Value Added in Exports Under NAFTA: A Binational Input–Output Model

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Abstract The work highlights the stylized fact that Mexico has had a significant gross trade surplus with the USA during the NAFTA period, proving the existence of a notable deficit for Mexico in terms of the added value incorporated in this trade. The value-added flow in Mexico's gross exports to the USA only reaches 164.4 billion dollars, while the domestic content of the USA gross exports is 188.7 billion dollars. In the disaggregation of added value, the great difference between domestic and foreign components incorporated in exports stands out, while for the USA the foreign added value in its exports reaches 2.5 billion dollars for the case of Mexico, this concept is 50.2 billion dollars, which is more than 20 times the amount it represents for the USA. A conclusion that derives directly from this last aspect is that during NAFTA an important part of the income from Mexican exports goes to remunerate productive factors used in the USA.

Keywords Value added in gross exports · Global value chains · NAFTA · Bilateral product input

1 Introduction

Perhaps the most important result during the period of the North American Free Trade Agreement (NAFTA) is the drastic change in the trade relationship between the USA and Mexico, turning Mexico's trade deficit into a surplus. This caused former President Donald Trump to decide to renegotiate or cancel it.

As an example of this stylized fact is that between 2013 and 2016, the commercial flow between both countries was more than 500 billion dollars annually. Of these, US imports originating in Mexico reached values close to 300 billion dollars and exports to Mexico showed figures around 240 billion dollars. Consequently, the

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gross trade deficit of the USA with Mexico, according to official statistics, was around 60 billion dollars for this period (Chiñas 2017).

However, during NAFTA both countries have maintained an intense flow of trade in intermediate inputs in respect of which an overestimation of the values recorded by their double counting is recognized as they are incorporated into the products that use them (Lalanne 2016). Moreover, it is known that the higher the content of intermediate input imports in Mexican exports, the lower the added value generated in Mexico and, therefore, a greater part of the export revenue is used to remunerate productive factors used in USA (De La Cruz et al. 2011; Fujii Gambero and Cervantes 2013). Hence, a correct measurement of the added value contained in exports between these two countries is a basic starting point for the net quantification of the trade balance and for assessing the relevance or effects of a change in the bilateral trade policy.

The present work carries out a binational and sectoral analysis for the study of the added value incorporated in trade between the USA and Mexico for 2013. The objective is to apply a methodology that allows us to characterize the commercial integration between both countries during NAFTA and investigate the breakdown of the content of the bilateral value added by making a comparative analysis between countries and sectors. To this end, a bi-regional (or binational) input-output table is used as an analytical framework, allowing, among other advantages, to analyze the interregional and intersectoral links of both countries (Miller and Blair 2009).

It is also important to mention some publications related to this current work. Boundi-Chraki analyzes the dependence and integration in NAFTA, especially the inter-relationship of Mexico with the USA and Canada by calculating the backward linkages, the forward linkages, and the interregional feedbacks generated by the three countries (Boundi-Chraki 2017). Torre, Chapa, and González estimate Mexico's gross output and its value added linked to the economic activity of the USA by sectors and regions (Torre et al. 2020). Lastly, Aroche and Marquez hypothesized that changes in the level of integration affect the ability an economy has to provide welfare opportunities to its population. They also show that a reduction in the degree of integration of an economy weakens its ability to achieve steady growth, because of the loss of the propagating effects of an expanding demand, even if exports expand at high rates. This might explain the disappointing performance of the Mexican economy in regard to these issues even after structural reforms have been adopted and exports growth has become a central component of the development strategy (Aroche and Marquez 2012).

The work is structured in such a way that Sect. 1 reviews the literature on vertical productive specialization and the measurement of added value contained in foreign trade. Section 2 presents the methodology for the breakdown of the added value of bilateral trade and its limits. Section 3 shows the database used and the estimation of the binational product input model for 2013. Section 4 shows the estimates of the value-added breakdown and a comparison of the sectoral results between the two countries. Finally, Section 5 indicates the relevance of the exercise for the USA and Mexico case.

2 Literature Review

NAFTA has been consistent with the increase in cross-border trade between countries, which is a dominant feature today and is a challenge for measuring world trade volumes. In particular, during this period, vertically integrated global production chains have emerged.

There is international literature that studies patterns of productive specializations from the perspective of the vertical integration of productive processes that employ a structural framework of product input. This highlights the seminal work of (Hummels et al. 2001), which adopts a global inter-country input–output (GICIO) and provides a formulation for the calculation of content in intermediate imports in exports, variable that they call vertical specialization (VS).

Additionally, there is literature that quantifies the content of value added in world trade using a multi-country input-output table (Trefler and Zhu 2010; Daudin et al. 2011; Johnson and Noguera 2012a, b; Koopman et al. 2012, 2014), which employs a GICIO and others like (Timmer et al. 2013; Baldwin and Lopez-Gonzalez 2015; Johnson 2014; Solaz 2016), which uses the World Input Output Database (WIOD). It is important to point out that the work of (Koopman et al. 2012) integrates vertical specialization measures and the breakdown of value added in international trade into a multi-country conceptual framework.

Torre et al. (2020) based their work on the World Input-Output Database 2016 and using the Hypothetical Extraction Method to estimate Mexico's gross output and value added linked to the economic activity of the USA and then the gross output and value added of the USA linked to Mexico's economic activity as well as the Ghosh Regional Model to estimate how the value added of Mexico linked to the economic activity in the USA is allocated among its sectors and regions. The authors capture the strong economic linkage between both economies at the aggregate level, as well as its sectoral concentration. The results also indicate that the Northern and Central regions of Mexico are those with the strongest link to the USA, followed by the Southern region, where the largest share of the oil industry is located (Torre et al. 2020). While Boundi-Chraki (2017) analyzes the dependence and integration in NAFTA, especially the inter-relationship of Mexico with the USA and Canada by calculating the backward linkages, the forward linkages, and the interregional feedbacks generated by the three countries (Boundi-Chraki 2017). And Aroche and Márquez (2012) employ the "important coefficients" of the input–output table as indicators of the level of integration between the industries in an economic structure. An economic structure is defined as a set of interdependent sectors linked by a set of intermediate demand flows. Such flows define the character of the aforementioned structure. It is hypothesized that changes in the level of integration affect the ability an economy has to provide welfare opportunities to its population. The article also shows that a reduction in the degree of integration of an economy weakens its ability to achieve steady growth, because of the loss of the propagating effects of an expanding demand, even if exports expand at high rates.

In addition, there is some international literature that addresses the national content of intermediate inputs in exports from the USA and Mexico during the NAFTA period. The most direct works by their scope and methodology are those of (De La Cruz et al. 2011) and (Fujii Gambero and Cervantes 2013). Both are based on the input-output table for Mexico, prepared by the National Institute of Statistics and Geography (Instituto Nacional de Estadística y Geografía—INEGI in Spanish) with data from 2003 and make estimates separately for the export maquiladora industry and for the rest of the activities exporters included in what INEGI calls the internal economy, both estimates used in the national model.[1]

They apply the methodology of (Koopman et al. 2012) that seeks to discriminate the information of companies in special foreign trade regimes in order to improve the estimation of the imported component of imports, under the premise that these companies have greater relative use of imported inputs than traditional companies do. The estimation strategy was to create new rows and columns in the single country model for these specific companies. The estimated single country model assumes that the companies (or rather the operations) that carry out *processing exports* allocate all their product to the final demand abroad, so that the intermediate use of these industries is zero. Thus, the national added value contained in exports is broken down into two parts: a fraction generated by maquiladora industry exports and, the other, by internal economy exports. In turn, each of these subdivides the direct and indirect added value contained in exports that estimated from the multipliers derived from the table of added value coefficients contained in IME and EI exports.

(De La Cruz et al. 2011) conclude that more than 85% of its exports are operations of global value chains. In addition, their estimates suggest that, on average, Mexican manufacturing exports have a share in the domestic added value of around 34%. Industries that have a national content of less than 50% represent approximately 80% of the country's manufacturing exports. The low internal value-added industries include computer and peripheral equipment, audio and video equipment, semiconductors and electronics. Industries with content greater than 65% represent only 5.1% of total exports of manufactured goods from Mexico. They also point out that the export industries that tend to use the IME program, for example, electronics, have a low domestic added value, while the industries that export under PITEX—the automobile and machinery industry—have a relatively higher domestic content.

Meanwhile (Fujii Gambero and Cervantes 2013) point out that the EMI with 62% of manufacturing exports contribute only 33% of the domestic added value contained in them. For its part, EI, which has 38% of exports, contributes 67% of the internal added value contained in exports. In the manufacturing sector, the added value of national origin represents 42% of the value of manufactured exports. This

[1]De La Cruz et al. (2011) makes the observation that INEGI reports information only on IME, but not on PITEX (Programa de Importación Temporal para Exportación), so Mexican imports from the US might be underestimated. They include data from both IME and PITEX.

proportion is significantly higher in EI exports (75%) than in IME (22%). Finally, the electronics (29% of the total), transportation (28%), and electrical equipment (9% of the total) sectors together contribute 66% of the value of the country's manufacturing exports.

The single country approach used by the last authors allows estimating the added value of exports without having to resort to multi-country input-output models, but to work directly with the domestic input-output table. However, single country models suffer from certain limitations when they are used to estimate the imports contained in exports: existence of the domestic and imported utilization table and their official availability.

3 Value-Added Methodology in Binational Trade

(Koopman et al. 2012) synthesize the conceptual framework that allows the complete breakdown of the origin of the added value contained in exports. In addition, they developed a general formulation and include the particular case of two countries (1 and 2). In the latter case, the partition of the input–output matrices balance equation for both countries is formally expressed by

$$\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} y_{11} + y_{12} \\ y_{21} + y_{22} \end{bmatrix} \tag{1}$$

where x_1 is total gross production of country 1 used as an intermediate or final input, internally or externally; y_{12} is the final demand in country 2 of final goods of country 1; and a_{ij} are the technical coefficients or direct coefficients. The same interpretation will be for x_2 denoting country 2.

Rearranging the previous terms we have

$$\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} I - a_{11} & a_{12} \\ a_{21} & I - a_{22} \end{bmatrix}^{-1} \begin{bmatrix} y_{11} + y_{12} \\ y_{21} + y_{22} \end{bmatrix} = \begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix} \begin{bmatrix} y_1 \\ y_2 \end{bmatrix} \tag{2}$$

where b_{ij} are the Leontief inverse or total coefficients, likewise, $y_1 = y_{11} + y_{12}$, and $y_2 = y_{21} + y_{22}$.

Defining the direct coefficients of added value (v_i) as the division of the added value (VA_i) between the production for each sector (X_i) and expressing it in a matrix way (although having no interaction they are treated as independent vectors), we have the following:

$$V = \begin{bmatrix} v_1 & 0 \\ 0 & v_2 \end{bmatrix} \tag{3}$$

Pre-multiplying Eq. (2) by Eq. (3) results in the internal and external value-added participation of country 1 and country 2, respectively. Following (Koopman et al. 2012) and without loss of generality, we can only work with the gross exports of country 1 to define the conceptual framework of value-added decomposition:

$$\begin{aligned} e_{12} &= y_{12} + a_{12}x_2 = [v_1 b_{11} e_{12} + v_2 b_{21} e_{12}] \\ &= [v_1 b_{11} y_{12} + v_1 b_{12} y_{22}] + \left[v_1 b_{12} y_{21} + v_1 b_{21} a_{12} (1 - a_{11})^{-1} y_{11}\right] \\ &\quad + v_1 b_{21} a_{21} (1 - a_{11})^{-1} e_{12} + \left[v_2 b_{21} y_{12} + v_2 b_{21} a_{12} (1 - a_{22})^{-1} y_{22}\right] \\ &\quad + v_2 b_{21} a_{12} (1 - a_{22})^{-1} e_{21} \end{aligned} \tag{4}$$

Equation (4) says that the gross exports of country 1 consist of final and intermediate goods and is made up of eight terms. Of these, the first two represent the domestic added value absorbed by the foreign economy, being in the case of the first through the final demand served directly by the domestic country and in the second by the final demand of the foreigner satisfied from abroad, the formulations would be expressed as:

$$\boldsymbol{v}_1 = v_1 b_{11} y_{12} \tag{5}$$

$$\boldsymbol{v}_2 = v_1 b_{12} y_{22} \tag{6}$$

The third term is domestic added value that is initially exported as an intermediate input but is returned to the domestic country as part of the final imports of the domestic country, being expressed as:

$$\boldsymbol{v}_3 = v_1 b_{12} y_{21} \tag{7}$$

The following term also represents the value added initially exported as an intermediate input but which in this case is returned to the country as part of the intermediate imports of the foreign country that are integrated into the final domestic products consumed in the domestic country:

$$\boldsymbol{v}_4 = v_1 b_{12} a_{21} (1 - a_{11})^{-1} y_{11} \tag{8}$$

The following term represents pure double counting and occurs when both countries export intermediate consumer goods back and forth that are absorbed by new exports of intermediate goods from the domestic country:

$$\boldsymbol{v}_5 = v_1 b_{12} a_{21} (1 - a_{11})^{-1} e_{12} \tag{9}$$

The sixth term is the foreign value added in the gross exports of the domestic country:

$$\boldsymbol{v}_6 = v_2 b_{21} y_{12} \tag{10}$$

The next term is part together with the previous one to the value added abroad that returns to it, in this case as part of the consumption of final goods in that country:

$$\boldsymbol{v}_7 = v_2 b_{21} a_{12} (1 - a_{22})^{-1} y_{22} \tag{11}$$

The last term is the one that represents the trade in both directions of intermediate goods that are returned abroad as intermediate goods and represent together with $\mathbf{v}_5$ the double counting in international trade although in this case the one that returns abroad.

$$\boldsymbol{v}_8 = v_2 b_{21} a_{12} (1 - a_{22})^{-1} e_{21} \tag{12}$$

The application developed for the economies of the USA and Mexico needs to consider a modification of the original model. By not having the rest of the world included in the binational model, it is not possible to determine the Mexican added value in extraregional intermediate inputs. This assumption implies that exports from the rest of the world behave as if they were of final goods. Thus, the VS[2] is overestimated and the VS1[3] will be underestimated. It is also important to recognize that according to the authors of the methodology in countries with high participation in global production chains, the added value that returns could be important.

4 Binational Input-Output Table

(Koopman et al. 2012) develop a conceptual framework based on a multi-country input–output model and its decomposition into a matrix of technical coefficients, a matrix of global and country total requirements, production vectors, final demand both internal and by country, exports and domestic and by country added value. Based on this, they make an analytical derivation of the previous eight components that are then able to combine to reproduce different measures of vertical specialization (previously used by others) and the measurement of sources of added value in international trade.

[2]VS measures the direct and indirect content of imports and is a measure for their foreign content. This is based on the assumption that imports have been produced completely abroad, without any domestic content, which is hardly true when the good is produced in more than two stages and there is intermediate good trade between both economies; that is, when the country trades intermediate goods in both directions Hummels et al. (2001).

[3]*VS1* generalizes the concept of VS proposed by (Hummels et al. 2001) by eliminating the assumption of no intermediate good trade in three directions. It adds value added indirect exports, the domestic content exported for third countries to produce intermediate good exports, and the domestic value added that returns as imports from third countries.

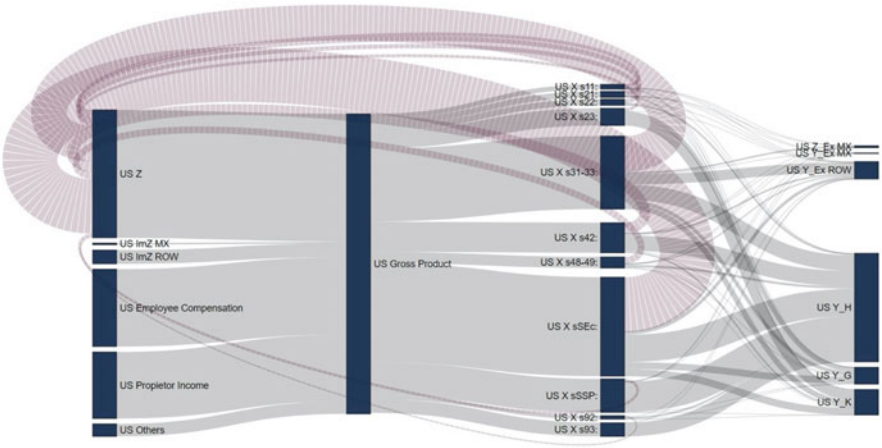

Fig. 1 Structural Relation of Transaction Flow of the US Economy. Source: based on IMPLAN 2013 IO model

Here we use an alternative methodology for immersion in foreign trade figures in the USA and Mexico. That is, we elaborate a binational input-output table. In assuming this task, it was considered appropriate that the level of sector aggregation had the highest level of detail possible. For the USA, the model contained in the IMPLAN (Minnesota Implan Group -MIG- 2017) was used for 2013 with a sector structure of 526 sectors. In the case of Mexico, the table built by INEGI for 2013 (INEGI 2014) was used at the four-digit level of the North American Industrial Classification System (NAICS) composed of 261 sectors.

Those models represented as the structural relation of transaction flows between the economic agents are shown in Figs. 1 and 2. Initially, we can see how in the US economy the production sectoral composition has a large share of the services sector and secondly the industrial sector, also in both cases half of its product is destined to productive inputs within the USA. In contrast, in the Mexican economy, the main sector is the industrial sector, followed by the services sector. In both, only 30% are productive inputs and in the industrial sector another 30% is exported to other countries mainly the USA.

In both economies, value added accounts for more than half of the gross product and is even somewhat higher in the Mexican economy compared with the USA. However, the internal composition in Mexico has a low proportion corresponding to employee compensation—30%—when this proportion for the USA is around 50%. It is also notable how the share of imports in production inputs is much more significant for the Mexican economy, where, in addition, about 60% comes from the USA, while for the US economy, imports from Mexico are around 5%. Something similar occurs with exports, which are relatively more important as a destination for production for the Mexican economy than for the USA and the main destination of those exports is the USA.

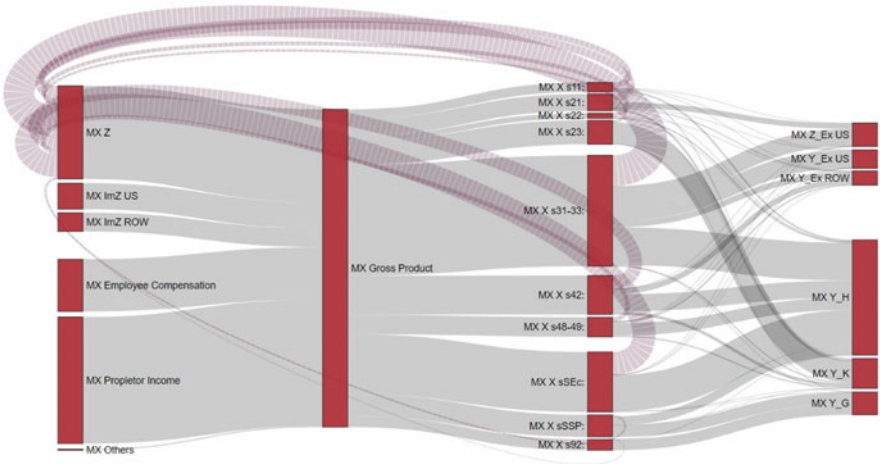

Fig. 2 Structural Relation of Transaction Flow of the US Economy. Source: based on INEGI 2013 IO model

The first step in the generation of the integrated model of the USA–Mexico was the sectorial compatibility of the individual models. Of the 526 sectors, a total of 488 had total correspondence at the four-digit level of the NAICS and the remaining 38 combined activities from various sectors which were assigned according to a weighting based on their relative participation in their aggregate using data from economic censuses This process resulted in 259 sectors. Finally, the compatibility of the activities between both models required minor adjustments in the classifications, which resulted in 247 economic sectors.

With the national models reconfigured to a compatible classification, the second step is the construction of the integrated model required for the estimation of trade flows between both countries at the level of interaction of individual sectors for which we have the specific aggregate flows of trade USA–Mexico and as part of the matrix of import flows at the level of sector interaction and aggregates of total exports by sector, a problem similar to that faced for the estimation of multiregional models referred to in (Canning and Wang 2005).

The reasoning that supports the estimation of foreign trade matrices begins by considering that trade between both countries is already part of the aggregates of imports and exports of the matrices of each country and therefore its incorporation into the matrix initially considers subtracting the values of trade flows of total imports and exports of the matrices of both countries, as appropriate. With this procedure, we can already incorporate these amounts to the trade matrices by making an initial distribution based on the structural composition of the import matrices for each country as appropriate. The consistency of the aggregates is achieved considering that the sum by rows of the trade flows between the USA and Mexico and the exports must coincide with the exports by sector of the individual models and the sum by columns of the trade flows between the USA and Mexico and the imports of

Table 1 Aggregate Representation of the Product Input Model of the USA and Mexico (Millions of US Dollars)

	Intermediate Demand		Final Demand			
	US	Mexico	US	Mexico	RM Exports	Total availability
US	12,165,962	178,532	14,377,515	56,799	1,658,836	28,437,643
Mexico	166,098	589,306	120,855	1,128,118	100,167	2,104,544
Imports from the rest of the world	1,207,596	128,716	1,068,879	48,138		
Primary factors	14,897,988	1,207,991	1,884,123			1,884,123
Total production	28,437,643	2,104,544	1,884,123			32,426,310

Source: Own calculation based on IMPLAN 2013 IO model (USA) and INEGI 2013 IO model (Mexico)

the rest of the countries must add up by sector the total imports of the individual models. Finally, the adjustment of trade values and of the imports and exports of the rest of the countries will be achieved using the RAS method (Lahr & De Mesnard 2004), which knowing the aggregates of a matrix performs an iterative procedure that adjusts the sum of the internal values to totals added by row and column.

The integrated model of the economies of the USA and Mexico, as can be seen in the following table, is a combination of economic interactions and the main aggregates of the economy for each economy and includes a record of trade flows. The above is an aggregate representation of the model where the rows identified as the USA and Mexico are composed of the integration of the values of the 247 economic sectors already mentioned and the columns of the intermediate demand block also identified as the USA and Mexico are also composed of the integration of the values of the 247 sectors of economic activity (Table 1).

The exposed binational model by rows is a representation of the production destinations that can be dedicated to meet the requirements of intermediate demand when its consumption involves the incorporation of a new product or as final consumption when consumers extract the production of the flow of productive interactions of the economy. By columns, the model represents the way in which production is generated and can be associated to a production function where inputs from other sectors of the economy are combined with primary factors such as labor and capital to generate the production. In the biregional model we can also identify the main aggregates of the national accounts system as gross domestic product—by consolidating the added value—household consumption, government consumption, intermediate demand, demand final, exports, among others.

5 Results

The results of the decomposition of the origin of the added value contained in the gross exports of the USA and Mexico in 2013 were calculated using the "decompr" module developed by (Quast and Kummritz 2015) that is integrated into the R software (R Core Team 2018) and is presented in Table 2.

For 2013, out of the 236 billion dollars exported by the USA to Mexico there were 120.2 billion dollars directly added value in the USA and another 62.1 billion dollars that were added in the USA, but exported as intermediate inputs and returned to USA to become part of exports again. Additionally, 6.4 billion dollars were part of a duplicate accounting, but which were part of the 188.7 billion dollars domestic product. The other components of exports from the USA to Mexico are 2.5 billion dollars of value added in Mexico and 1.4 billion dollars of duplicate accounting generated in Mexico. Finally, 43.3 billion dollars are integrated that are imported by the USA from other nations to be integrated into exports to Mexico.

In addition, the results show that out of the 287 billion dollars of exports from Mexico to the USA, the direct added value in Mexico included in them reaches 140.5 billion dollars to which we must add 22.5 billion dollars of added value that returns to Mexico and 1.5 billion dollars of accounting double that integrate the 164.4 billion dollars of domestic production contained in the exports. The rest is made up of 50.2 billion dollars value added in the USA and a double accounting from the USA that reaches the amount of 6.4 billion dollars, and the 65.9 billion dollars imports from third countries.

We can highlight the fact that in terms of domestic added value the content in the gross exports of the USA reaches 188.7 billion dollars, while the domestic content of

Table 2 Results of the Value-Added Breakdown of Trade Between the USA and Mexico

Component	USA (1)	Mexico (2)
Domestic added value in final exports	46,358.1	61,712.4
Domestic added value in intermediate exports absorbed by direct importers	73,797.4	78,753.4
Domestic added value in intermediate exports re-exported to third countries	11,858.8	19,933.9
Domestic added value that returns as final goods	29,722.9	882.4
Domestic added value that returns home as intermediate goods	20,532.7	1666.0
Double counting of domestic origin	6426.0	1470.9
Foreign added value in exports of final products from the direct importer	882.4	29,722.9
Foreign added value in exports of intermediate goods from the from the direct importer	1666.0	20,532.7
Double counting of foreign origin due to the production of direct importer exports	1470.9	6426.0
Trade with the participation of third countries	43,309.5	65,852.5
Total gross bilateral trade	236,024.7	286,953.0

Source: Own elaboration, based on (Koopman et al. 2012) model

Table 3 Breakdown of Value Added and Relative Indicators of Trade between the USA and Mexico

Value-added breakdown	USA to Mexico	Mexico to USA
Value added in exports	120,155.5	140,465.8
National value added	161,737.2	161,282.0
Foreign value added	2548.4	50,255.6
National content in gross exports	188,695.9	164,418.9
Pure double count of national origin	6426.0	1470.9
Pure double count of foreign origin	1470.9	6426.0
Trade with the participation of third countries	43,309.5	65,852.5
Relative indicators		
Value added to export ratio (Johnson and Noguera)	0.5091	0.4895
Export value added	0.6853	0.5621
National export content	0.7995	0.5730
Total gross bilateral trade	236,024.7	286,953.0

Source: Own elaboration, based on (Koopman et al. 2012) model

the gross exports of Mexico is around 164.4 billion dollars. This is a result with great implications because it means that when we take into account the imported contents of the gross exports, the domestic content of the USA exceeds that of Mexico. In terms of trade between the two countries, this implies that it would be the USA who would maintain a surplus relationship in the balance trade with Mexico as opposed to the conclusions derived from the analysis of gross foreign trade between both countries.

Additionally, the difference between the domestic and foreign components of the added value incorporated in exports can be observed because for the USA the foreign added value in its exports reaches 2.5 billion dollars for the case of Mexico, this concept is around 50.2 billion dollars that is more than 20 times the amount that it represents for the USA.

Finally, imports from third countries are larger for the Mexican economy where they reach 65.9 billion dollars than its equivalent for the USA economy where they account for 43.3 billion dollars.

Conversely, the analysis of these figures in aggregate terms by concept and in relative terms can be done by calculating the indices used by other authors referred to by (Koopman et al. 2012) who had previously researched the value-added content in exports. These results are presented in Table 3.

The table shows how both in the domestic value-added content and in the total domestic content the commercial relationship favors the USA which in terms of trade means that it is a surplus—it has an export value that exceeds that of its imports. Also notable is the differences in the content of foreign added value in the exports of each country. In terms of the proportion of added value proposed by Johnson and Noguera (VAX ratio) applied to US–Mexico trade figures, the value reaches 51% for the USA while in the case of Mexico it is 50%. In the case of the

domestic value added and domestic content ratios in relation to gross exports, they reach values close to 80% in the case of the USA and 57.3% in the case of Mexico.

The results of the relative indices show how when considering trade volumes in terms of added value, they only partially account for the participation of countries in international trade and how to integrate the return value added the position of countries in terms of trade may change, as in the case of the US–Mexico trade relationship. In addition to this, it is also important to recognize how imports from the rest of the countries explain part of the trade in gross terms between countries and that their integration allows identification closer to the contributions of each country and third parties in international trade relations.

The findings by sectors show in Table 4. The information contained in the table shows how trade between the two countries is highly concentrated, because of the total of 247 sectors; the 15 main exporters accumulate more than 58% of exports. In terms of added value, these are sectors where the percentage of the same is for the majority of the cases below the average but which stand out as being inputs of a great variety of processes. In that sense, as you will remember the great difference we can place it as part of the intermediate products that return to the US economy as intermediate products that are then integrated into products of the USA that are exported. This is the case, for example, of sector 3344 Manufacture of electronic components were the DVA is more than 14 billions and 60% is returned DVA a production first made in the US and then exported to México, returned as imports to be incorporated again to US production finally exported to México.

In contrast, the sectors such as *3363 Manufacture of parts for motor vehicles* have low added value but a strong sectorial link with the rest of the sectors of the economy. In that case, the sector has 7.3 billion dollars of the 16.8 billion exported as domestic added value and an additional 5.9 billion as return value added. Taking all this into account, the sector will have a high domestic product content as part of exports.

In summary, the volume of exports from the USA to Mexico shows how among the main exporters we have sectors that generally do not stand out as high value-added sectors. Instead, the main exporters include a variety of industrial processes in some cases highlighting by the magnitude of the return value added as part of the trade in intermediate products that are exported and imported to be integrated back into exported products.

For the by sectors exports from Mexico to the USA it is noted that among the main exporters, the high aggregate sectors do not stand out again. Futhermore, the returned DVA in México is mainly return as finals products, unlike those of the USA exports. That makes the added value of return not very significant and in this case the added value abroad has an important proportion of Mexico's gross exports.

Table 4 Results of the Value-Added Breakdown in the US and Mexico Trade by Main Sectors

		Domestic content						Foreign content				
		Domestic value added (DVA)										
		Value added in export		DVA re-exported	Returned DVA		Double count	Foreign value added (FVA)		Double count	Rest of the world	Gross bilateral trade
NAICS	Description	DVA_FIN	DVA_INT	DVA_INTrex	RDV_FIN	RDV_INT	DDC	MVA_FIN	MVA_INT	MDC		
3344	Manufacture of electronic components	678	2841	2136	5518	2949	818	13	55	227	2983	18,220
3241	Manufacture of petroleum and coal products	0	8784	701	543	725	191	0	600	149	6381	18,073
3363	Manufacture of parts for motor vehicles	286	5996	971	4630	1226	370	6	128	155	3065	16,832
3251	Manufacture of basic chemical products	316	6283	564	691	1326	328	7	131	61	2377	12,083
3252	Manufacture of synthetic resins and rubber and chemical fibers	0	3152	524	1229	1366	313	0	64	71	1856	8574
3361	Manufacture of cars and trucks	5660	39	8	50	7	2	251	2	3	1914	7937
3342	Manufacture of communication equipment	2551	530	432	1294	587	180	51	11	51	1978	7665
3341	Manufacture of computer and peripheral equipment	2302	1511	441	995	561	154	48	31	45	1466	7554

3339	Manufacture of other machinery and equipment for the industry in general	3162	1323	182	303	410	112	62	26	20	1169	6771
3345	Manufacture of measuring, control, navigation, and electronic medical equipment	2227	889	336	891	609	176	33	13	30	1006	6208
3336	Manufacture of internal combustion engines, turbines, and transmissions	263	2129	413	957	640	249	8	62	67	1267	6055
3261	Plastic products manufacturing	605	2008	347	868	621	158	9	28	28	914	5587
3353	Manufacture of electricity generation and distribution equipment	676	1219	379	815	961	274	19	34	68	994	5441
3329	Manufacture of other metal products	150	1867	334	848	932	263	2	29	37	779	5240
3359	Manufacture of other electronical equipment and accessories	470	1144	376	981	816	235	14	34	73	1040	5183

Source: Own elaboration, based on (Koopman et al. 2012) model

6 Conclusions

From the study, we highlight the fact that even though Mexico officially has a significant gross trade surplus with the USA during the NAFTA period, there is a notable deficit for the former in terms of the added value incorporated in this trade. Thus, the flow of added value in the gross exports of Mexico to the USA only reaches 164.4 billion dollars, while the domestic content of the gross exports of the USA is 188.7 billion dollars. In the disaggregation of added value, the main difference between the domestic and foreign components of the added value incorporated in exports is that while for the USA the foreign added value in its exports reaches 2.5 billion dollars for the case of Mexico, this concept is of around 50.2 billion dollars which is more than 20 times the amount that it represents for the USA. A conclusion that derives directly from this last aspect is that, as a result of NAFTA, an important part of Mexican export revenues is used to remunerate productive factors used in the USA.

In the sector disaggregation, the result that stands out mainly due to its importance is that of the Electronic Component Manufacturing sector is 46.5% and for which of the 18 billion gross exports 5.7 are domestic added value, 8.5 billion are added value of return and 3 more are imports from third countries so that these sources manage to explain 17 of the 18 billion dollars traded. In addition to the sector of Manufacture of parts for motor vehicles whose 7.3 billion dollars of the 16.8 billion exported are domestic added value and only 5.9 billion are return value added, because it has a high content of domestic product as part of exports gross. The conclusion derived from this aspect is the difference and importance between the consumption of intermediate goods of both countries and their consequences in the generation of added value in certain sectors of activity.

Therefore, a correct measurement of the added value contained in exports between these two countries should be a basic starting point for the net quantification of the trade balance and to assess the suitability or effects of a change in the bilateral trade policy.

Finally, an important limitation to take into account in future works that try to estimate the added value incorporated in the commercial interrelations between both countries is the need to incorporate the impact of the rest of the world endogenously in the net balance of the distribution of the added value at the level as disaggregated as we present. In the case of the countries considered here, the importance of this is really evident and, in the end, it cannot be said that third countries are taking advantage of the commercial agreements without taking into account their impact. Ultimately, its estimate is really complex.

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