resources in Mexico towards the production of relatively more skilled-intensive industries. Thus, for instance, during this period we observe increases in the trade balance of relatively skilled-intensive industries whose output is, at the same time, relatively close to final use; e.g., *Pharmaceutical Products* and *Beverages* industries (for a detailed industry-level analysis, see the upcoming subsection). Moreover, changes in this first period mainly stemmed from increases in the skill-intensity of exports, and to a smaller extent from changes in the skill-intensity of imports.

Figure 7. Average Human Capital Intensity of Mexican Manufacturing Exports and Imports



Source: Own calculations with data from Bank of Mexico and Nunn and Trefler (2013).
Notes: This figure depicts the average skill-intensity of Mexican manufacturing exports (solid curve) and imports (dotted curve). These skill-intensity measures are computed as weighted averages of industry-level measures of skill-intensity using trade flows by industry as weights, as explained in detail in Subsection 5.1. The skill intensity measures for 2017 were computed employing accumulated trade flows from January to July of that year.

Figure 8. Difference between Average Human Capital Intensity of Mexican Manufacturing Exports and Imports



Source: Own calculations with data from Bank of Mexico and Nunn and Trefler (2013).
Notes: This figure depicts the difference between the skill-intensity of Mexican manufacturing exports and imports, constructed as explained in detail in Subsection 5.1. The skill-intensity measures for 2017 were computed employing accumulated trade flows from January to July of that year.

Regarding the second period identified in Figure 8, which runs from China's accession into the WTO to the mid-/end-2000s, the difference between the average skill-intensity of exports and imports remained relatively constant. In turn, this suggests that the reduction in the number of stages of the GVCs that were domestically-produced, i.e., the smaller contribution to GVCs, was not associated with resource relocations between skilled-intensive and unskilled-intensive goods.

Finally, during the third period identified in Figure 8, which begins in the mid- to end-2000s, the difference between the skill-intensity of exports and imports increases in absolute terms. This suggests that the rise in the number of stages of the GVCs produced in Mexico was accompanied by a structural change in the specialization of the economy towards relatively less human capital intensive industries. Indeed, it is observed an increase in the trade balance of unskilled-intensive industries whose output is, at the same time, close to final use; e.g., *Animal Slaughtering and Processing* and *Automobiles and Trucks Manufacturing*. In the upcoming section, we suggest that a potential explanation for this result is the response of Mexico to global competition with China.

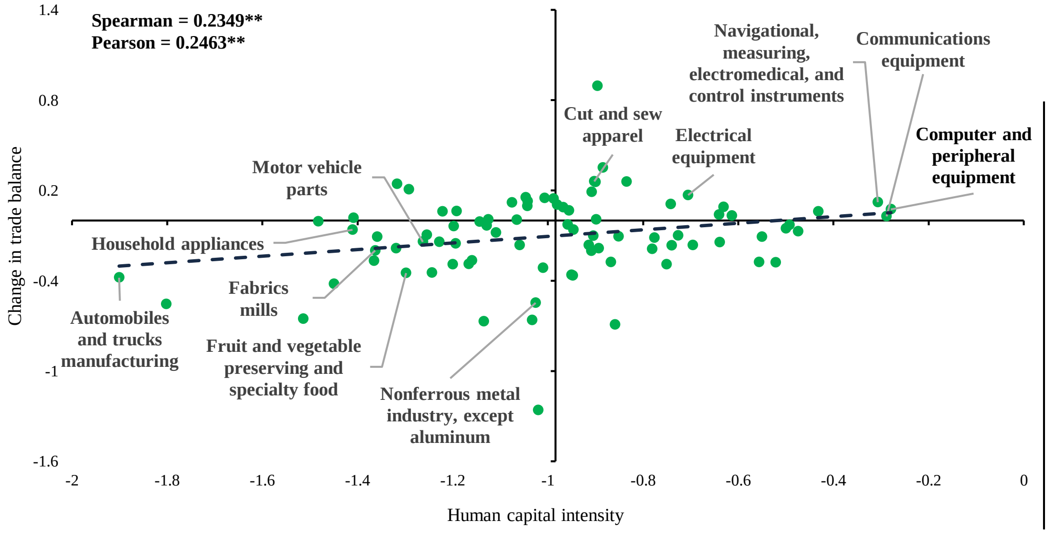
5.2.1 Human Capital Intensity and Trade Balance at Industry-Level

This sub-subsection explores correlations between the average human capital intensity in production and changes in trade balance at the level of industries by using the Pearson and the Spearman coefficients. The aim is to identify the industries that more strongly explain the changes in specialization associated with the two periods of Mexico's insertion into GVCs. To perform this exercise, we use the same industry-level indicators of skill-intensity constructed in Subsection 5.1 and match them with data on international trade by using the correspondence tables between the TIGIE and the SCIAN classifications constructed in Section 3.

Figure 9 shows the correlation between skill-intensity and the change in the trade balance over 1995-2001 at the industry-level; i.e., over the period beginning immediately after NAFTA and ending in 2001. The figure shows that there was a positive and statistically significant correlation between the changes in the trade balance of manufacturing industries and their human capital intensity. That is, those industries that increased their trade balance were on average those with greater human capital intensity. For instance, *Computer and Peripheral Equipment*, *Communications Equipment*, *Navigational, Measuring, Electromedical and Control Instruments*, *Electrical Equipment* and *Cut and Sew Apparel*, which are relatively high skill-intensive industries, all increased its trade balance.

In contrast, *Automobiles and Trucks Manufacturing*, *Household Appliances*, *Nonferrous Metal Industry, except Aluminum*, *Fruit and Vegetable Preserving and Specialty Food* and *Fabric Mills*, which are industries relatively low human capital-intensive, experienced a reduction in their trade balance. Thus, for instance, resources relocated from the smelting of ores (such as copper ore) into non-ferrous metals (such as copper) and their refining (i.e. away from the *Nonferrous Metal Industry, except Aluminum*). Similarly, there seems to have been relocations from the production of fabrics made of yarn (*Fabric Mills*) to the production of electric motors and electric powers generators (*Electrical Equipment*). That is, over the first period identified in Figure 8 resources seem to have relocated from low- to high skill-intensive industries.

Figure 9. Human Capital Intensity and Change in the Trade Balance over 1995-2001

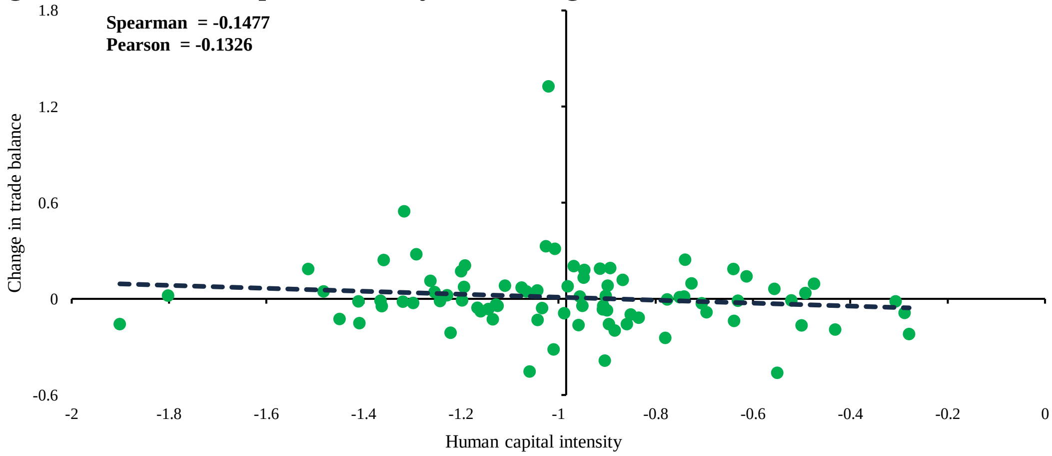


Source: Own calculations with data from Bank of Mexico and Nunn and Trefler (2013).
Notes: The trade balance of each industry was divided by its total trade (i.e., the sum of its exports and its imports). Trade balances for 2017 reflect accumulated trade flows from January to July of that year. Human capital intensity is computed as the ratio between non-production workers wages and total worker wages, as explained in Subsection 5.1. ***, **, * denote significance at 1%, 5% and 10% levels, respectively.

Figure 10 shows the correlation between human capital intensity and the change in the trade balance over 2001-2006; i.e., over the period starting with China's entrance into the WTO and ending in mid-2000s. This figure shows that, during this period, the relationship between the changes in the trade balance and skill-intensity is not statistically significant. This suggests that, as argued above, there was not a relocation of resources across high and low human capital-intensive industries; that is, the specialization pattern seems have not changed significantly after China's accession into the WTO.

Finally, Figure 11 presents the correlation between the level of skill-intensity and the changes in trade balance during 2006-2017; i.e., since mid-2000s. This figure highlights two main points. First, the trade balance of *Automobiles and Trucks Manufacturing*, which as noted above is a relatively unskilled-intensive industry, substantially increased. More generally, the figure shows that the correlation between changes in trade balance and skill-intensity at the industry-level was significant and negative. Thus, for example, *Automobiles and Trucks Manufacturing*, *Household Appliances*, *Nonferrous Metal Industry, except Aluminum*, *Fruit and Vegetable Preserving and Specialty Food* and *Fabric Mills*, which are relatively low human capital intensive industries, increased in their trade balance. Interestingly, these industries are precisely the same as those that reduced their trade balance during the first period regarding Mexico's integration into the GVCs; i.e., the period beginning immediately after NAFTA (see Figure 9).

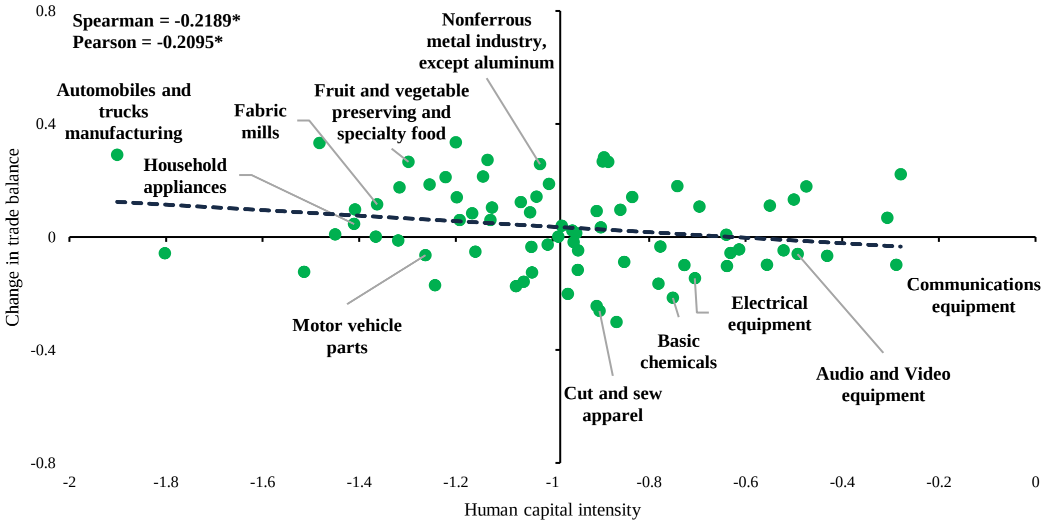
Figure 10. Human Capital Intensity and Change in the Trade Balance over 2001-2006



Source: Own calculations with data from Bank of Mexico and Nunn and Trefler (2013).
Notes: The trade balance of each industry was divided by its total trade (i.e., the sum of its exports and its imports). Trade balances for 2017 reflect accumulated trade flows from January to July of that year. Human capital intensity is computed as the ratio between non-production workers wages and total worker wages, as explained in Subsection 5.1. ***, **, * denote significance at 1%, 5% and 10% levels, respectively.

In contrast to the industries whose trade balance increased, *Communications Equipment*, *Audio and Video Equipment*, *Electrical Equipment*, *Basic Chemicals* and *Cut and Sew Apparel*, which are relatively high human capital-intensive industries, show a reduction in their trade balance over 2006-2017. It is worth noting that many of these industries are precisely those that increased their trade balance in the period beginning immediately after NAFTA (see Figure 9). This suggests that the skill change in Mexican production that started after NAFTA seems to have started to reverse in recent years.

Figure 11. Human Capital Intensity and Change in the Trade Balance over 2006-2017



Source: Own calculations with data from Bank of Mexico and Nunn and Trefler (2013).
Notes: The trade balance of each industry was divided by its total trade (i.e., the sum of its exports and its imports). Trade balances for 2017 reflect accumulated trade flows from January to July of that year. Human capital intensity is computed as the ratio between non-production workers wages and total worker wages, as explained in Subsection 5.1. The sample was truncated at the 5th and 95th percentiles. ***, **, * denote significance at 1%, 5% and 10% levels.

To further investigate this hypothesis, Table 1 focuses on the six industries that contributed the most to changes in the difference between the skill-intensity of exports and imports over 1995-2001. Thus, in this table, the first and second columns show the contribution of each of these industries to the change in $SI_{Mex,t}^{XM}$ during 1995-2001 and 2006-2017, respectively. For each industry, this contribution equals the difference between the change in its export and its imports shares multiplied by its skill intensity level; i.e., $\left(\Delta\frac{X_{Mex,i,t}}{X_{Mex,t}} - \Delta\frac{M_{Mex,i,t}}{M_{Mex,t}}\right)SI_i$. Note that, given that our measure of skill-intensity takes only negative values, a positive value in this contribution indicate that the export share of the industry decreased relative to its import share, suggesting that resources are relocating from that industry to other industries. By the same token, a negative contribution suggests that resources are relocating towards that industry. Finally, the fourth column classifies the industry into high or low human capital-intensive, depending on whether its value of the skill-intensity measure lies above or below the mean.

In Table 1 the contribution of relatively low human capital intensive industries was positive over 1995-2001 and negative over 2006-2017; i.e., the contribution of *Automobiles and Trucks Manufacturing* and *Iron and Basic Steel Industry*. This suggests that resources relocated away from these industries over the period immediately after NAFTA, and that resources have relocated towards them since the mid-2000s. Further, the inverse pattern is observed for relatively high human capital-intensive industries, such as *Electrical Equipment* and *Cut and Sew Apparel*. That is, the contribution of these industries was negative during 1995-2001 and positive during 2006-2017.

Table 1. Top Six Industries that Contributed Most to the Change in the Difference between the Average Human Capital Intensity of Export and Imports over 1995-2001

Industry	Contribution to change in $SI_{Mex,t}^{XM}$ over 1995-2001	Contribution to change in $SI_{Mex,t}^{XM}$ over 2006-2017	Human capital intensity
Automobiles and trucks manufacturing	0.044	-0.135	Low
Iron and steel basic industry	0.034	-0.001	Low
Electronic components	0.020	-0.004	High
Computer and peripheral equipment	-0.010	-0.005	High
Electrical equipment	-0.011	0.007	High
Cut and sew apparel	-0.022	0.015	High

Source: Own calculation with data from Bank of Mexico and Nunn and Trefler (2013).
Notes: For each industry, the contribution to the change in $SI_{Mex,t}^{XM}$ is the difference between the change in its export share over the respective period and the change in its import share over the same period multiplied by its level of human capital intensity. Industries were classified according to its capital intensity level computed on the basis of Nunn and Trefler (2013). Industries with a human capital intensity above sample mean were classified as high human capital-intensive and industries with a human capital intensity below mean were classified as low human capital-intensive.

5.3 External Validity to the Skill Intensity Result

This subsection provides external validity by showing that the result that the two periods of Mexican insertion into GVCs were characterized by production processes of different skill-intensity can be found with different data and methodology. In particular, it explores the same question as Subsections 5.2 by using the WIOD methodology employed by Aguirre, Cardozo and Tobal (forthcoming) and additional data from the OECD ICIO tables. Different methodologies and data suggests that the results are robust.

5.3.1 GVCs Linked to U.S. manufacturing consumption

As noted in Section 2, the upstreamness results of Section 4 are consistent with Aguirre, Cardozo and Tobal (forthcoming). Taking this into account, we investigate whether Mexico integrated in GVCs relative more through skilled-intensive output than through unskilled-intensive output in the period following NAFTA than in the more recent period of integration into GVCs. Specifically, using Aguirre, Cardozo and Tobal's methodology (forthcoming) and the WIOD we compute the Mexican value added embedded in U.S. manufacturing consumption differentiating between high human capital-intensive industries and low human capital-intensive industries over 1995-2014; there are no available data before 1995 and after 2014 and thus we are unable to calculate the value added for the whole period under study.[24]

The Mexican value added in high-skilled and low-skilled industries are computed following three steps: (i) employing the methodology of Aguirre, Cardozo and Tobal (forthcoming) and the WIOD, we calculate the Mexican value added embedded in U.S. manufacturing consumption at the industry-level; (ii) having computed this value added, we classify the industries comprised in this database into high human capital-intensive and low human capital-intensive ones based on our measure of human capital-intensity constructed with Nunn and Trefler's data (2013) (see Subsection 3.2 for the classification of the industries); and (iii) we sum the value added in industries classified as low human capital-intensive and the value added in industries classified as high human capital-intensive. Then we compute the change over time in the ratio between them as follows

$$\Delta Z = \frac{VAD_t^{Mex,LS}}{VAD_t^{Mex,HS}} - \frac{VAD_{t-n}^{Mex,LS}}{VAD_{t-n}^{Mex,HS}} \qquad (8)$$

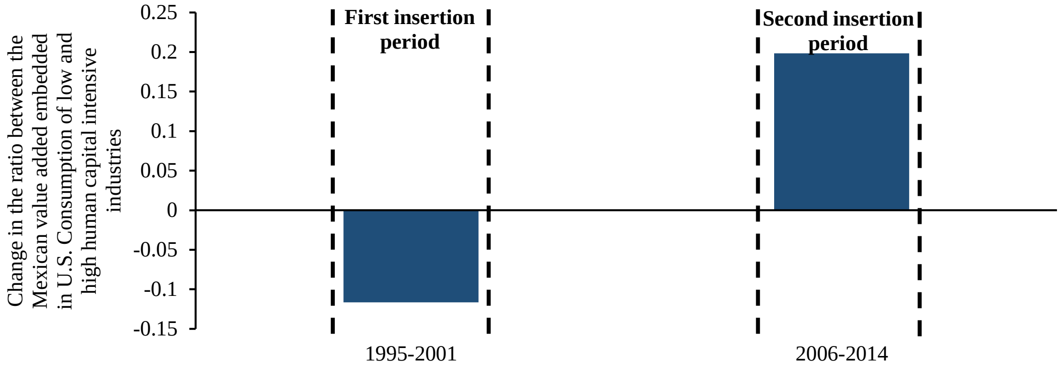
where $VAD_t^{Mex,LS}$ and $VAD_t^{Mex,HS}$ denote the Mexican value added embedded in U.S. manufacturing consumption in low-skilled and high-skilled industries at year t; and ΔZ is the change in the $VAD_t^{Mex,LS}$ to $VAD_t^{Mex,HS}$ ratio between year t and $t-n$. Intuitively, positive values of ΔZ indicate that the value added generated in low human capital-intensive industries increases relative to the value added generated in high human capital-intensive industries.

The expression in Equation (8) is computed for the two insertion processes of Mexico into GVCs; i.e., for 1995-2001 and for 2006-2014, and the results are presented in Figure 12. This figure shows that the Mexican value added embedded in U.S. manufacturing consumption in high human capital-intensive industries increased relative to the Mexican value added embedded in low human capital-intensive ones from 1995 to 2001, while the opposite pattern is observed for 2006-2014. Consistent with Section 5.2, this suggests that the two periods in which Mexico increased its contribution to the GVCs have different characteristics in terms of their use human capital; that is, the increase in the contribution after NAFTA was accompanied by an increase in the intensity in the use of human capital,

[24] There are two versions of the WIOD. The first one provides data of linkages between 41 countries and 35 economic sectors over 1995-2011. The second one provides productive linkages between 44 countries and 56 economic sectors during 2000-2014. We employ the first one to calculate the Mexican value added embedded in U.S. manufacturing consumption at the industry-level over 1995-2006, and the second one to compute this value added over 2006-2014.

while the increase in the contribution since mid-2000s have been accompanied by a decrease in this intensity.

Figure 12. Change in the Mexican Value Added Embedded in U.S. Manufacturing Consumption of Low Human Capital-Intensive Relative to High Human Capital-Intensive Industries



Source: Own calculations with data from World Input-Output database (WIOD) and Nunn and Trefler (2013).
Notes: This figure shows the change in the ratio between the Mexican value added embedded in U.S. manufacturing consumption in low human capital intensive-industries and that embedded in high human capital-intensive industries.

5.3.2 Value Added Embedded in Gross Exports

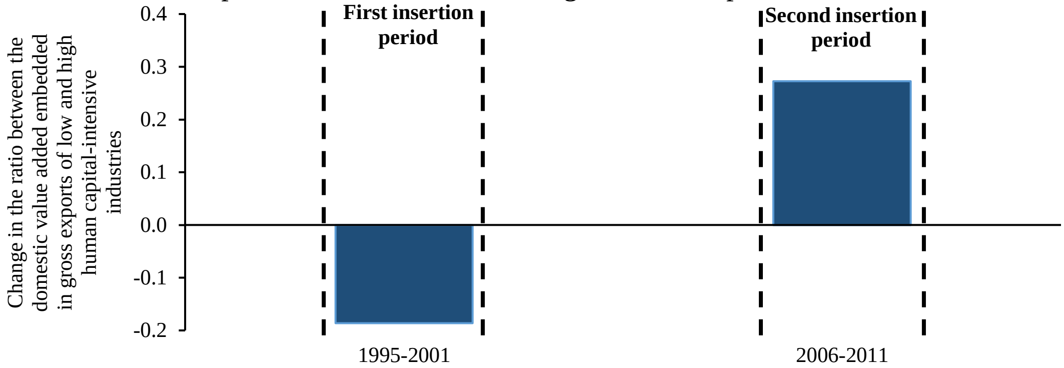
In the second additional exercise, we retrieve estimations of the domestic value added embedded in Mexican gross exports at the industry-level for 1995-2011 from the TiVA database.[25] These estimations are based on the OECD ICIO tables but no information is available for previous and later years. Similarly to the exercise performed in the previous sub-subsection, we classify the industries included in this database into high human capital-intensive and low human capital-intensive, according to our industry-level measure of human capital intensity constructed on the basis of Nunn and Trefler (2013). Having classified the industries, we sum the domestic value added of industries classified as high-skilled and the value added of industries classified as low-skilled, and compute the change over time in the ratio between them as expressed in Equation (8).

Results are presented in Figure 13. This figure shows that while the domestic value added embedded in gross exports of high human capital-intensive industries increased relative to the value embedded in gross exports of low human capital-intensive industries from 1995 to 2001, the opposite is observed over 2006-2011. Consistent with Subsection 5.2 and the previous sub-subsection, this suggests that there was in Mexico a relocation towards industries relatively more human capital-intensive in the years following

[25] There are no available estimations of the domestic value added embedded in Mexican gross exports for the years preceding 1995 and the years after 2011.

NAFTA, and that since mid-/end-2000s the domestic economy has reallocated resources towards less human capital-intensive industries.

Figure 13. Change in the Domestic the Value Added Embedded in Mexican Gross Exports of Low Human Capital-Intensive Relative to High Human Capital-Intensive Industries



Source: Own calculations with data from Organization for Economic Cooperation and Development (OECD) Trade in Value Added (TiVA) database.
Notes: This figure depicts the change in the ratio between the domestic value added embedded in gross exports of low human capital intensive-industries and that embedded in gross exports of high human capital-intensive industries.

6. Global Competition with China

Mexico and China exhibit similarities. Both economies went through deep trade liberalization over the past decades and, at the time their trade liberalized, they could both be understood as relative unskilled labor abundant countries, suggesting possibly that they were competitors in global markets. Consistent with this idea, for instance, Blecker (2014) and Chiquiar, Fragoso and Ramos-Francia (2008) argue that China's entry into the WTO enabled this country to gain market share in the U.S. at the expense of some of the share obtained by Mexico after NAFTA was signed. Along the same lines, Chiquiar, Covarrubias and Salcedo (2017) exploit regional variation in Mexican labor market outcomes to provide evidence supporting this fact.[26]

Figures D.4 and D.5 in Appendix D provide evidence consistent with this fact. Retrieving data from UN Comtrade database and the U.S. Census Bureau, Figure D.4 calculates the share of U.S. manufacturing imports from Mexico and China in total U.S. manufacturing imports for 1993-2017, and Figure D.5 calculates changes in these shares. While both figures yield the same message, we concentrate on Figure D.5 since it is

[26] According to Chiquiar, Covarrubias and Salcedo (2017), China's entry into the WTO increased its exports to the U.S. market which, by substituting Mexican products, reduced Mexico's share in this market and, through this channel, negatively affected the Mexican labor market. Consistent with this idea, their results show that the increase in U.S. imports from China increased total unemployment and reduced manufacturing employment in Mexico. In this sense, Chiquiar, Covarrubias and Salcedo (2017) provide evidence supporting the idea that China´s entry into the WTO enabled this country to gain market share in the U.S. at the expense of Mexico.

visually clearer. This figure identifies the exact same three periods identified in the analyses undertaken in Subsections 4.2 and 5.2. During 1995-2001, both Mexico and China increased its share, on average, by 0.68 percentage points (pp) and 0.50 pp, respectively. Notwithstanding, from 2001 to 2006, Mexico's participation fell while the increase in Chinese share accelerated. Finally, since 2006, the share of Mexican imports has been rising again coinciding with a slowdown in the increase in China's share. That is, while the fall in Mexico's share coincides with China's accession to the WTO, its recent recovery has been accompanied by a slowdown in the increase in the share of China. This suggests that Chinese competition shaped Mexico's insertion into GVCs.

Related to this point, some analysts have emphasized that the recent recovery in Mexican participation has been linked to changes in the fundamentals of the Chinese economy and, in particular, to the increase in its labor costs (see IMF, 2012 and 2015). According to these analysts, the recent increase in the labor costs in China reduced its competitiveness relative to Mexico in manufacturing, particularly in those sectors that are relatively more labor-intensive. This allowed Mexico to recover some of the share in the U.S. market it had lost with China in these sectors, increasing its total share in this market.

To dig deeper into this hypothesis, Figure D.6 in Appendix D shows the manufacturing unit labor costs in Mexico and the total unit labor costs in China. This figure shows that both countries had similar unit labor costs over 1993-mid-2000s, consistent with the idea that they could have specialized in similar industry types as China entered the WTO. However, note that since the mid-2000s labor costs have been increasing in China but not in Mexico. Thus, even though China and Mexico could have initially specialized in similar industry types, the competition between these two countries may have attenuated over the past years, coinciding with the recent recovery in Mexican exports. That is, the evidence on unit labor costs also suggests that Mexico's insertion process into GVCs has been shaped by competition with China.

Thus, given that Mexico and China were likely competitors in global markets, the present section compares the Mexican and Chinese experiences regarding their insertion into GVCs. Moreover, in light of the potential of global competition with China in explaining the Mexican process of insertion into GVCs, this section employs the methodologies presented in Subsections 4.1 and 5.1 to dig deeper into this last hypothesis.

6.1 Analysis of the Chinese Position in the GVCs Compared to Mexico's Position

In comparing Mexico with China, we begin by using the upstreamness measures. For China, the measures refer to 1993-2011 and are taken from Chor, Manova and Yu (2014); for Mexico, we use the measures presented in Subsection 4.2. In this regard, it is worth mentioning that, given that the aggregation level of the IO tables used by Chor, Manova and Yu (2014) is different from the aggregation level of the Mexican IO tables, the ensuing measures are not directly comparable and, therefore, we adjust the Mexican values to increase comparability with China.[27]

Figure 14 shows the average upstreamness of exports and imports. In this figure, the solid and dotted curves show the upstreamness of exports and imports; while the green and red colors indicate "Mexico" and "China," respectively. The measures for China refer to the total economy, not only manufacturing, since these are the results available in Chor, Manova and Yu (2014). Figure 15 shows the difference between the upstreamness of exports and imports for each country which, as argued above, provides an estimate of the number of production stages that are domestically performed.

Three conclusions emerge from Figures 14 and 15. First, total exports in China were persistently less upstream than total imports, suggesting that the Chinese economy imported goods that were processed and then re-exported. Second, the difference between the upstreamness of its exports and imports widened steadily, continuously and almost uninterruptedly (in absolute terms) over the whole sample period; that is, from 1993 to 2011. Interestingly, this suggests that, in contrast with the Mexican case, the number of stages produced in China increased with no interruption. That is, China's insertion into GVCs is characterized by an increase in insertion for a period of almost 20 years.[28]

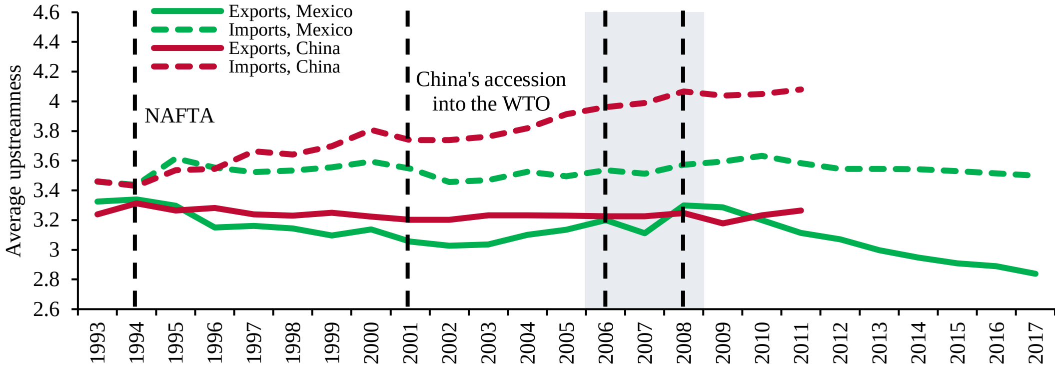
Third, while changes in GVC insertion mainly stem from changes in the upstreamness of exports in Mexico, the steady increase in the number of stages produced in China is mainly explained by a rise in the upstreamness of imports. The fact that the upstreamness

[27] Of course, the associated industry classifications, i.e., and *not just* the aggregation levels, are different. Nonetheless, in adjusting the Mexican measures we used the fact that the English names of two industries were particularly similar: the *Nonferrous Metal Industry, except Aluminum* for the Mexican case and the *Nonferrous Metal Mining Industry* for the Chinese case. Taking this into account, we multiplied the Mexican measures by an expansion factor. This factor was proportionally increased as we went from the least to the most upstream industries, as follows: (i) initially, the value of the least upstream industry in Mexico, *Automobiles and Trucks Manufacturing*, was multiplied by 1; (ii) then, the factor was proportionally increased until the value of the sixth most upstream industry in Mexico, *Nonferrous Metal Industry, except Aluminum,* was equal to the value of the most upstream industry in China, *Nonferrous Metal Mining Industry*; and (iii) for the remaining industries, the factor was extrapolated.

[28] Chor, Manova and Yu's industry-level measures of upstreamness (2014) goes from a minimum value of 1 (corresponding to the *Social Welfare* industry) to 5.9 (corresponding to *Nonferrous metal mining industry)*. This implies that, in this case, the number of stages conforming the production process equals 4.9. As a percentage of this number of stages, the portion of the GVCs undertaken in China increased from 4.6% in 1993 to 16.8% in 2011.

of Chinese imports increased steadily is consistent with the hypothesis that China managed to substitute imported inputs for domestic production, as suggested by evidence on intensification of industrial linkages provided, for instance, by Andreosso and Yue (2004) and Holz (2011).

Figure 14. Average Upstreamness of Mexican and Chinese Exports and Imports



Source: Own calculations with data from Bank of Mexico, National Institute of Statistics and Geography (INEGI) and Chor, Manova and Yu (2014).

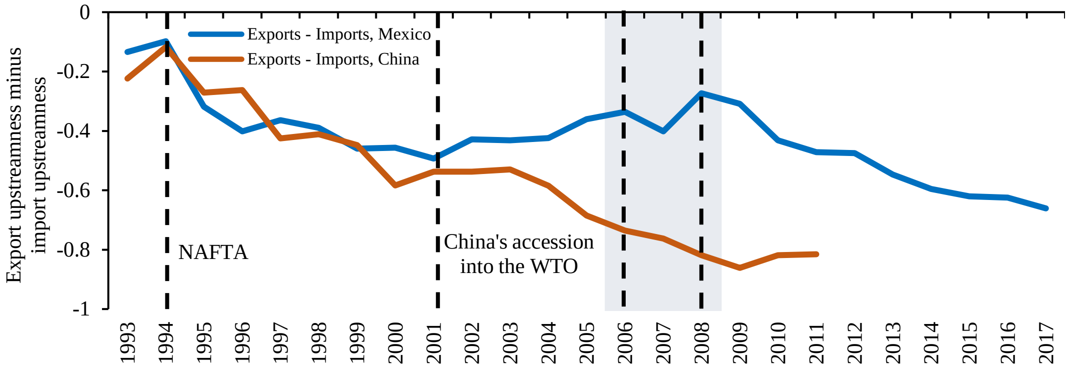
Notes: This figure depicts the average upstreamness levels of Mexican manufacturing exports and imports (green solid and green dotted curves) and the average upstreamness levels of Chinese total exports and imports (red solid and red dotted curves). These upstreamness levels are computed as weighted averages of industry-level measures of upstreamness using trade flows by industry as weights, as explained in detail in Subsection 4.1. In order to achieve comparability between Mexico and China, the measures of upstreamness at the industry-level of Mexico were adjusted in manner that the upstreamness value of its sixth most upstream industry, *Nonferrous Metal Industry*, was equal to the most upstream industry in China, *Nonferrous Metal Mining Industry* (see footnote 27). The upstreamness measures of Mexico for 2017 were computed employing accumulated trade flows from January to July of that year.

Motivated by the fact that China largely integrated into GVCs through non-processing activities, which as argued by Manova and Yu (2016) is more prone to substitute imported inputs for domestic production and thus more strongly associated with greater amounts of domestic value added, we proceed by considering two cases in the comparison between Mexico and China: (a) processing trade that, for the case of Mexico, is approximated for with trade in the *maquiladora* sector; (b) non-processing trade that, for the case of Mexico, is approximated for with trade in the *non-maquiladora* sector. Figures 16 presents the difference between the average upstreamness of exports and imports for the Mexican non-automotive, *maquiladora* sector (blue solid curve) and for the Chinese processing industry (orange solid curve). Figure 17 shows the same analysis for the Mexican *non-maquiladora* sector and for the Chinese non-processing industry.

Figure 16 shows that, while the number of production stages carried out in the Mexican non-automotive *maquiladora* sector increased steadily and with almost no interruption since 1995, this number remained relatively constant in the Chinese processing sector.

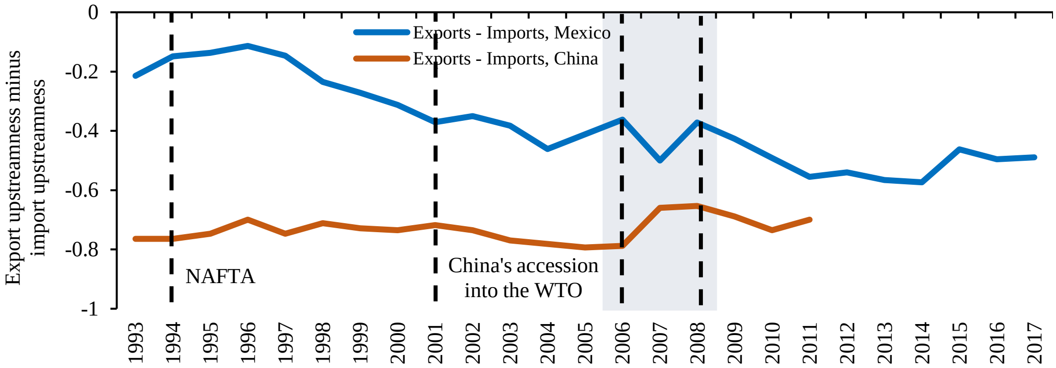
Figure 17 shows the opposite pattern for the *non-maquiladora* and non-processing industries.

Figure 15. Difference between Average Upstreamness of Exports and Imports in Mexico and China



Source: Own calculations with data from Bank of Mexico, National Institute of Statistics and Geography (INEGI), and Chor, Manova and Yu (2014).
Notes: This figure shows the difference between the upstreamness of Mexican manufacturing exports and imports (blue solid curve), and the difference between the average upstreamness of Chinese total exports and imports (orange solid curve). These upstreamness measures are constructed as explained in detail in Subsection 4.1. The upstreamness measures of Mexico for 2017 were computed employing accumulated trade flows from January to July of that year.

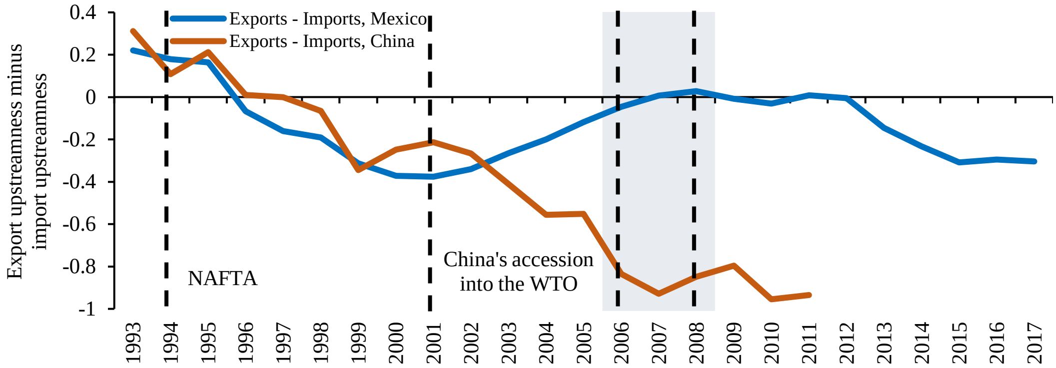
Figure 16. Difference between Upstreamness of Exports and Imports in Mexico and China
Maquiladora Sector



Source: Own calculations with data from Bank of Mexico, National Institute of Statistics and Geography (INEGI), and Chor, Manova and Yu (2014).
Notes: This figure depicts the difference between the average upstreamness of Mexican non-automotive, *maquiladora* exports and imports (blue solid line), and the difference between the average upstreamness of Chinese processing exports and imports (orange solid line). The upstreamness measures are constructed as explained in detail in Subsection 4.1. The upstreamness measures for Mexico are constructed considering only trade flows of firms that participated at least one years between 1993 and 2006 in the *Maquiladora* program implemented by the Mexican government, and excluding trade flows associated with the industries of the automotive sector; i.e., *Automobiles and Trucks Manufacturing*, *Motor Vehicles Bodies and Trailers*, and *Motor Vehicle Parts* industries. The upstreamness measures of Mexico for 2017 were computed employing accumulated trade flows from January to July of that year.

In particular, in this case the number of stages produced by the non-processing sector of China increased steadily, but the number of stages produced in the non-automotive *non-maquiladora* sector of Mexico display the three periods mentioned above (for further details, see Sub-subsection 4.2.2). That is, Figures 16 and 17 show that the Mexican and the Chinese experiences of insertion into GVCs differ not only in terms of whether it is the upstreamness of exports or imports mainly driving their contribution to GVCs, but also because Mexico arguably deepened its integration in the *maquiladora* sector but China arguably deepened its integration in the non-processing trade industry.[29]

Figure 17. Difference between Average Upstreamness of Exports and Imports in Mexico and China
Non-Maquiladora Sector



Source: Own calculations with data from Bank of Mexico, National Institute of Statistics and Geography (INEGI), and Chor, Manova and Yu (2014).
Notes: This figure depicts the difference between the average upstreamness of Mexican non-automotive, *non-maquiladora* exports and imports (blue solid line), and the difference between the average upstreamness of Chinese non-processing exports and imports (orange solid line). These upstreamness measures are constructed as explained in detail in Subsection 4.1. The upstreamness measures for Mexico are constructed considering only trade flows of firms that did not participated in any year between 1993 and 2006 in the *Maquiladora* program implemented by the Mexican government, and excluding trade flows associated with the industries of the automotive sector; i.e., *Automobiles and Trucks Manufacturing*, *Motor Vehicles Bodies and Trailers*, and *Motor Vehicle Parts* industries. The upstreamness measures of Mexico for 2017 were computed employing accumulated trade flows from January to July of that year.

6.2 Specialization of the Mexican and Chinese Economies and their Degree of Competition

This subsection compares product specialization in Mexico and China over their insertion processes into GVCs. To the extent that both economies were, at some point, unskilled labor abundant countries, and should therefore have specialized in similar goods according to traditional trade theory, this comparison will allow exploring whether the two countries were competitors in global markets. In addition, the present subsection presents more direct evidence on the degree of competition between the two economies, based on the traditional notion of comparative advantage. Ultimately, this will help understand the extent to which China shaped Mexico's insertion process into GVCs.

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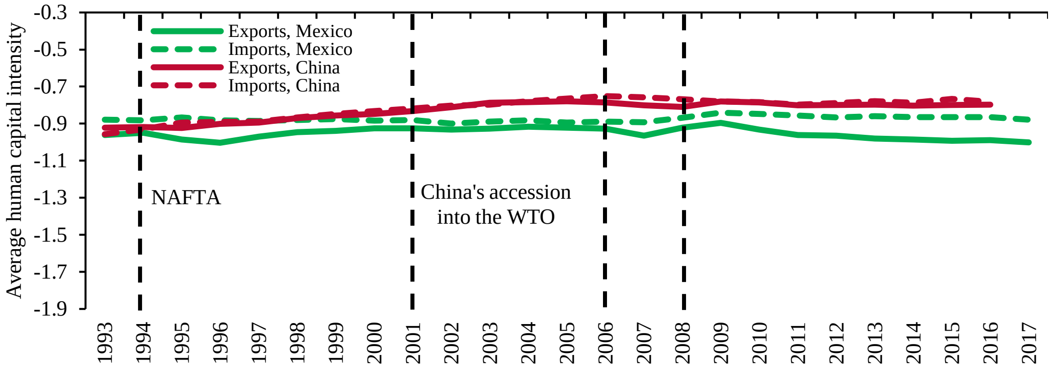
[29] As noted in footnote 28, the number of production stages implied by Chor, Manova and Yu's measures of upstreamness (2014) is 4.9. As a percentage of this number, the Chinese processing sector performed 15.7% of the GVCs in 1994, while it performed the 14.4% in 2011. Further, also as a percentage of the number of stages implied by Chor, Manova and Yu, the slice of the GVCs produced by the Chinese non-processing sector increased from 0% in 1994 (note that Chinese non-processing exports were more upstream than imports in this year) to 19.2% in 2011.

In comparing specialization in Mexico and China, we use data on international trade from the UN Comtrade database and construct measures on the average skill-intensity of Chinese manufacturing exports and imports in the exact same manner we have done for Mexico in Section 5; i.e., as weighted averages of the industry-level measures of human capital intensity employing trade flows by industry as weights (see Subsection 5.1 for details on these measures).

Figure 18. Average Human Capital Intensity of Manufacturing Exports and Imports in Mexico and China

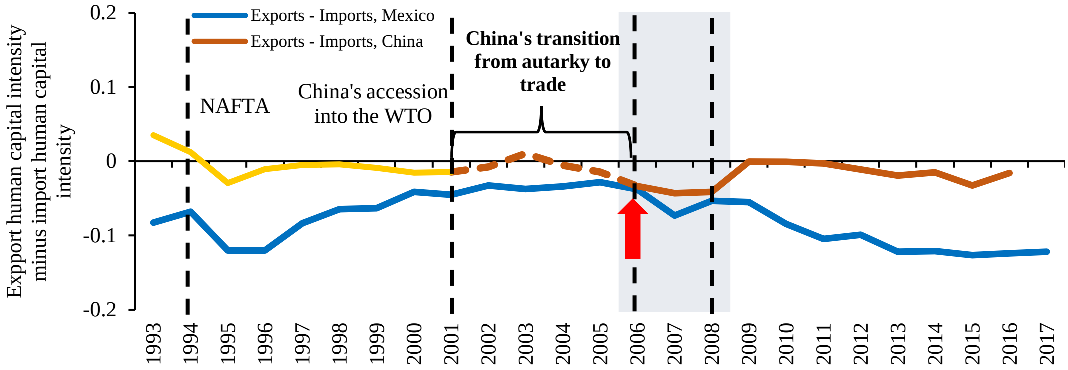


Source: Own calculations with data from Bank of Mexico, United Nations (UN) Comtrade and Nunn and Trefler (2013). Notes: This figure depicts the average human capital intensity levels of Mexican manufacturing exports and imports (green solid and green dotted curves), and the average human capital intensity levels of Chinese manufacturing exports and imports (red solid and red dotted curves). These skill intensity levels are computed as weighted averages of industry-level measures of human capital intensity using trade flows by industry as weights, as explained in detail in Subsection 5.1. The human capital intensity measures of Mexico for 2017 were computed employing accumulated trade flows from January to July of that year.

Figure 18 shows the results by depicting with solid and dotted curves the average skill-intensity of exports and imports, and with red and green curves the cases of China and Mexico. In this figure, the measures are depicted over the range of values taken by our industry-level measure of skill-intensity; i.e., from -0.3 to -1.9. Depicting these measures over this range allows assessing how far the average skill-intensity of Mexican trade flows are from Chinese flows and, thus, assessing how similar these countries are in terms of their specialization. Figure 19 shows the difference between the average human capital intensity of exports and imports that, as noted above, provides information regarding the specialization patterns of domestic economies.

Figure 18 shows that the average skill-intensity was similar in China and Mexico for both exports and import in 2001. The fact that the skill intensity was similar across countries for the two series is consistent with the idea that they specialized in similar products, possibly implying that they were competitors in global markets when China entered the WTO. Nonetheless, note in Figure 18 that this difference has been widening, particularly since the mid-/end-2000s, precisely when the skill-intensity of Mexican exports started to fall. In turn, these results are consistent with the idea that initially, when China entered the WTO, competed strongly with Mexico but then the degree of competition between these two countries has weakened, particularly over the last decade.

Figure 19. Difference between Average Human Capital Intensity of Manufacturing Exports and Imports of Mexico and China



Source: Own calculations with data from Bank of Mexico, United Nations (UN) Comtrade and Nunn and Trefler (2013).
Notes: This figure depicts the difference between the average human capital intensity of Mexican manufacturing exports and imports (blue solid curve), and the difference between the average human capital intensity of Chinese manufacturing exports and imports (orange solid curve), constructed as explained in detail in Subsection 5.1. The skill intensity measures of Mexico for 2017 were computed employing accumulated trade flows from January to July.

Furthermore, based on the dynamics of the specialization indicators shown in Figure 19, it is possible to distinguish two periods since China's insertion into the WTO. For the period previous to 2001 it is hard to use standard trade theory to interpret the results for China in terms of resource allocation in this economy. Indeed, this is a period in which resource allocation in this economy does not seem to have been led by international trade. During the period beginning in 2001 and ending in the mid- to end-2000s, the difference between the average skill-intensity of exports and imports for China increased. Indeed, the sign of this relocation is consistent with standard theory of international trade, since it implied a relocation towards the production of unskilled-intensive goods, in which the Chinese economy should have had comparative advantage according to its relative unskilled-labor abundance in 2001.

Following this resource relocation in China, the specialization indicator for this economy takes the exact same value as for the Mexican economy in 2006, suggesting that the similarity in the goods produced by the two economies and thus the degree of competition between them may have peaked in this year. Interestingly, this is exactly the same year in which we have identified the beginning of a new GVC insertion period for Mexico and, importantly, the beginning of the period in which Mexico seems to have started a process of resource relocation towards the production of relatively less skill-intensive goods. The fact that the upstreamness and the skill-intensity analysis identify the same year, i.e., 2006, and that at the same time this is precisely the year in which the specialization indicators of Mexico and China take the exact same value is arguably consistent with the idea that global competition between the countries shaped the process of Mexican insertion into GVCs.

In the period starting in the mid- to end-2000s, the difference between the average skill-intensity of manufacturing exports and imports decreased for China (i.e., it approximated to zero), suggesting that the specialization of this economy shifted towards relatively more skill-intensive industries. This is consistent with the results obtained by Lin and Treichel (2012), who point out that while wages in the Chinese manufacturing sector have risen rapidly, its surplus labor has diminished and, therefore, China has been facing pressures to upgrade its industrial structure into a more capital- and high-skilled intensive one. Furthermore note that this change in specialization in China coincides precisely with the change in the specialization pattern of the Mexican economy. Thus, at some point, the change in specialization seems a natural response of the Mexican economy to global competition with China.

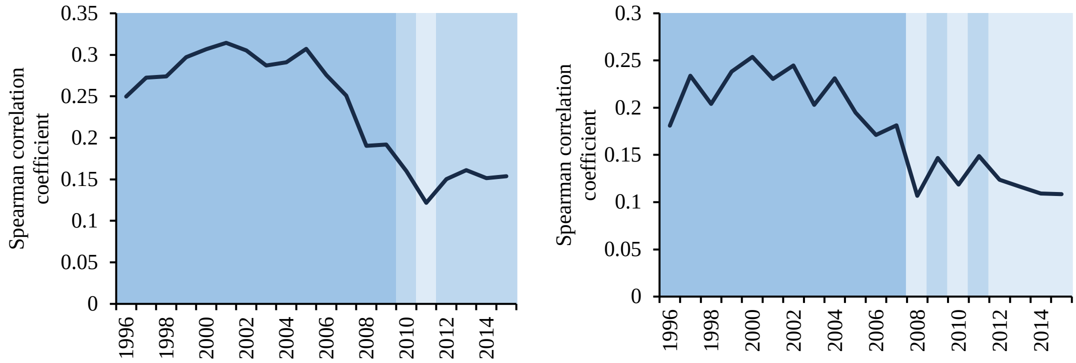
However, a problem with drawing conclusions only on the basis of the specialization patterns shown in Figures 18 and 19 is that these indicators are obtained by taking averages. Thus, it could well be the case that, even though both countries have similar average values, dispersion among industries may have implied that they did not specialize in the same industries and, thus, were not competitors in 2001. Following this logic, we complement the analysis with indicators that compare Mexico and China by sectors and draw conclusions on these comparisons. In particular, we employ the rank correlation between the revealed comparative advantage (RCA) indexes of Mexico and China to examine the degree of competition between these two countries since mid-1990s. The RCA index proposed by Balassa (1965) mimics a country's comparative advantage, and it is constructed as follows

$$RCA_i^j = \frac{x_i^j}{x_i^{world}} \quad (9)$$

where RCA_i^j is the revealed comparative advantage of country j in the good i, and x_i^j is the share of country j's exports of good i over its total exports, and x_i^{world} is the share of world exports of good i over total world exports. When $RCA_i^j > 1$, it is councluded that country j has a comparative advantage in good i; that is, if the share of good i in country j's total exports is higher than the share of this good in world exports.

Figure 20. Spearman Correlation between RCA Indexes of China and Mexico

a. World Market b. United States



Source: Own calculations with data from United Nations (UN) Comtrade.
Notes: This figure shows the Spearman correlation coefficients between the RCA indexes of Mexico and China at the industry-level. These RCA indexes are constructed as the ratio between the share of good i in country's j's total exports and the share of this good in world exports. , and denote significance at 1%, 5% and 10% levels.

Employing trade data retrieved from UN Comtrade at 3-digit SITC Rev. 3 classification, we construct RCA indexes for Mexico and China using the expression in (9). Having constructed the RCA indexes, we compute the Spearman correlation coefficient for them. This coefficient measures the degree of ordinal correlation between the two abovementioned indexes and, thus, it provides information about the similarities between these two countries in terms of their patterns of comparative advantage. The larger the value of the coefficient, the larger their similarities in terms of their patterns of comparative advantage and, therefore, the degree of competition between them.

The Spearman correlation between the RCA indexes of Mexico and China are presented in Figure 20 over 1996-2015; for years previous to 1996 and years after 2015 there are no trade data available at 3-digit SITC Rev. 3 classification for all the countries needed to construct world exports. In this figure, panel a show the correlation between the RCA indexes constructed employing world exports, while panel b shows the correlation between RCA indexes constructed using exports to the U.S.

Figure 20 shows a positive, large and highly significant correlation coefficient from 1996 to the mid-2000s, which is observed regardless of the market considered.[30]

[30] The Spearman correlation coefficient between the RCA indexes of Mexico and China is large compared to the correlation coefficients between the RCA indexes of Mexico and other Latin American countries that are arguably

Notwithstanding, both the magnitudes of the coefficients and their significance have dropped since mid-2000s. Therefore, consistent with the analysis undertaken above, this suggests that Mexico and China competed strongly in both the international and the U.S. markets during the first half of the 2000s but that competition have weakened afterwards.

7. Conclusion

The evidence presented in this paper suggests that both NAFTA and the competition with China have shaped the process of Mexican insertion in GVCs. NAFTA seems to have induced Mexican firms to increase their participation in the international production networks and specialize in the production of relatively more skill-intensive goods. In turn, China's entry into the WTO seems to have reduced Mexico's contribution to the GVCs. Over the last years, the contribution of the Mexican economy to the GVCs seems to have recovered some of the ground it lost with China's accession to the WTO. Notwithstanding, this recovery has been accompanied by a change in the specialization pattern of the domestic economy towards the production of relatively less skill-intensive industries, which seems to be a response to the competition with the Asian country.

On the other hand, the Mexican and Chinese processes of insertion in GVCs have differed in two main aspects. First, unlike Mexico, China has increased its participation in global production networks steadily and almost uninterruptedly. Second, while changes in China's degree of participation in GVCs stem mainly from changes in the average position of its imports along the supply chain, in Mexico the changes in its participation are mainly explained by changes in the average position of its exports. This is consistent with the idea that, in contrast to the Mexican economy, trade openness has induced a substitution of imported intermediate goods by domestic production in China.

similar to it; e.g., Argentina, Brazil, Chile and Peru. For instance, when world exports are considered, the average correlation coefficient between the indexes of Mexico and China over 1996-2006(2008) was 0.28 (0.27), while the average coefficients between the indexes of Mexico and Argentina, Mexico and Brazil, Mexico and Chile, and Mexico and Peru were 0.10(0.11), 0.14(0.14), 0.11(0.12) and 0.25(0.25), respectively.

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Appendix A. Correspondence Table between 6-digit Level HS and 4-digit Level NAICS Classifications

This appendix presents the strategy used to aggregate Pierce and Schott's (2012) correspondence tables between 10-digit level HS and the 6-digit level NAICS classifications to obtain a mapping between the 6-digit level HS and the 4-digit level NAICS for 1993-2006. In the first strategy, we aggregate Pierce and Schott's tables through two main steps:

1. In the first step, we consider only the first six digits in Pierce and Schott's (2012) 10-digit level HS classification and the first four digits of their 6-digit NAICS classification, thus obtaining a correspondence between the 6-digit HS and the 4-digit NAICS classifications for each HS code at the 10-digit level.

2. In the second step, we allocate each 6-digit HS code to the corresponding 4-digit NAICS based on the following criteria:

   Case 1: If all the 10-digit level HS categories within a 6-digit level HS code had the same 4-digit level NAICS code, then this 6-digit level HS code were allocated to this 4-digit NAICS code.

   Case 2: If the 10-digit level HS categories within a 6-digit level HS code had multiple 4-digit level NAICS codes, then this 6-digit level code were distributed among the different 4-digit level NAICS. This distribution was made on the basis of the proportion of the number of the 10-digit level HS categories within the 6-digit level HS code that were mapped into the corresponding 4-dgit NAICS codes.

Figure A.1 provides an example of a visual representation of the correlation table we construct according to the above two mentioned steps.

As a result we have a correlation table between six-digit HS and four-digit NAICS for the period 1993-2006.

Figure A.1. Correlation Table between HS6 and NAICS4

	HS Group	HS6 Subgroup	NAICS4	SCIAN4	
Case 1	1	11XXXX	11XX	11XX	
Case 2	2	21XXXX	21XX	21XX	2/3 of trade data
	2	22XXXX	21XX	21XX	
	2	23XXXX	22XX	22XX	1/3 of trade data

Appendix B. Correlation Table between WIOD 2013 and NAICS 2007

This appendix provides a description of the methodology we follow to classify the skill levels of the WIOD 2013. On one hand, Nunn and Trefler (2013) measure human capital intensity for 85 industries at four-digit NAICS 2007. On the other hand, WIOD 2013 provides information for 35 industries mostly at the two-digit ISIC Rev. 3 level. To link the two information systems, we consider the following steps:

1. For the construction of the link between NAICS and ISIC Rev.3 we use the correlation tables available in UN: (1) ISIC Rev.4 and NAICS 2007, (2) ISIC Rev.4 and ISIC Rev.3.1, and (3) ISIC Rev.3.1 and ISIC Rev.3. As each correlation table might provide multiple correspondences, each industry in NAICS4 might have multiple correspondences in ISIC Rev.3 (see Figure B.1 for an example of the correspondences between NAICS 2007 and ISIC Rev.3). Once we identify the NAICS industries in ISIC Rev.3, we group consider the first two digits of ISIC Rev.3 to group the industries in the sectors proposed by WIOD according to OCDE.

Figure B.1. Correlation Table between WIOD

WIO_isic3	ISIC3_2	ISIC3code	ISIC31code	ISIC4code	NAICS4
1	11	11XX	11XX	11XX	1111
1	11	11XX	11XX	11XX	1112
1	22	22XX	22XX	22XX	1113
1	22	22XX	22XX	33XX	1111
1	22	22XX	22XX	33XX	1115

2. Step 1 allows us grouping the skill measures into WIOT classification. As we pointed out, NAICS might have multiple correspondences, then we weight the skill measure by the exports participation of each group, then we normalize the new measure and assign the median skill value to the WIOT sectors.

3. To classify the industries between high- and low-skilled labors, we consider the median of the data. Values below the median were classified as low-skilled labor and above the median, as high-skilled.

4. By following steps 1 to 3, we are able to classify 23 out of 35 sectors of WIOT. To classify the other 12 sectors, the education level was considered, then sectors

whose workers have at least eight years of education on average were classified as high-skilled labor.

Appendix C. Additional Tables

Table C.1. Export Share by Industry in Automotive Manufacturing
Percentage

Industry	1994	1995	1996	2000	2001	2002	2006	2008	2010	2014	2017
Automobile and trucks manufacturing	48.9	53.6	57.3	54.0	54.8	52.2	50.0	56.7	59.3	57.1	57.6
Motor vehicle bodies and trailers manufacturing	7.5	10.2	10.1	12.0	10.8	10.0	10.7	1.6	1.6	2.0	2.0
Motor vehicle parts manufacturing	43.7	36.2	32.6	34.0	34.4	37.8	39.2	41.8	39.2	40.9	40.4
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: Own calculations with data from Bank of Mexico.
Notes: The export share of each industry is computed as the exports of the respective industry over the sum of exports of all the industries. Green-shaded and red-shaded cells highlights the years in which export shares consecutively increased and decreased, respectively.

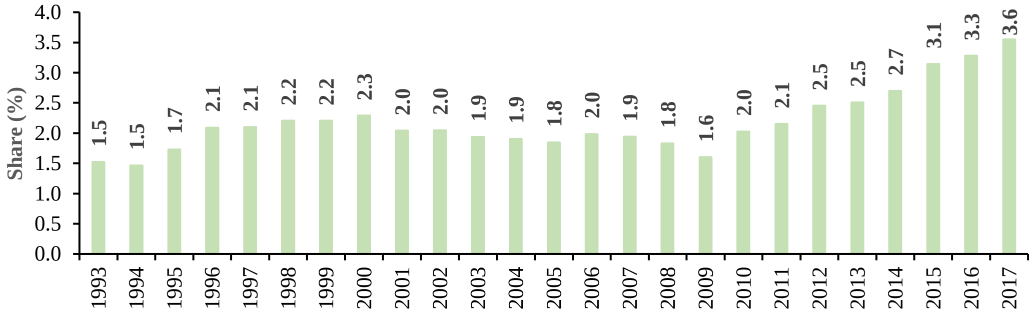
Table C.2. Import Shares by Industry in Automotive Manufacturing
Percentage

Industry	1994	1995	1996	2000	2001	2002	2006	2008	2010	2014	2017
Automobile and trucks manufacturing	43.0	12.5	17.0	36.3	37.7	42.6	47.5	39.8	31.7	27.1	29.9
Motor vehicle bodies and trailers manufacturing	6.6	6.1	5.9	6.3	5.9	5.6	5.1	3.4	2.9	3.2	3.2
Motor vehicle parts manufacturing	50.4	81.3	77.1	57.4	56.4	51.8	47.4	56.8	65.4	69.7	66.9
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: Own calculations with data from Bank of Mexico.
Notes: The import share of each industry is computed as the imports of the respective industry over the sum of imports of all the industries. Green-shaded and red-shaded cells highlights the years in which import shares consecutively increased and decreased, respectively.

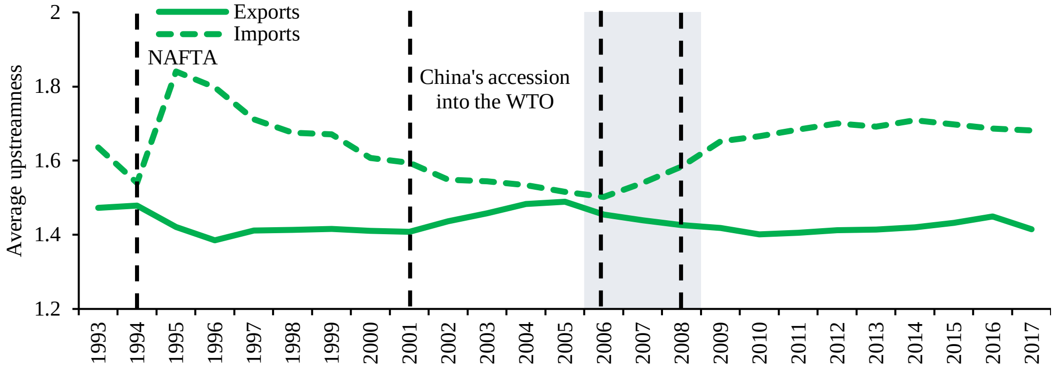
Appendix D. Additional Figures

Figure D.1. Automotive Sector Participation in Mexico's GDP



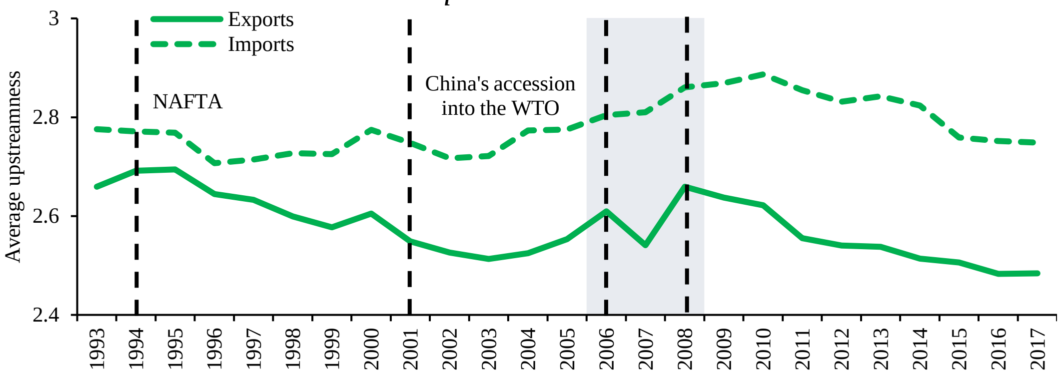
Source: National Institute of Statistics and Geography (INEGI).
Notes: The share is calculated by dividing the production of the automotive sector over GDP, at current prices. The automotive sector includes *Automobiles and Trucks Manufacturing*, *Motors Vehicles Bodies and Trailers*, and *Motor Vehicle Parts* industries of the SCIAN classification. The share for 2017 reflects data until the third quarter of 2017.

Figure D.2. Average Upstreamness of Mexican Automotive Exports and Imports



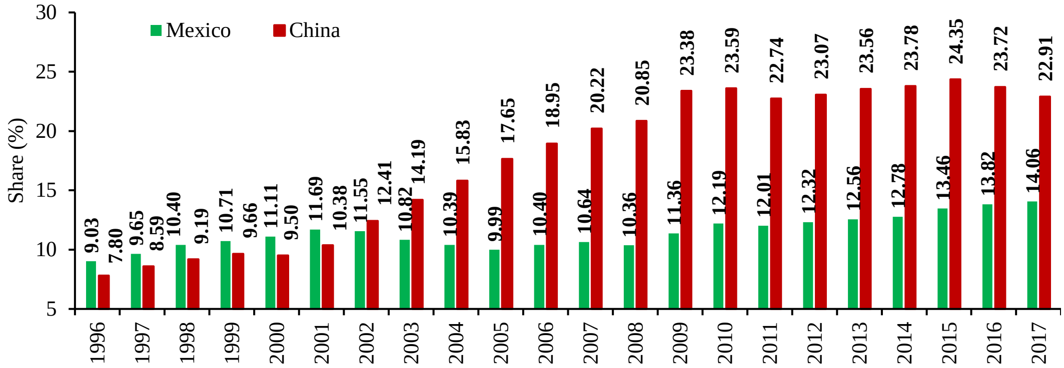
Source: Own calculations with data from Bank of Mexico and National Institute of Statistics and Geography (INEGI). Notes: This figure depicts the average upstreamness levels of Mexican exports (solid line) and imports (dotted line) of the automotive sector. These upstreamness levels are computed as weighted averages of industry level measures of upstreamness using trade flows by industry as weights, as explained in detail in Subsection 5.1. The weighted averages consider only those industry-level measures of upstreamness and the trade flows associated with those industries that conform the automotive sector; i.e., *Automobiles and Trucks Manufacturing*, *Motors Vehicles Bodies and Trailers*, and *Motor Vehicle Parts* industries. The upstreamness measures for 2017 were computed employing accumulated trade flows from January to July of that year.

Figure D.3. Average Upstreamness of Non-Automotive Exports and Imports
Maquiladora Sector



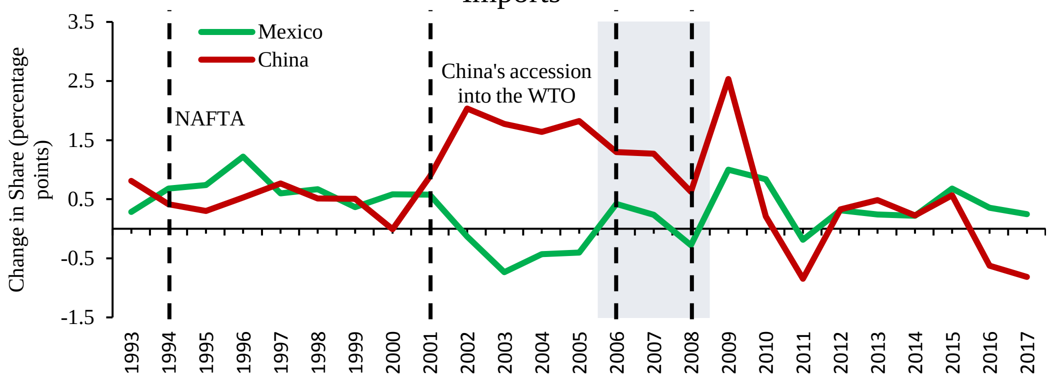
Source: Own calculations with data from Bank of Mexico and National Institute of Statistics and Geography (INEGI). Notes: This figure depicts the average upstreamness levels of Mexican exports (solid line) and imports (dotted line) of the non-automotive, *maquiladora* sector. These upstreamness levels are computed as weighted averages of industry level measures of upstreamness, using trade flows by industry as weights (see Subsection 5.1 for a description of the construction of the upstreamness measures). The weighted averages consider only trade flows of firms that participated at least one year between 1993 and 2006 in the *Maquiladora* program implemented by the Mexican government, and excludes trade flows associated with the industries of the automotive sector; i.e., *Automobiles and Trucks*, *Motors Vehicles Bodies and Trailers,* and *Motor Vehicle Parts* industries.

Figure D.4. Mexican and Chinese Share in U.S. Total Imports



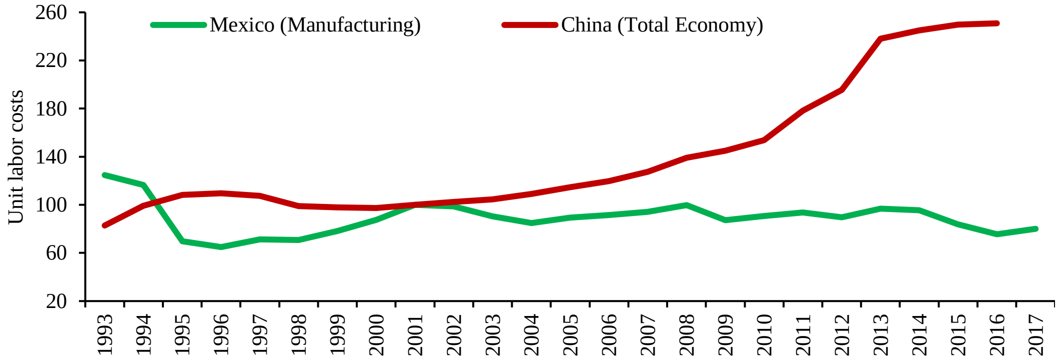
Source: Own calculations with data from United Nations (UN) Comtrade and the United States Census Bureau.
Notes: The share of Mexico and China in total U.S. imports are computed, respectively, as U.S. imports from Mexico and China over total U.S. imports. The shares for 2017 reflects data until May of 2017.

Figure D.5. Change in Mexican and Chinese Shares in Total U.S. Manufacturing Imports



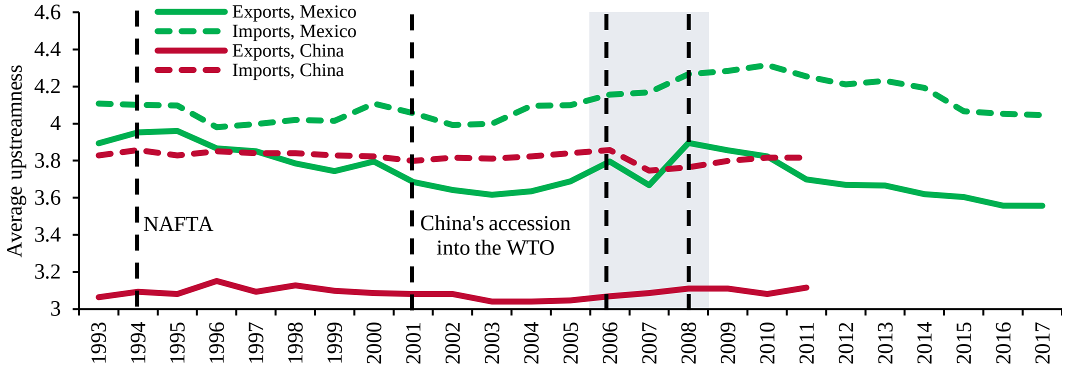
Source: Own calculations with data from United Nations (UN) Comtrade and the United States Census Bureau.
Notes: This figure shows the change in the share of Mexico (China) in total U.S. manufacturing imports, computed as U.S. manufacturing imports from Mexico (China) over total U.S. manufacturing imports. Data from United Nations (UN) Comtrade are used for 1993-1999, and data from United States Census Bureau are used for 2000-2017. For 2017, the shares were computed employing accumulated flows from January to May of that year.

Figure D.6. Unit Labor Costs



Source: National Institute of Statistics and Geography (INEGI) and Haver Analytics.
Notes: Unit labor costs are calculated based on current dollars, and they are defined as the labor cost per unit of output. Reference year for the data is 2001. The latest available year for China is 2016.

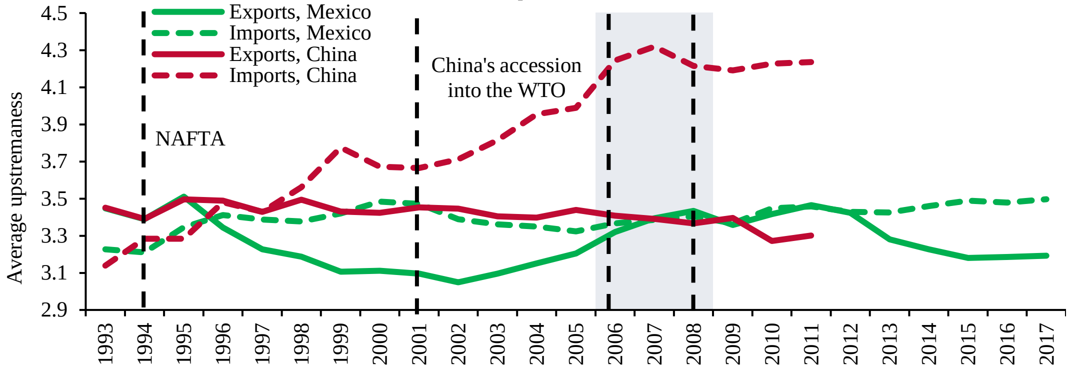
Figure D.7. Average Upstreamness of Mexican and Chinese Exports and Imports
Maquiladora Sector



Source: Own calculations with data from the Bank of Mexico, National Institute of Statistics and Geography (INEGI) and Chor, Manova and Yu (2014).

Notes: This figure depicts the average upstreamness levels of Mexican exports and imports (green solid and dotted curves) for the *maquiladora* sector and the average upstreamness levels of Chinese exports and imports (red solid and dotted curves) for the processing sector. These upstreamness measures are constructed as explained in detail in Subsection 5.1. In order to achieve comparability between Mexico and China, the measures of upstreamness at the industry-level of Mexico were adjusted in manner that the upstreamness value of its sixth most upstream industry, *Nonferrous Metal Industry, except Aluminum*, was equal to the most upstream industry in China, *Nonferrous Metal Mining Industry* (see footnote 27). The upstreamness measures for Mexico are constructed considering only trade flows of firms that participated at least one years between 1993 and 2006 in the *Maquiladora* program implemented by the Mexican government, and excluding trade flows associated with the industries of the automotive sector; i.e., *Automobiles and Trucks*, *Motors Vehicles Bodies and Trailers*, and *Motor Vehicle Parts* industries. The upstreamness measures for China were retrieved from Chor, Manova and Yu (2014).

Figure D.8. Average Upstreamness of Mexican and Chinese Exports and Imports
Non-Maquiladora Sector



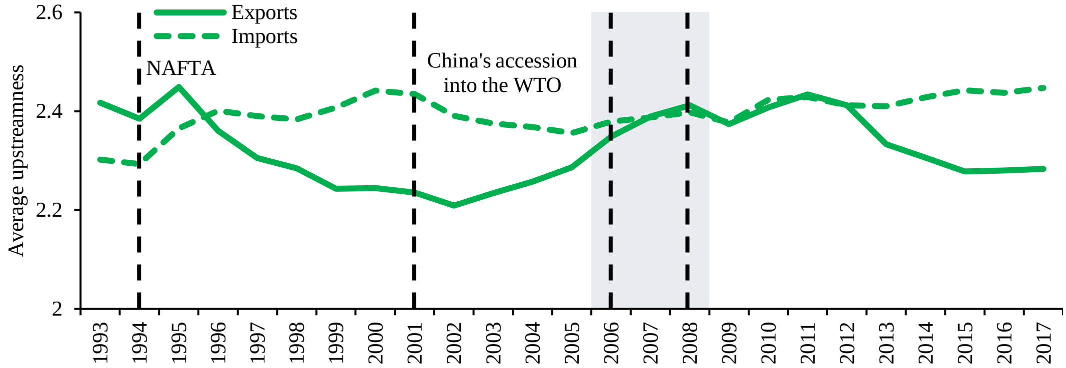
Source: Own calculations with data from the Bank of Mexico, National Institute of Statistics and Geography (INEGI) and Chor, Manova and Yu (2014).

Notes: This figure depicts the average upstreamness levels of Mexican exports and imports (green solid and dotted curves) for the *non-maquiladora* sector and the average upstreamness levels of Chinese exports and imports (red solid and dotted curves) for the non-processing sector. These upstreamness measures are constructed as explained in detail in Subsection 5.1. In order to achieve comparability between Mexico and China, the measures of upstreamness at the industry-level of Mexico were adjusted in manner that the upstreamness value of its sixth most upstream industry, *Nonferrous Metal Industry, except Aluminum*, was equal to the most upstream industry in China, *Nonferrous Metal Mining Industry* (see footnote 27). The upstreamness measures for Mexico are constructed considering only trade flows of firms that did participate in any year between 1993 and 2006 in the *Maquiladora* program implemented by the Mexican government, and excluding trade flows associated with the industries of the automotive sector; i.e., *Automobiles and Trucks*, *Motors Vehicles Bodies and Trailers*, and *Motor Vehicle Parts* industries. The upstreamness measures for China were retrieved from Chor, Manova and Yu (2014).

Appendix E. The Insertion of the Mexican Non-Automotive, Non-Maquiladora Manufacturing Sector into GVCs

This appendix provides an analysis of the insertion process of the Mexican non-automotive, *non-maquiladora* manufacturing sector into GVCs. For this purpose, Figure E.1 shows the average level of upstreamness of non-automotive, *non-maquiladora* exports and imports between 1993 and 2014. In this figure, the green solid line represents the level of upstreamness of exports ($U^X_{Mex,t}$) and the green dotted line shows the level of imports upstreamness ($U^M_{Mex,t}$). As discussed in Subsection 4.1, the difference between these two lines provides an estimate of the number of stages of the manufacturing GVCs performed by the Mexican non-automotive, *non-maquiladora* sector. This difference is depicted in Figure 9 in the main body text.

Figure E.1. Average Upstreamness of Non-Automotive Exports and Imports
Non-Maquiladora Sector



Source: Own calculations with data from Bank of Mexico and National Institute of Statistics and Geography (INEGI).
Notes: This figure depicts the average upstreamness levels of Mexican exports (solid line) and imports (dotted line) of the non-automotive, *non-maquiladora* sector. These upstreamness levels are computed as weighted averages of industry level measures of upstreamness, using trade flows by industry as weights (see Subsection 5.1 for a description of the construction of the upstreamness measures). The weighted averages consider only trade flows of firms that did not participate in any of the years between 1993 and 2006 in the *Maquiladora* program implemented by the Mexican government, and excludes trade flows associated with the industries of the automotive sector; i.e., *Automobiles and Trucks*, *Motors Vehicles Bodies and Trailers*, and *Motor Vehicle Parts* industries.

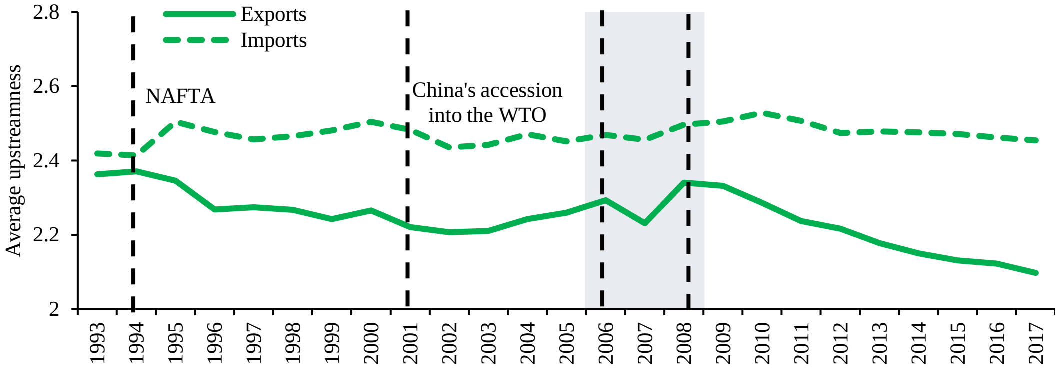
Two main conclusions arise from Figures E.1 and 9. First, in contrast to total, automotive and non-automotive, *maquiladora* manufacturing, non-automotive, *non-maquiladora* exports have not been less upstream than imports over the whole period. Indeed, during 1993-1995, exports were more upstream than imports, suggesting that the Mexican non-automotive, *non-maquiladora* sector exported raw materials and imported final goods. Notwithstanding, the opposite pattern is observed over 1996-2006 and 2012-2014, when exports were more downstream than imports. This implies that, during these two periods, the non-automotive, *non-maquiladora* sector imported intermediate goods that were processed or assembled and, then, re-exported; that is, some of the stages the manufacturing GVCs was executed by Mexican *non-maquiladoras*. It is worth noting that exports and imports of the non-automotive, *non-maquiladora* sector showed similar levels of upstreamness between 2007 and 2011.

The second conclusion that arises from Figures E.1 and 9 is that, in line with total manufacturing and in contrast to the automotive sector, the average imports upstreamness of non-automotive, *non-maquiladora* sector has remained relatively constant while the average upstreamness of its exports has varied significantly. This implies that the changes in the number of stages of the GVCs produced by the Mexican non-automotive, *non-maquiladora* sector observed in Figure 9 are mainly explained by changes in the average upstreamness of its exports.

Based on the dynamics of the number of stages of the GVCs produced by the Mexican non-automotive, *non-maquiladora* sector, approximated with the difference between the average upstreamness of its exports and imports (i.e., $U_{Mex,t}^{XM}$), it is possible to distinguish three different periods in the insertion process of this sector. After NAFTA, and until around 2001, the number of stages steadily increased. This trend is reversed after 2001, which coincides with the entrance of China into WTO, and the number of stages continued to fall until late 2000's. Finally, in the last part of the sample (i.e., after 2008), the number of stages remained constant for few years and then started to increase again.

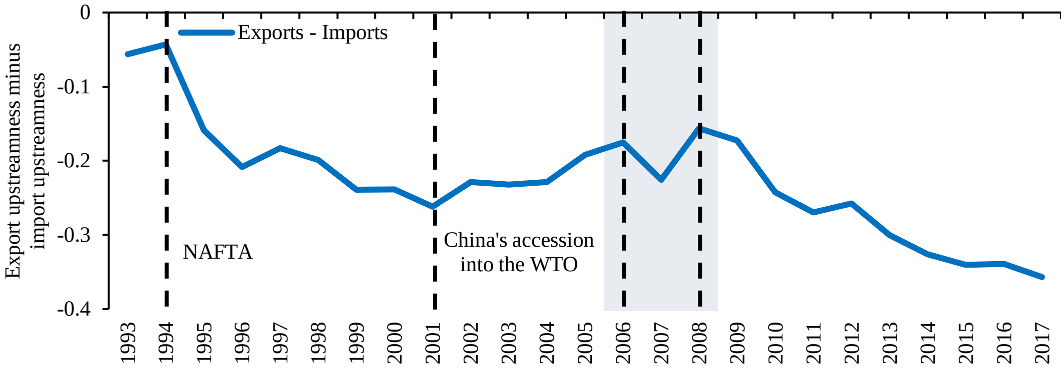
Appendix F. Robustness to the New Historical Bridge and to the Empirical Results

Figure F.1. Average Upstreamness of Mexican Manufacturing Exports and Imports



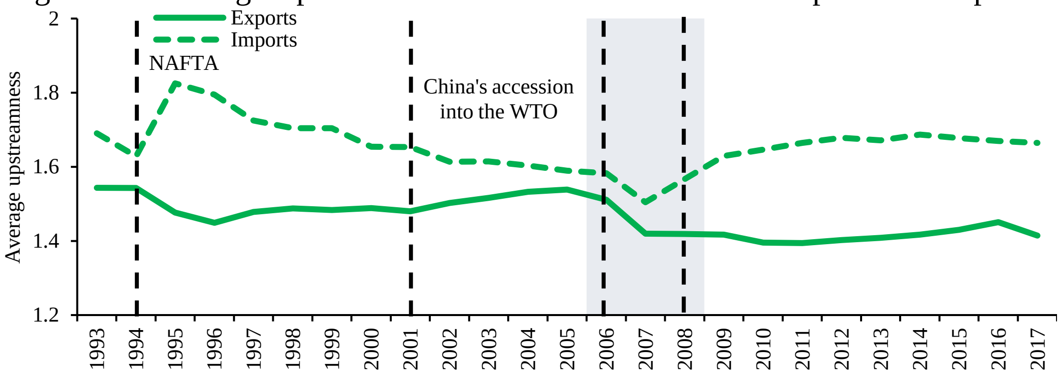
Source: Own calculations with data from Bank of Mexico and National Institute of Statistics and Geography (INEGI).
Notes: This figure depicts the average upstreamness levels of Mexican manufacturing exports (solid curve) and imports (dotted curve). These upstreamness levels are computed as weighted averages of industry-level measures of upstreamness, using trade flows by industry as weights (see Subsection 4.1 for a description of the construction of the upstreamness measures). The upstreamness measures for 2017 were computed employing accumulated trade flows from January to July of that year.

Figure F.2. Difference between Average Upstreamness of Mexican Manufacturing Exports and Imports



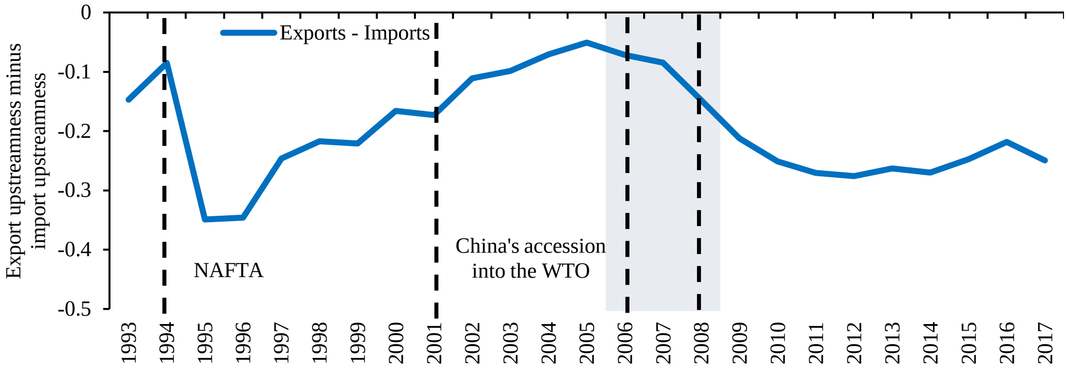
Source: Own calculations with data from Bank of Mexico and National Institute of Statistics and Geography (INEGI). Notes: This figure depicts the difference between the average upstreamness of Mexican manufacturing exports and imports, constructed as explained in detail in Subsection 4.1. The upstreamness measures for 2017 were computed employing accumulated trade flows from January to July of that year.

Figure F.3. Average Upstreamness of Mexican Automotive Exports and Imports



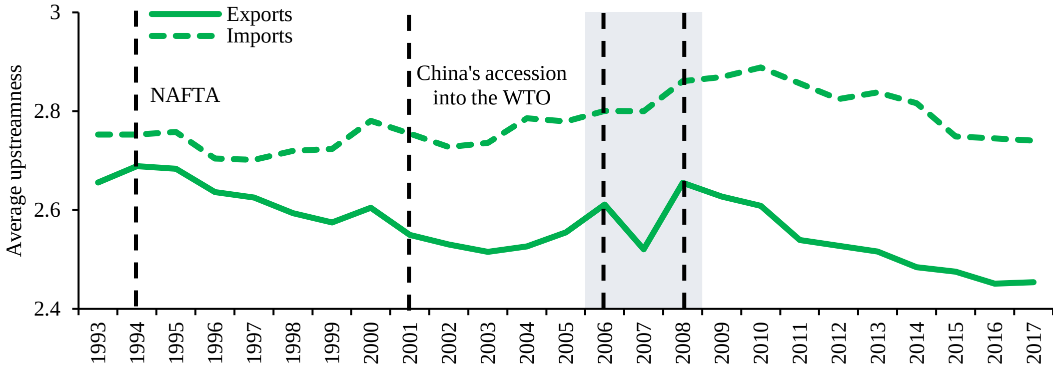
Source: Own calculations with data from Bank of Mexico and National Institute of Statistics and Geography (INEGI). Notes: This figure depicts the average upstreamness levels of Mexican exports (solid line) and imports (dotted line) of the automotive sector. These upstreamness levels are computed as weighted averages of industry level measures of upstreamness, using trade flows by industry as weights (see Subsection 4.1 for a description of the construction of the upstreamness measures). The weighted averages consider only those industry-level measures of upstreamness and the trade flows associated with those industries that conform the automotive sector; i.e., *Automobiles and Trucks*, *Motors Vehicles Bodies and Trailers*, and *Motor Vehicle Parts* industries. The upstreamness measures for 2017 were computed employing accumulated trade flows from January to July of that year.

Figure F.4. Difference between Average Upstreamness of Mexican Automotive Exports and Imports



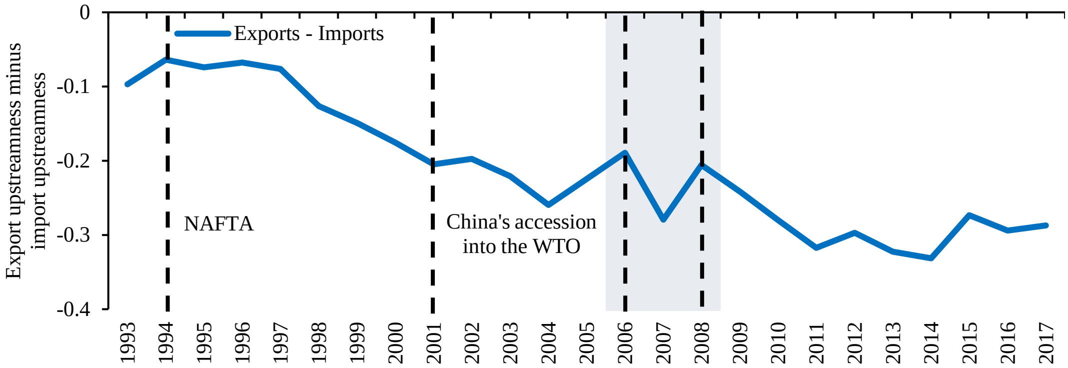
Source: Own calculations with data from Bank of Mexico and National Institute of Statistics and Geography (INEGI). Notes: This figure depicts the difference between the average upstreamness of Mexican exports and imports in the automotive sector, constructed as explained in detail in Subsection 4.1, but considering only those industry-level measures of upstreamness and trade flows associated with the industries that conform the automotive sector; i.e., *Automobiles and Trucks*, *Motors Vehicles Bodies and Trailers*, and *Motor Vehicle Parts* industries. The upstreamness measures for 2017 were computed using accumulated trade flows from January to July of that year.

Figure F.5. Average Upstreamness of Non-Automotive Exports and Imports *Maquiladora* Sector



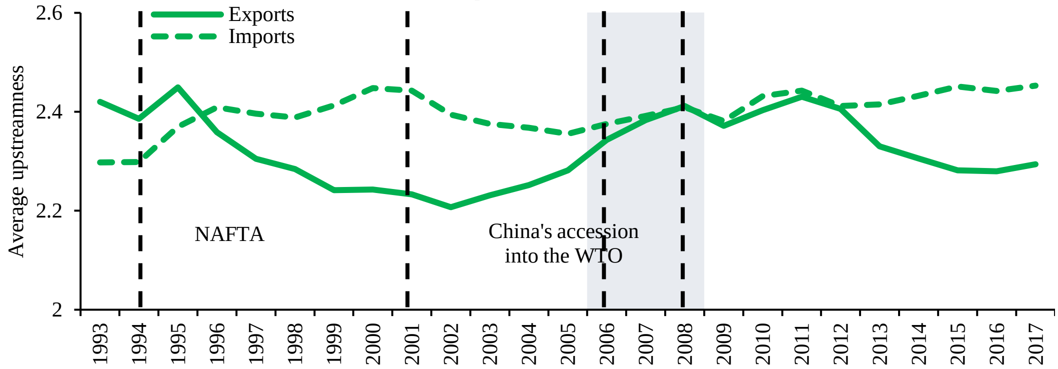
Source: Own calculations with data from Bank of Mexico and National Institute of Statistics and Geography (INEGI). Notes: This figure depicts the average upstreamness levels of Mexican exports (solid line) and imports (dotted line) of the non-automotive, *maquiladora* sector. These upstreamness levels are computed as weighted averages of industry level measures of upstreamness, using trade flows by industry as weights (see Subsection 4.1 for a description of the construction of the upstreamness measures). The weighted averages consider only trade flows of firms that participated at least one year between 1993 and 2006 in the *Maquiladora* program implemented by the Mexican government, and excludes trade flows associated with the industries of the automotive sector; i.e., *Automobiles and Trucks*, *Motors Vehicles Bodies and Trailers*, and *Motor Vehicle Parts* industries.

Figure F.6. Difference between Average Upstreamness of Mexican Non-Automotive Exports and Imports
Maquiladora Sector



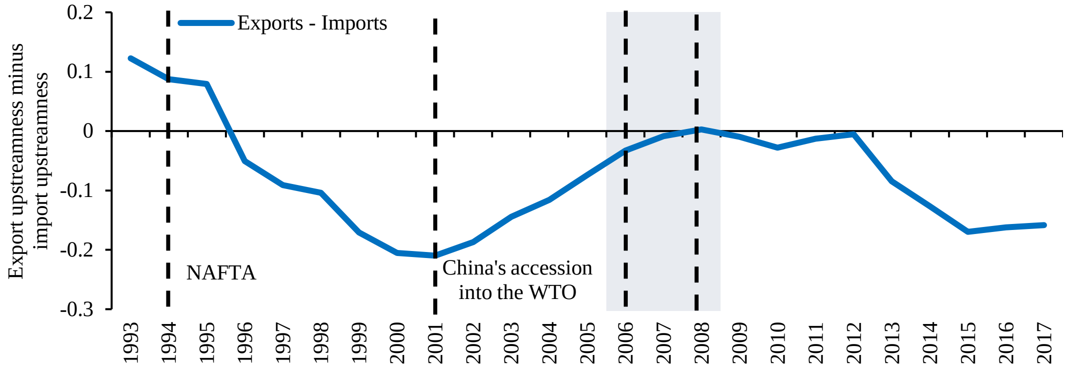
Source: Own calculations with data from Bank of Mexico and National Institute of Statistics and Geography (INEGI). Notes: This figure depicts the difference between the average upstreamness of Mexican exports and imports of the non-automotive, *maquiladora* sector, constructed as explained in detail in Subsection 4.1. These upstreamness measures are constructed considering only trade flows of firms that participated at least one year between 1993 and 2006 in the *Maquiladora* program, and excluding trade flows associated with the industries of the automotive sector; i.e., *Automobiles and Trucks*, *Motors Vehicles Bodies and Trailers*, and *Motor Vehicle Parts* industries.

Figure F.7. Average Upstreamness of Non-Automotive Exports and Imports
Non-Maquiladora Sector



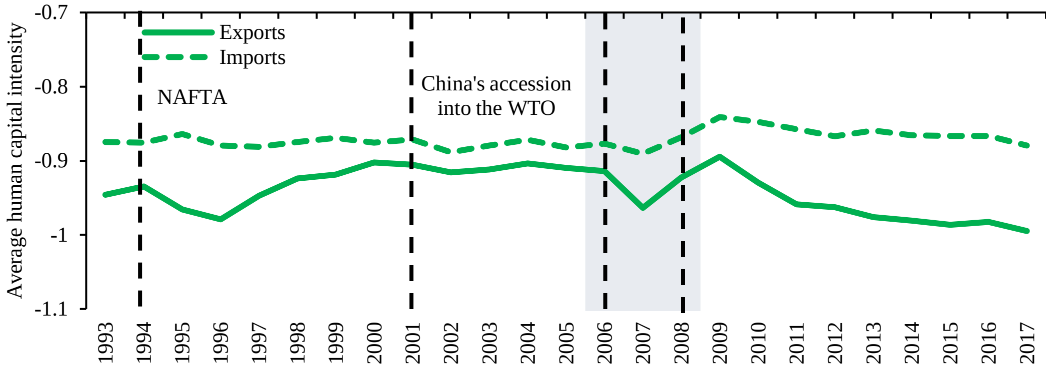
Source: Own calculations with data from Bank of Mexico and National Institute of Statistics and Geography (INEGI). Notes: This figure depicts the average upstreamness levels of Mexican exports (solid line) and imports (dotted line) of the non-automotive, non-maquiladora sector. These upstreamness levels are computed as weighted averages of industry level measures of upstreamness, using trade flows by industry as weights (see Subsection 4.1 for a description of the construction of the upstreamness measures). The weighted averages consider only trade flows of firms that did not participate in any of the years between 1993 and 2006 in the Maquiladora program implemented by the Mexican government, and excludes trade flows associated with the industries of the automotive sector; i.e., Automobiles and Trucks, Motors Vehicles Bodies and Trailers, and Motor Vehicle Parts industries.

Figure F.8. Difference between Average Upstreamness of Mexican Non-Automotive Exports and Imports
Non-Maquiladora Sector



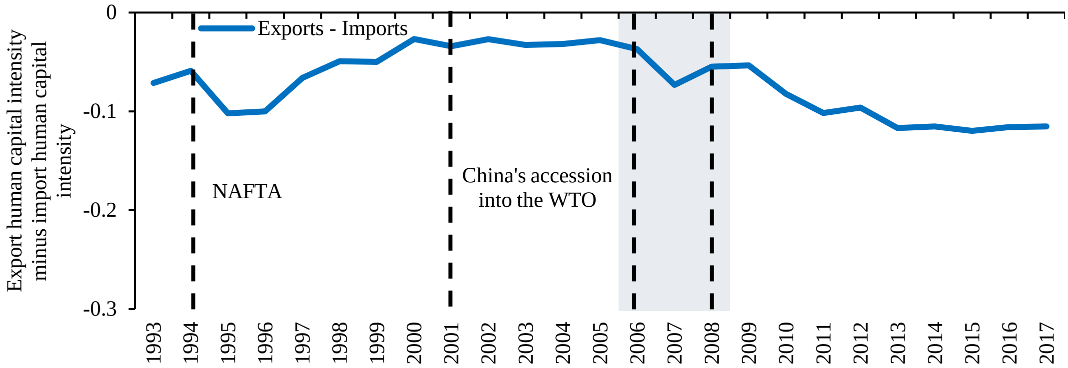
Source: Own calculations with data from Bank of Mexico and National Institute of Statistics and Geography (INEGI).
Notes: This figure shows the difference between the average upstreamness of Mexican exports and imports for the non-automotive, *no-maquiladora* sector, constructed as explained in detail in Subsection 4.1. These upstreamness measures are constructed considering only trade flows of firms that did not participate in any year between 1993 and 2006 in the *Maquiladora* program implemented by the Mexican government, and excluding trade flows associated with the industries of the automotive sector; i.e., *Automobiles and Trucks*, *Motors Vehicles Bodies and Trailers*, and *Motor Vehicle Parts*.

Figure F.9. Average Human Capital Intensity of Mexican Manufacturing Exports and Imports



Source: Own calculations with data from Bank of Mexico and Nunn and Trefler (2013).
Notes: This figure depicts the average skill intensity of Mexican manufacturing exports (solid curve) and imports (dotted curve). These skill intensity measures are computed as weighted averages of industry-level measures of skill intensity, using trade flows by industry as weights (see Subsection 5.1). The skill intensity measures for 2017 were computed employing accumulated trade flows from January to July of that year.

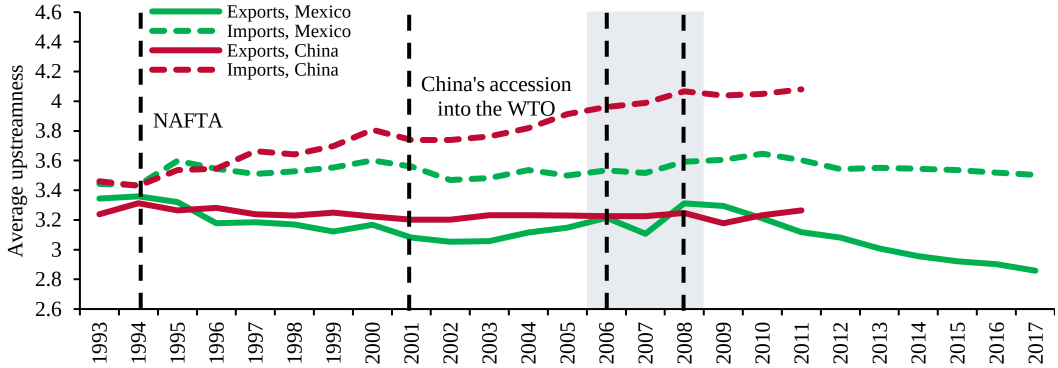
Figure F.10. Difference between Average Human Capital Intensity of Mexican Manufacturing Exports and Imports



Source: Own calculations with data from Bank of Mexico and Nunn and Trefler (2013).

Notes: This figure depicts the difference between the average human capital intensity of Mexican manufacturing exports and imports, constructed as explained in detail in Subsection 5.1. The skill intensity measures for 2017 were computed employing accumulated trade flows from January to July of that year.

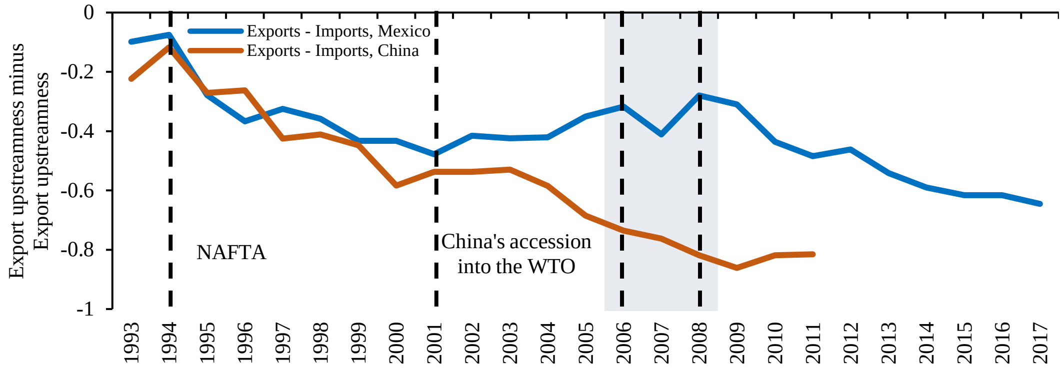
Figure F.11. Average Upstreamness of Mexican and Chinese Exports and Imports



Source: Own calculations with data from the Bank of Mexico, National Institute of Statistics and Geography (INEGI) and Chor, Manova and Yu (2014).

Notes: This figure depicts the average upstreamness levels of Mexican manufacturing exports and imports (green solid and green dotted curves) and the average upstreamness levels of Chinese total exports and imports (red solid and red dotted curves). These upstreamness levels are computed as weighted averages of industry-level measures of upstreamness, using trade flows by industry as weights (see Subsection 4.1 for a description of how the upstreamness levels are constructed). In order to achieve comparability between Mexico and China, the measures of upstreamness at the industry-level of Mexico were adjusted in manner that the upstreamness value of its sixth most upstream industry, *Nonferrous Metal Industry, except Aluminum*, was equal to the most upstream industry in China, *Nonferrous Metal Mining Industry* (see footnote 27). The upstreamness measures of Mexico for 2017 were computed employing accumulated trade flows from January to July of that year.

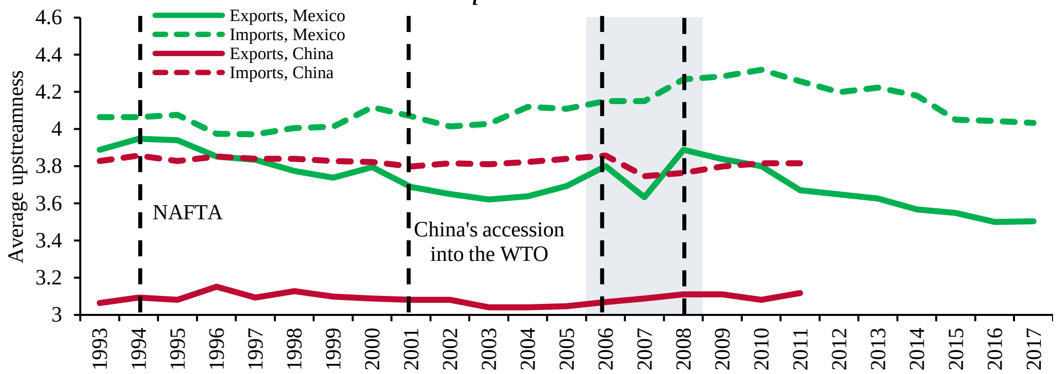
Figure F12. Difference between Average Upstreamness of Exports and Imports of Mexico and China



Source: Own calculations with data from the Bank of Mexico, National Institute of Statistics and Geography (INEGI), and Chor, Manova and Yu (2014).

Notes: This figure shows the difference between the upstreamness of Mexican manufacturing exports and imports (blue solid curve), and the difference between the average upstreamness of Chinese total exports and imports (orange solid curve). These upstreamness measures are constructed as explained in detail in Subsection 4.1. The upstreamness measures of Mexico for 2017 were computed employing accumulated trade flows from January to July of that year.

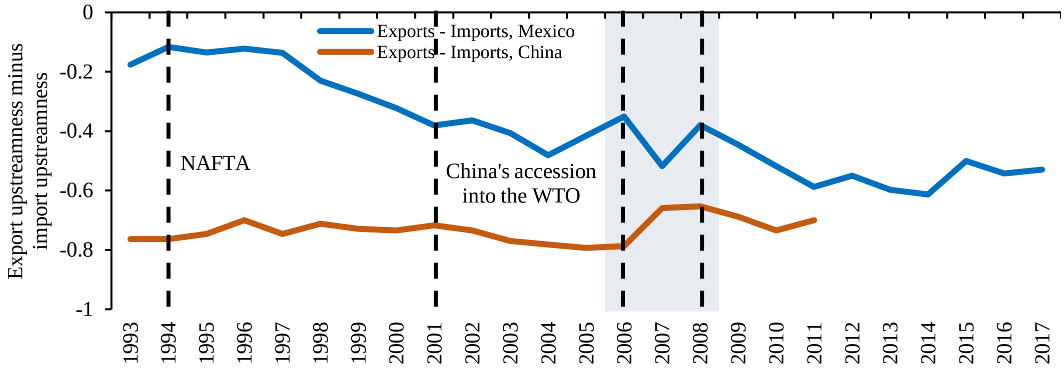
Figure F.13. Average Upstreamness of Exports and Imports of Mexico and China *Maquiladora* Sector



Source: Own calculations with data from the Bank of Mexico, National Institute of Statistics and Geography (INEGI) and Chor, Manova and Yu (2014).

Notes: This figure depicts the average upstreamness levels of Mexican exports and imports (green solid and dotted curves) for the *maquiladora* sector and the average upstreamness levels of Chinese exports and imports (red solid and dotted curves) for the processing sector. These upstreamness measures are constructed as explained in detail in Subsection 4.1. In order to achieve comparability between Mexico and China, the measures of upstreamness at the industry-level of Mexico were adjusted in manner that the upstreamness value of its sixth most upstream industry, *Nonferrous Metal Industry, except Aluminum*, was equal to the most upstream industry in China, *Nonferrous Metal Mining Industry* (see footnote 27). The upstreamness measures for Mexico are constructed considering only trade flows of firms that participated at least one years between 1993 and 2006 in the *Maquiladora* program implemented by the Mexican government, and excluding trade flows associated with the industries of the automotive sector; i.e., *Automobiles and Trucks*, *Motors Vehicles Bodies and Trailers*, and *Motor Vehicle Parts* industries. The upstreamness measures for China were retrieved from Chor, Manova and Yu (2014).

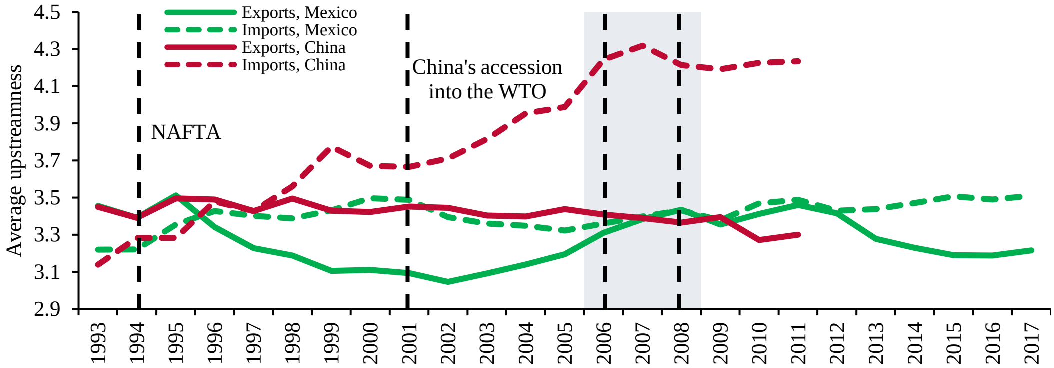
Figure F.14. Difference between Average Upstreamness of Exports and Imports of Mexico and China
Maquiladora Sector



Source: Own calculations with data from the Bank of Mexico, National Institute of Statistics and Geography (INEGI), and Chor, Manova and Yu (2014).

Notes: This figure depicts the difference between the average upstreamness of Mexican non-automotive, *maquiladora* exports and imports (blue solid line), and the difference between the average upstreamness of Chinese processing exports and imports (orange solid line). These upstreamness measures are constructed as explained in detail in Subsection 4.1. The upstreamness measures for Mexico are constructed considering only trade flows of firms that participated at least one years between 1993 and 2006 in the *Maquiladora* program implemented by the Mexican government, and excluding trade flows associated with the industries of the automotive sector; i.e., *Automobiles and Trucks*, *Motors Vehicles Bodies and Trailers*, and *Motor Vehicle Parts* industries. The upstreamness measures of Mexico for 2017 were computed employing accumulated trade flows from January to July of that year.

Figure F.15. Average Upstreamness of Exports and Imports of Mexico and China
Non-Maquiladora Sector

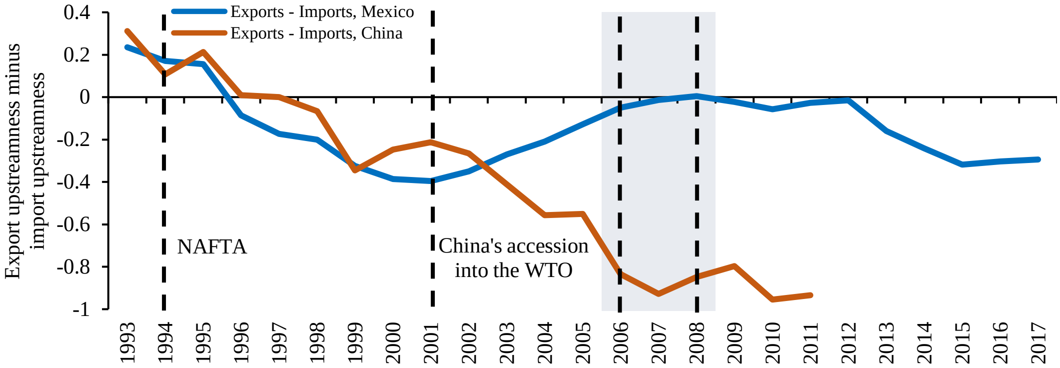


Source: Own calculations with data from the Bank of Mexico, National Institute of Statistics and Geography (INEGI) and Chor, Manova and Yu (2014).

Notes: This figure depicts the average upstreamness levels of Mexican exports and imports (green solid and dotted curves) for the *non-maquiladora* sector and the average upstreamness levels of Chinese exports and imports (red solid and dotted curves) for the non-processing sector. These upstreamness measures are constructed as explained in detail in Subsection 4.1. In order to achieve comparability between Mexico and China, the measures of upstreamness at the industry-level of Mexico were adjusted in manner that the upstreamness value of its sixth most upstream industry, *Nonferrous Metal Industry, except Aluminum*, was equal to the most upstream industry in China, *Nonferrous Metal Mining Industry* (see footnote 27). The upstreamness measures for Mexico are constructed considering only trade flows of firms that did participate in any year between 1993 and 2006 in the *Maquiladora* program implemented by the Mexican government, and excluding trade flows associated with the industries of the automotive sector; i.e., *Automobiles and Trucks*, *Motors Vehicles Bodies and Trailers*, and *Motor Vehicle Parts* industries. The upstreamness measures for China were retrieved from Chor, Manova and Yu (2014).

Figure F.16. Difference between Average Upstreamness of Exports and Imports of Mexico and China

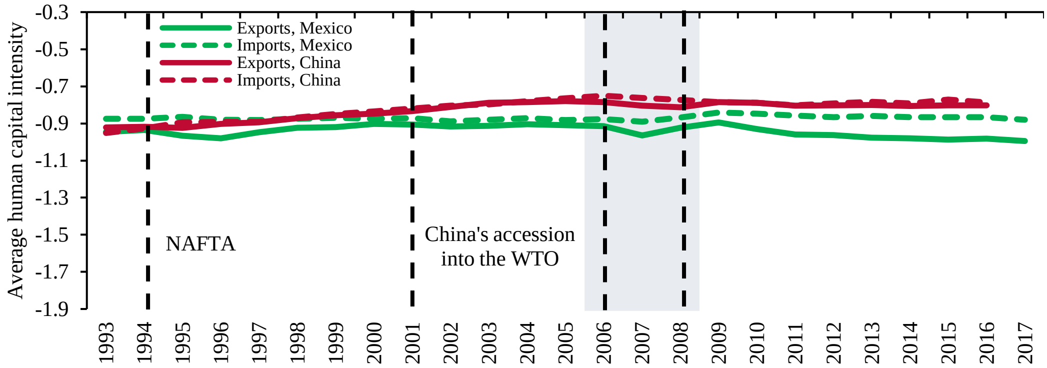
Non-Maquiladora Sector



Source: Own calculations with data from the Bank of Mexico, National Institute of Statistics and Geography (INEGI), and Chor, Manova and Yu (2014).

Notes: This figure depicts the difference between the average upstreamness of Mexican non-automotive, non-*maquiladora* exports and imports (blue solid line), and the difference between the average upstreamness of Chinese non-processing exports and imports (orange solid line). These upstreamness measures are constructed as explained in detail in Subsection 4.1. The upstreamness measures for Mexico are constructed considering only trade flows of firms that did not participated in any year between 1993 and 2006 in the *Maquiladora* program implemented by the Mexican government, and excluding trade flows associated with the industries of the automotive sector; i.e., *Automobiles and Trucks*, *Motors Vehicles Bodies and Trailers*, and *Motor Vehicle Parts* industries. The upstreamness measures of Mexico for 2017 were computed employing accumulated trade flows from January to July of that year.

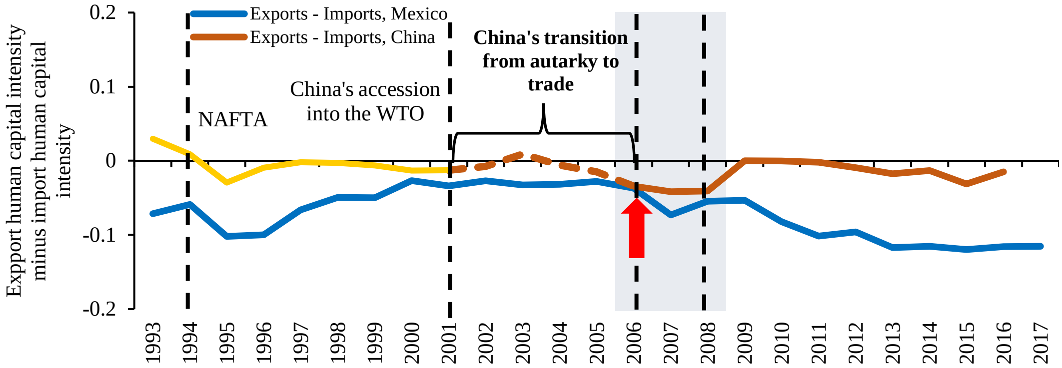
Figure F.17. Average Human Capital Intensity of Manufacturing Exports and Imports of Mexico and China



Source: Own calculations with data from Bank of Mexico, United Nations (UN) Comtrade and Nunn and Trefler (2013).

Notes: This figure depicts the average human capital intensity levels of Mexican manufacturing exports and imports (green solid and green dotted curves), and the average human capital intensity levels of Chinese manufacturing exports and imports (red solid and red dotted curves). These skill intensity levels are computed as weighted averages of industry-level measures of human capital intensity, using trade flows by industry as weights (see Subsection 5.1 for further details). The human capital intensity measures of Mexico for 2017 were computed employing accumulated trade flows from January to July of that year.

Figure F.18. Difference between Average Human Capital Intensity of Manufacturing Exports and Imports of Mexico and China



Source: Own calculations with data from Bank of Mexico, United Nations (UN) Comtrade and Nunn and Trefler (2013). Notes: This figure depicts the difference between the average human capital intensity of Mexican manufacturing exports and imports (blue solid curve), and the difference between the average human capital intensity of Chinese manufacturing exports and imports (orange solid curve), constructed as explained in detail in Subsection 5.1. The skill intensity measures of Mexico for 2017 were computed employing accumulated trade flows from January to July of that year.