WP/16/207

IMF Working Paper

The Role of Newly Industrialized Economies in Global Value Chains

by Dominik Boddin

I N T E R N A T I O N A L   M O N E T A R Y   F U N D

 WP/16/207

IMF Working Paper

Statistics Department

The Role of Newly Industrialized Economies in Global Value Chains[1]

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October 2016

Abstract

In light of increased vertical specialization and the dominance of trade in intermediates rather than final goods, this paper seeks to raise awareness of the limitations of traditional trade measures on a gross output basis. To do so, this paper uses the WIOD, a world input output table, as an alternative trade measure to analyze the role of six newly industrialized economies in global value chains. The differences between measures on a gross output basis and value added basis are striking. Export shares measured by both methods differed by more than 20 percent for some industries. These findings highlight the need for more sophisticated world input output data to form a better understanding of global trade dynamics and country interdependencies.

JEL Classification Numbers: F14, F15, F63

Keywords: Global Value Chains, Vertical Specialization, Newly Industrialized Economies

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[1] The author is grateful to Thomas Alexander, Paul Austin, Johannes Bröcker, Paul Cashin, Claudia Dziobek, Cornelia Hammer, Chris Hinchcliffe, Joji Ishikawa, Gary Jones, Silvia Matei, Kenji Moriyama, Horst Raff, Luca Ricci, Mika Saito, Piyaporn Sodsriwiboon and seminar participants at the IMF Statistics Department for their helpful comments.

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I. INTRODUCTION

International trade over the last 20–25 years is characterized by an ever more flattening of the world (Antras, 2015). Triggered by the interaction of several developments starting in the 1990's, unbundling their production became profitable for many firms.[2] The opening of China, particularly due to its accession of the World Trade Organization (WTO) in 2001, and the fall of the Iron Curtain provided a large new workforce at comparatively low wages for international production. This coincided with liberal trade policies adopted in many countries that fostered globalization and decreasing transportation cost. The Uruguay Round created the WTO in 1995. Mean tariff rates decreased dramatically from 34 percent in 1996 to 2.9 percent in 2012 (World Development Indicators). The number of regional trade agreements more than quadrupled from the mid 1990's to today (WTO Secretariat). Improvement of information, communication, and other technologies further decreased transport costs. Inventions such as the Internet made it possible to communicate instantaneously with people on the other side of the globe at almost zero cost. As a result of these developments, trade in intermediate goods largely replaced traditional final goods trade (Ricardo's world of "clothes against wine"). Trade in intermediate goods accounts for approximately two thirds of world trade today.

Prominent examples that document vertical specialization are the production of Apple's iPod (Dedrick et al., 2010) and Boeing's Dreamliner 787 (Tang et al. 2009). In both cases, a great proportion of the component production is outsourced and a sizeable proportion of the product's value added is generated abroad. Figure A1 in the Appendix shows the Dreamliner's suppliers. More than 70 percent of the plane's value is not generated by Boeing. The literature on offshoring (see for instance Feenstra and Hanson, 1996, and Feenstra, 2010) and later the trade in task literature (see Grossman and Rossi-Hansberg, 2008 and Baldwin and Robert-Nicoud, 2010) also documented the relocation of jobs and slicing up of the value chain.

The rapid increase in vertical specialization poses challenges to the traditional measurement of international trade flows and calls for new measures. Gross trade fails to allocate value added along global value chains across countries and cannot account for the fact that an increasing share of export value is generated by imported intermediates.[3] A number of newly available world input output tables allows the identification of value added flows. Following the seminal work of Hummels et al. (2001), recent studies that make use of these newly available data highlight some policy implications of vertical specialization. For instance, Koopman et al. (2010) calculate value added trade and revise the comparative advantage of

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[2] Also tax incentives can be a reason for multinationals to slice up their production.

[3] Relocation of production can also have large impacts on national accounts, especially for small economies (see for instance Ireland).

countries. Johnson and Noguera (2012a) recalculate bilateral trade deficits and show that the US trade deficit with China is much lower when measured in value added terms.[4]

If data quality and coverage for value added data increases, for the IMF, trade in value added might be a more accurate measure to determine the openness parameter for its quota calculation as double counting is avoided.[5] Slicing up the value chain across borders creates spillovers across countries. Given these inter-country linkages, it is essential to understand the position of countries in global value chains to assess the vulnerability to the transmission of shocks. A prominent example is the paper by Boehm et al. (2015), who use the evidence from the 2011 Tohoku earthquake in Japan to show the transmission of shocks along global value chains. Shortly after the earthquake and tsunami hit Japan, US production for goods that required components from the affected Japanese areas dropped. An analysis of global value chains supports the Fund's policy advice and the U.N. sustainable development goals (SDGs). Access to world markets is one necessary condition for sustained economic growth and poverty reduction (WTO, 2001), and global value chains provide key measures. Recent work by the World Bank (Taglioni and Winkler, 2016) highlights the importance to identify countries' positions in GVC to adjust policies in three steps: attracting foreign direct investment (FDI), expanding and strengthening GVC participation and turning GVC participation into sustainable growth.

The topic of trade in value added is of significant interest to international institutions and policy makers. For instance, an UN expert group comprised members from the IMF, OECD, UN, World Bank, and WTO is currently working on a "Handbook on a System of Extended International Global Accounts."[6] The economic literature has recently seen a growing number of studies on this topic, but there is need for individual country studies as Stehrer and Stöllinger (2013) stress. Examples such as their study on Austria's position in the Global Economy and work on Denmark by Andersen et al. (2015) pose an exception.[7] Both focus on small open economy. This study contributes to the economic literature by performing a similar analysis for the position of newly industrialized economies in global value chains, including Brazil, China, India, Indonesia, Mexico and Turkey. The analysis shows that while

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[4] Other papers in this field include Daudin et al. (2011) and Johnson and Noguera (2012b). See Saito and Salgado for macroeconomic policy implications.

[5] The current quota formula is (among others) relevant for the voting power and access to financing for countries and is calculated as a weighted average of GDP (50 percent), openness (30 percent), economic variability (15 percent), and international reserves (5 percent). Openness is calculated based on gross exports and imports. At the current stage available trade in value added data does not allow for robust adjustment of the openness quota (see http://www.imf.org/external/np/pp/eng/2012/110812a.pdf).

[6] For further information, see for instance UNECE (2015) and OECD (2015).

[7] See also short trade in value added country profiles provided by the OECD-WTO: http://www.oecd.org/sti/ind/measuringtradeinvalue-addedanoecd-wtojointinitiative.htm.

all are outsourcing locations[8] and at a similar stage of development, newly industrialized economies play very different roles in global production and in global value chains.

The paper is organized as follows: Section two introduces the data and shows the computation to derive information on value added trade. Section three shows and compares the results for the newly industrialized economies and the final section concludes and discusses some policy implications.

II. Data & Calculations

Traditional trade data on a gross output bases do not allow quantifying the geography of global production, to answer questions about the origin and destination of value added in value chains. This paper, therefore, uses the World Input Output Database (WIOD) to calculate a number of indicators to determine the role of newly industrialized economies in global value chains.[9]

The WIOD is arguably the most suited dataset among a number of recently available world input output datasets.[10] The data are provided for the 1995 to 2011 period and include 35 industries comprising primary-, durable-, nondurable-, service- and finance industries. The WIOD covers 41 countries,[11] the 41st country is the rest of the world modeled as one economy. The majority of the countries are members of the European Union (EU 27), but the data also include the newly industrialized economies of Brazil, China, India, Indonesia, Mexico and Turkey. These countries account for more than 90 percent of GDP generated by newly industrialized countries.[12] World input output data cannot be measured directly, but are compiled from data provided by national statistics (national account statistics, supply and use tables) and international trade data in goods and services. Consequently, the data quality depends on the data quality of the national statistics (which is one of the reasons for the European country bias in the WIOD). See Dietzenbacher et al. (2013) for a detailed description of the WIOD construction.

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[8] See for instance Autor et al. (2013) and Dauth et al. (2014) on China; Hummels et al. (2001) and Bergin et al. (2009) on Mexican Maquiladoras and Liu and Trefler (2008) on outsourcing to India (and China).

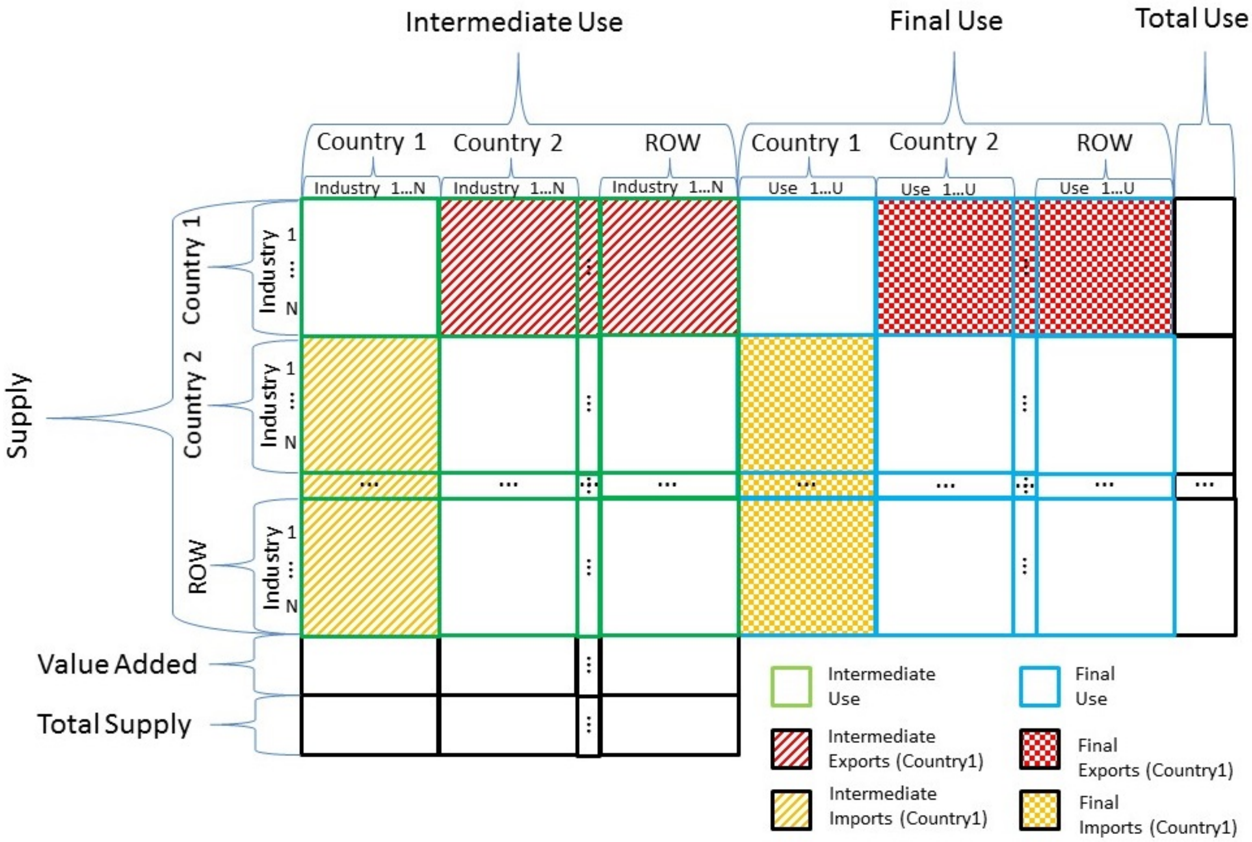
[9] The WIOD project is funded by the European Commission, comprises of a number of partners and is coordinated by the University of Groningen. See http://www.wiod.org/new_site/home.htm for further information.

[10] Other data sets include GTAP, TiVa, EORA, IDE-JETRO.

[11] Countries include Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovak Republic, Slovenia, Spain, Sweden, United Kingdom, Canada, United States, Brazil, Mexico, China, India, Japan, South Korea, Australia, Taiwan, Turkey, Indonesia, Russia and RoW.

[12] The remaining newly industrialized countries that are not covered by the data are South Africa, Malaysia, the Philippines, and Thailand.

Figure 1. Outline of The World Input Output Tables of the WIOD Database



Even though the availability of world input output data is a step towards a better understanding of global value chains, the need for further improvement of the data should be highlighted. The fact that the data quality of world input output tables depends on the reliability of national statistics, creates a tradeoff between data coverage and data quality. The better the data quality, the fewer countries can be covered. For instance, IDE-JETRO arguably is the data with the highest quality, but covers only a few Asian countries. Other data such as EORA cover almost all the countries in the world, but the data quality is comparatively lower. A first step to improve world input output tables therefore has to be the improvement of national data such as supply and use tables. At that, the IMF takes on an important role by providing assistance, especially to countries with lower data quality. Additionally, attempts should be undertaken to generate more disaggregated data. The WIOD covers 35 industries, which is much more aggregated than traditional trade data as for instance provided by UN Comtrade database. The fact that national country data is needed to capture the development of vertical specialization also raises the need to standardize methods of measurements, compilation of data and data classification.

Despite the need for further improvement, world input output tables are the best data source to determine global value chains. Figure 1 shows the outline of the world input output tables of the WIOD database (for one year). The green area highlights the intermediate use matrix of dimension 1435*1435 (41 countries*35 industries).

This matrix shows the production (rows) for all industries (35) in the origin countries (41) that is used as intermediate inputs (columns) by all industries (35) in the destination countries (41). The 35*35 squares on the main diagonal accordingly show intermediate domestic consumption of domestic production, whereas squares off the main diagonal show intermediate consumption of foreign production. For instance, for country 1 the red dashed squares show intermediate exports, whereas the yellow dashed squares show intermediate imports. The blue matrix shows the final use matrix. This matrix shows the production for all industries in the origin countries that is used as final input by the destination countries. Final consumption contains five different categories (such as capital formation, household or government consumption). As before, squares on the main diagonal are domestic final consumption of domestically produced goods, whereas squares off the main diagonal show final consumption of foreign production. Again, for country 1 the red squared squares show final exports, whereas the yellow squared squares show final imports. The total use and total supply have to be identical.

To analyze the position of newly industrialized economies in global value chains, the main focus of this paper lies on the origin and share of foreign value added in exports and the destination of foreign consumption of domestic value added. To compute the required indicators, this paper follows Miller and Blair (2009) and Foster-McGregor and Stehrer (2013).[13] Starting point is the equation:

$$y^t = \tilde{A}^t y^t + f^t \quad [1]$$

with

$$y^t = \begin{bmatrix} y_{11}^t \\ y_{12}^t \\ \vdots \\ y_{ON}^t \end{bmatrix}_{1435*1} ,$$

$$\tilde{A}^t = A^t \oslash TO^t,$$

where

$$A^t = \begin{bmatrix} A_{11-11}^t & A_{11-12}^t & \cdots & A_{11-DN}^t \\ A_{12-11}^t & A_{12-12}^t & \cdots & A_{12-DN}^t \\ \vdots & \vdots & \ddots & \vdots \\ A_{ON-11}^t & A_{ON-12}^t & \cdots & A_{ON-DN}^t \end{bmatrix}_{1435*1435}$$

[13] As mentioned previously, this computation also follows closely the work of Stehrer and Stöllinger (2013) for Austria and Andersen et al. (2015) for Denmark.

and

$$TO^t = [TO_{11}^t \quad TO_{12}^t \quad \cdots \quad TO_{DN}^t]_{1*1435},$$

$$f^t = \begin{bmatrix} \sum_{d=1}^{D} \sum_{j=1}^{J} f_{11-dj}^t \\ \sum_{d=1}^{D} \sum_{j=1}^{J} f_{12-dj}^t \\ \vdots \\ \sum_{d=1}^{D} \sum_{j=1}^{J} f_{ON-dj}^t \end{bmatrix}_{1435*1},$$

and *o=1…O, d=1…D, n=1…N, j=1…J*,

Equation [1] states that the total gross output y^t for industry *n=1,…,N* in origin country *o=1,…,O* equals the total intermediate demand $\tilde{A}^t y^t$ by industry *n=1,…,N* plus the total final demand f^t of category *j=1,…,J* in destination country *d=1,…,D* at time *t* in equilibrium.[14] Consumption is of domestic origin if *o=d* and of foreign origin if o≠*d*. Matrix $\tilde{A}^t$ shows the intermediate input coefficients for a given industry in a given destination country, i.e. the share of inputs from an industry in a given origin country per unit of gross output. To obtain $\tilde{A}^t$, the matrix of intermediate inputs (in absolute values) A^t is divided ($\oslash$) by the total output vector TO^t: Every element in a given column of matrix A^t (i.e. all the inputs for an industry in a destination country) is divided by the same element of the total output vector TO^t (which shows the total output of that particular industry in the destination country). For instance, A_{11-12}^t is the amount of intermediate inputs produced by origin country one's industry one and consumed by destination country one's industry two. Dividing A_{11-12}^t by TO_{12}^t (the total output of country one's industry two) yields the share of intermediate inputs produced by origin country one's industry one in gross output of country one's industry two. f^t is the total final demand. Total final demand for products produced by industry *n* in origin country *o* is obtained by summing up the consumption of that industry's products in all final demand categories in all destination countries. For instance, $\sum_{d=1}^{D} \sum_{j=1}^{J} f_{12-dj}^t$ is the total final demand by destination country one to *D* and category 1 to *J* for goods produced by country one's industry two. Rearranging [1] yields:

$$y^t = \left(I - \tilde{A}^t\right)^{-1} f^t, \quad [2]$$

with $L^t = (I - A^t)^{-1}$ being the Leontief inverse that shows how much production from each industry in each country is required given a vector of final good consumption. Using the Leontief inverse allows us to compute the foreign value added component embodied in exports:

$$FVA_o^t = vac^t * L^t * x^t, \qquad [3]$$

[14] As shown above, the WIOD contains 41 industries (N=41), 35 origin and destination countries (O,D=35), and five final consumption categories (J=5).

with

$$vac^t = [VA_{11}^t \quad VA_{12}^t \quad \cdots \quad VA_{ON}^t]_{1*1435} \; ./ \; [TO_{11}^t \quad TO_{12}^t \quad \cdots \quad TO_{ON}^t]_{1*1435}$$

$$\text{and } x^t = \begin{bmatrix} \sum_{d=1}^{D} \sum_{n=1}^{N} A_{11-dn}^t + \sum_{d=1}^{D} \sum_{j=1}^{J} f_{11-dj}^t \\ \sum_{d=1}^{D} \sum_{n=1}^{N} A_{12-dn}^t + \sum_{d=1}^{D} \sum_{j=1}^{J} f_{12-dj}^t \\ \vdots \\ \sum_{d=1}^{D} \sum_{n=1}^{N} A_{ON-dn}^t + \sum_{d=1}^{D} \sum_{j=1}^{J} f_{ON-dj}^t \end{bmatrix}_{1435*1} \quad , \text{d} \neq \text{o}$$

The foreign value added share FVA_O^t for country *o* is the product of the value added coefficients vector vac^t with the Leontief Inverse L^t and the export vector x^t. The value added coefficient for a given industry in a given country is the share of value added generated within that industry VA_{on}^t relative to the total output TO_{on}^t of that industry. Thus the value added coefficient vector vac^t is the element wise division (./) of the value added vector and the total output vector. vac^t includes value added coefficients for all industries in all countries, but is *0* for industries in country *o*. The export vector x^t is the sum of foreign intermediate and final consumption. For instance, the exports of industry one in origin country one consists of foreign intermediate consumption $\sum_{d=1}^{D} \sum_{n=1}^{N} A_{11-dn}^t$ and foreign final consumption $\sum_{d=1}^{D} \sum_{j=1}^{J} f_{11-dj}^t$. To obtain foreign value added of a particular country embodied in country *o*'s exports, only the value added coefficients from that particular country are used (and the other set equal to *0*).

To compute the foreign consumption of domestic value added (FCDVA), the value added coefficient vector is element wise multiplied (.*) with the product of Leontief inverse L^t and final demand matrix F^t:

$$FCDVA^t = vac^t .* L^t * F^t \qquad [4]$$

$$\text{with } F^t = \begin{bmatrix} F_{11-1}^t & F_{11-2}^t & \cdots & F_{11-D}^t \\ F_{12-1}^t & F_{12-2}^t & \cdots & F_{12-D}^t \\ \vdots & \vdots & \ddots & \vdots \\ F_{ON-1}^t & F_{ON-2}^t & \cdots & F_{ON-D}^t \end{bmatrix}_{1435*41},$$

where for every destination country *d* the final demand categories *1* to *J* have been added up to obtain a total final demand for every destination. For instance, F_{12-2}^t shows the final consumption of goods produced by origin country one's industry two in destination country 2. Equation [4] yields $FCDVA^t$ of dimension 1435*41, which shows how much value added generated by industry *n* in origin country *o* is consumed in destination country *d*.

III. THE POSITION OF NEWLY INDUSTRIALIZED ECONOMIES IN GLOBAL VALUE CHAINS

When firms slice up their production, they have to determine which stage of the production should take place in which country.[15] Countries at the beginning of the value chain ("upstream producer") typically produce raw materials, which, further down the value chain, are combined with other raw materials into intermediate inputs. Each production step adds value, and intermediate inputs are getting more and more sophisticated. At the end of the global value chain, the "downstream producer" assembles the finalized intermediate inputs to a final product. Identifying the role that countries play in global production is important: Policy advice for upstream producers will very much differ from the set of policies that is suited for downstream producers.

A. Value Added, Trade and Output

Table 1 shows the growth of total exports and imports from 1995 to 2011 (1995=1) for Brazil, China, India, Indonesia, Mexico, and Turkey. For instance, Chinese exports in 2011 were 12.41 times larger than in 1995. From all countries China showed the largest increase for all four indicators over the time of observation followed by India, suggesting that these two countries are the major drivers of worldwide growth in the past three decades (see for instance Srinivasan, 2006). This also holds true for their role from recovery after the financial crisis in 2008. For all of the six newly industrialized economies, all indicators reached pre-crisis levels already in 2010, whereas recovery of the industrialized economies took much longer. In Denmark, for instance, all indicators were still below pre-crisis level in 2011 (Andersen et al. 2015). Graph A2 and A3 in the Appendix show the detailed development of trade, output and value added over the years 1995 to 2011. Another observation is that for all countries value added and output grew less than exports and imports. The fact that the domestic economy grew less than trade can be interpreted as an increase in specialization.

Table 1: Six NICs: Growth of Total Exports and Imports, Value Added and Output 1995–2011 (1995=1)

	Brazil	China	India	Indonesia	Mexico	Turkey
Total Exports	5.27	12.41	8.01	4.04	4.26	5.53
Total Imports	4.7	12.6	8.61	3.71	4.77	6.43
Value Added	3.11	10.06	5.08	3.51	3.6	3.28
Output	3.17	11.79	4.96	3.59	3.48	3.71

Source: WIOD, Author's calculations.

[15] A number of studies explain how firms organize global value chains; see for instance Antràs and Chor (2013) and Antràs and de Gortari (2016).

Table 2 sheds light on the relative importance of intermediate and final products. In 2011 all countries exported more intermediate products than final products. For instance, India exported almost four times more intermediate than final products. The figures are similar for the ratio of intermediate

Table 2: Six NICs: Ratio of Intermediate to Final Exports in 2011

	Brazil	China	India	Indonesia	Mexico	Turkey
Intermediate- / Final Exports	2.69	1.22	1.11	4.02	1.63	1.4
Intermediate- / Final Imports	7.98	4.69	2.52	3.05	1.97	0.94

Source: WIOD, Author's calculations.

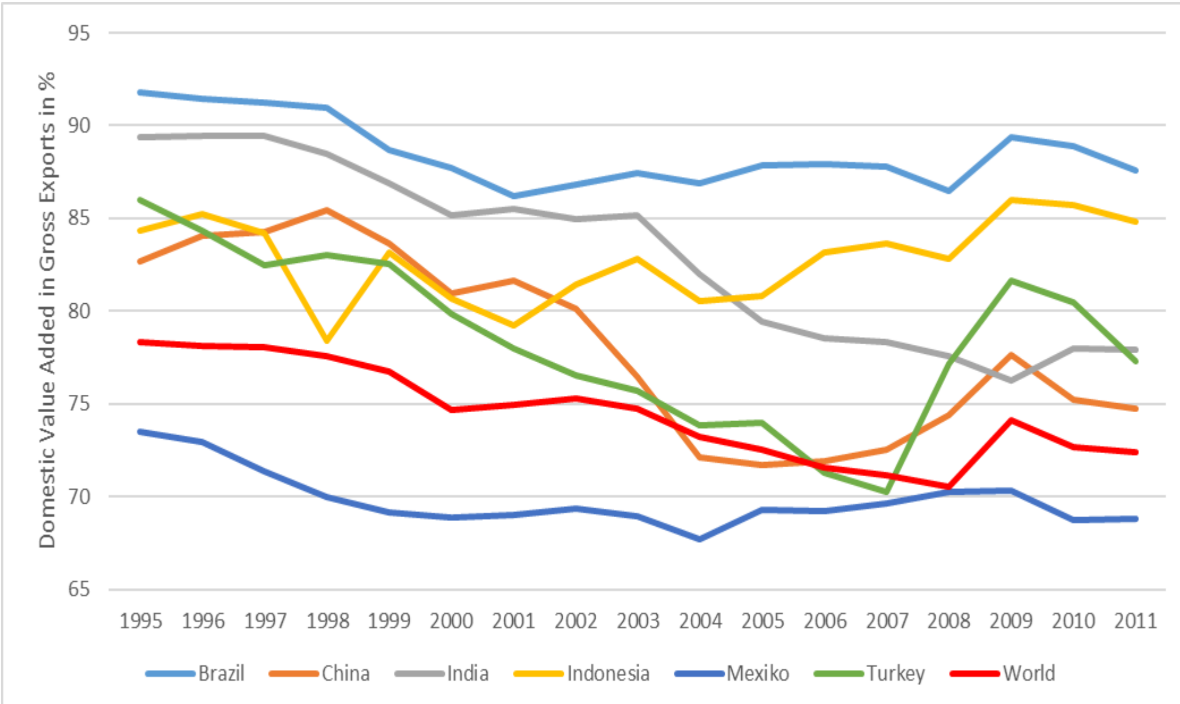
to final imports. All countries imported a higher number of intermediate products except Turkey, which imported more final than intermediate products. Over the period from 1995 to 2011 the relative importance of intermediate products generally increased (see table A1 in the Appendix), except for India and Mexico, where trade in both intermediate imports and exports grew faster than in final imports and exports. The dominance of intermediate goods trade reflects the major role that global value chains play in international trade. The figures additionally give an idea about a country's upstream-/ downstreamness. China's much higher ratio of intermediate to final imports, as compared to the ratio of intermediate to final exports, suggests a rather downstream position of China. This is in line with the idea of China being a main assembler in global value chains. As for instance documented for the IPod (Dedrick et al., 2010), components are produced in several countries and then being shipped to China for final assembly.

B. Foreign and Domestic Value Added in Exports

Using equation [3] yields the foreign value added content embodied in exports FVA^t. Figure 2 shows the domestic value added component (1-FVA^t) for all six NICs and the World from 1995 until 2011.[16] The domestic value added share decreased for all countries except Indonesia, confirming the increasing importance of global value chains in international trade. The largest decrease of about 8 percentage points can be observed for China, whose domestic value added share in gross exports dropped from around 83 percent in 1995 to around 75 percent in 2011. Consequently, in 2011 25 percent of the export value was not generated in China itself, but already previously imported for the production of export goods.

[16] Note that the shares of domestic / foreign value added are also potentially influenced by price changes that cannot be captured here. Consider a country whose domestic value added is mostly generated by natural resources: Especially if the resource prices show a high volatility (e.g., oil or gas), frequent decreases (increases) in the prices of natural resources will decrease (increase) the share of domestic value added.

Figure 2: Six NICs: Domestic Value Added in Gross Exports of NICs (in percent) from 1995 to 2011



Source: WIOD, Author's calculations.

The trend of decreasing domestic value added shares was interrupted by the 2008 financial crisis. On average, the domestic value added share in NICs increased by about 3 percent from 2008 to 2009. Even before the reverse development during the financial crisis, however, a slowdown of increased foreign value added in exports can be observed for countries like China and Mexico. Accordingly, it is an open question, whether with the further recovery from the financial crisis, the trend of the late 1990's and early 2000's continues, or whether shares remain at a rather stable pre-crisis level. A potential explanation for constant or even increasing domestic value added shares is learning from GVC participation (see for instance Cattaneo et al., 2013, and Humphrey and Schmitz, 2002). Starting as an assembling destination, firms in for instance China learn (by doing) over time, gradually take over more skill intensive steps of production and upgrade their industrial production. Partly intermediate inputs that were imported previously can now be produced domestically.

Mexico has the lowest share of domestic value added of traded goods with less than 70 percent in 2011. The reason for this figure is Mexico's role as an assembly location for US intermediate products. Maquiladoras located close to the US border receive intermediate inputs from the US that are assembled and shipped back (see for instance Hummels et al. 2001, Bergin et al. (2007).

With close to 90 percent in 2011, Brazil has the largest share of domestic value added in gross exports. Brazil's tariff regime, which is more protectionist than the average Latin American country (see Cardoso 2009), may be the reason. This finding also supports the observations in the economic literature that the term "global" value chains might need to be changed to "local" value chains, as the phenomenon is restricted to "Factory North America," "Factory Europe" and "Factory Asia". Baldwin and Lopez-Gonzalez (2015) present interesting stylized facts, which show that within and across these continents trade relationships are strongest. For instance, the most intensive supply-chain relationship is found in North America and the biggest producer and consumer of intermediates are the US, China and Germany. Africa and Latin America (and thus Brazil) are largely excluded from the international production network. However, Indonesia also does not play a major role in international production.[17]

All countries except Mexico show a larger share of domestic value added in gross exports than the world average. Considering that a majority of world trade takes place between highly industrialized countries, this is not surprising. For trade between highly industrialized economies, distance is often closer (e.g., Intra-EU-Trade) and therefore border effects can expected to be smaller (better quality of institutions, lower nontariff barriers, better information, similar culture, legal security, etc.,).[18] Considering the higher obstacles for trade with newly industrialized economies, it is remarkable that all the newly industrialized economies (except Mexico) showed a higher decrease in the domestic value added share than the world average. For instance, India's domestic value added share was around 11 percentage points above world average in 1995. This number was reduced to around 5 percentage points in 2011.

To address the question of where the foreign value added in exports originates from, an altered version of equation 3 yields foreign value added shares in exports by partner country. Figure 3 depicts the foreign value added by partner country in percentage of total foreign value added for China and Mexico for the years 2011 (in blue) and 1995 (in orange) and Figure A4 in the Appendix shows the same graphs for Brazil, Indonesia, India and Turkey. For instance, China's foreign value added share was about 25 percent in 2011 (see previous figure). The data show that the share from the "Rest of the World" as the largest contributor accounts for more than 30 percent of this foreign value added share – ergo for a value of

[17] Another explanation may be that Brazil (and Indonesia) produce less skill intensive goods than other NICs that usually show less vertical specialization or goods that are at the first stages of the value chain (and thus do not require as much intermediate inputs).

[18] See for instance Anderson and van Wincoop (2003), who show that borders reduce trade between industrialized countries by only 20 to 50 percent or Head and Mayer, who document a decrease of the border impact over time for European countries. Applying the same estimation method to China, Poncet (2003) yields much higher estimates for border effects than those observed for Europe or North America (e.g., McCallum, 1995 and Helliwell, 1998). See Head and Mayer (2013) for an overview of sources of resistance to cross-border trade.

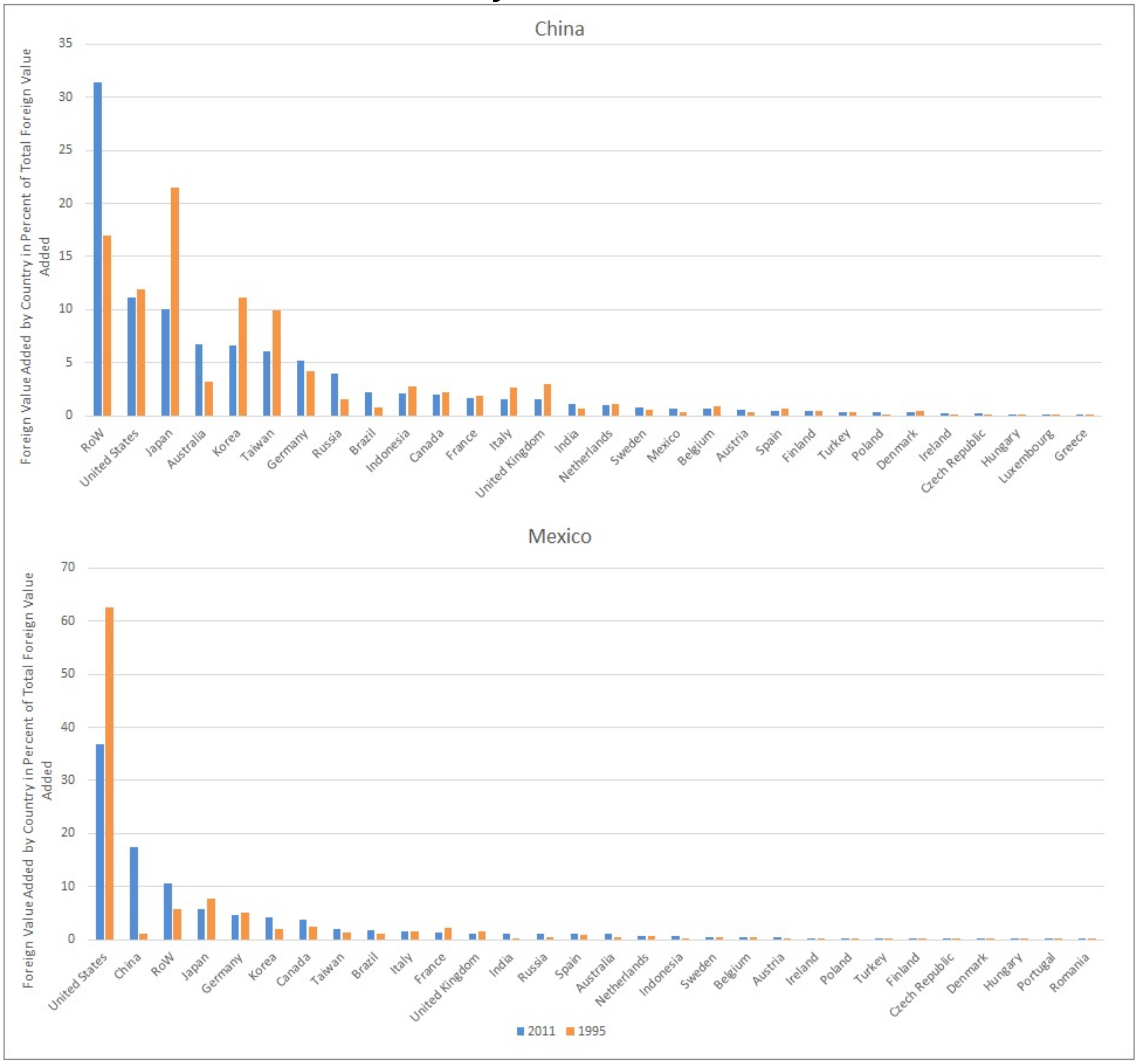
around 7.5 percent in China's total exports. The "Rest of the World" consists of all countries that are not directly covered by the WIOD. This includes many Asian countries such as Bangladesh, Malaysia, the Philippines, and Singapore, major producers of intermediates imported by China (see for instance Antràs and de Gortari, 2016). Generally, many countries with high shares in foreign value added in Chinese exports show close geographic proximity to China. Apart from the "Rest of the World," Japan (10 percent), Korea (6 percent) and Taiwan (6 percent) are among the six largest foreign value added contributors.

This result is similar for the other NICs (except Mexico): The "Rest of the World" always accounts for the largest share in foreign value added. Apart from physical proximity, economic size, the other classic gravity parameter, seems to play a role as a determinant for foreign value added shares. For most NICs, at least three, often four of the five largest contributors in value added shares of exports originate from the four largest economies (Japan, China, Germany, and the US). An exception is Turkey, for which the US and Asian countries play less of a role because of its proximity to the EU and Russia, and also China as shown above.

The importance of intermediate inputs from countries with close proximity for China's production of export goods is in line with its role as a major assembling destination. Many intermediate components, especially in the field of "Electrical and Optical Equipment" (see Figure 5) are produced by other Asian countries (particularly by the Tiger states) and then shipped to China for final assembly. Mexico differs from the other NICs in the sense that the origin of foreign value added embodied in its export is very concentrated. In 1995, more than 60 percent of foreign value added in Mexican exports originated from the US. This share dropped to around 37 percent in 2011, which is still more than twice as high as the second largest share of 17 percent from China. In 1995 China accounted for only around 1 percent of foreign value added – this means that the Chines share in 2011 was more than 15 times higher than in 1995.

An increase of China's contribution to value added exports can also be observed for Brazil (increase of factor 7), Indonesia (increase of factor 4), India (increase of factor 5) and Turkey (increase of factor 3). This observation shows that China's role in global production is not only that of a final assembler. In addition, it also produces intermediates that are then further used along global value chains. The share of foreign value added from the other five NICs only increased slightly since 1995 and remained at fairly low levels.

Figure 3. Foreign Value Added in Exports for China and Mexico by Partner Country – 1995 and 2011



Source: WIOD, Author's calculations.

C. Trade in Value Added - Foreign Consumption of Domestic Value Added

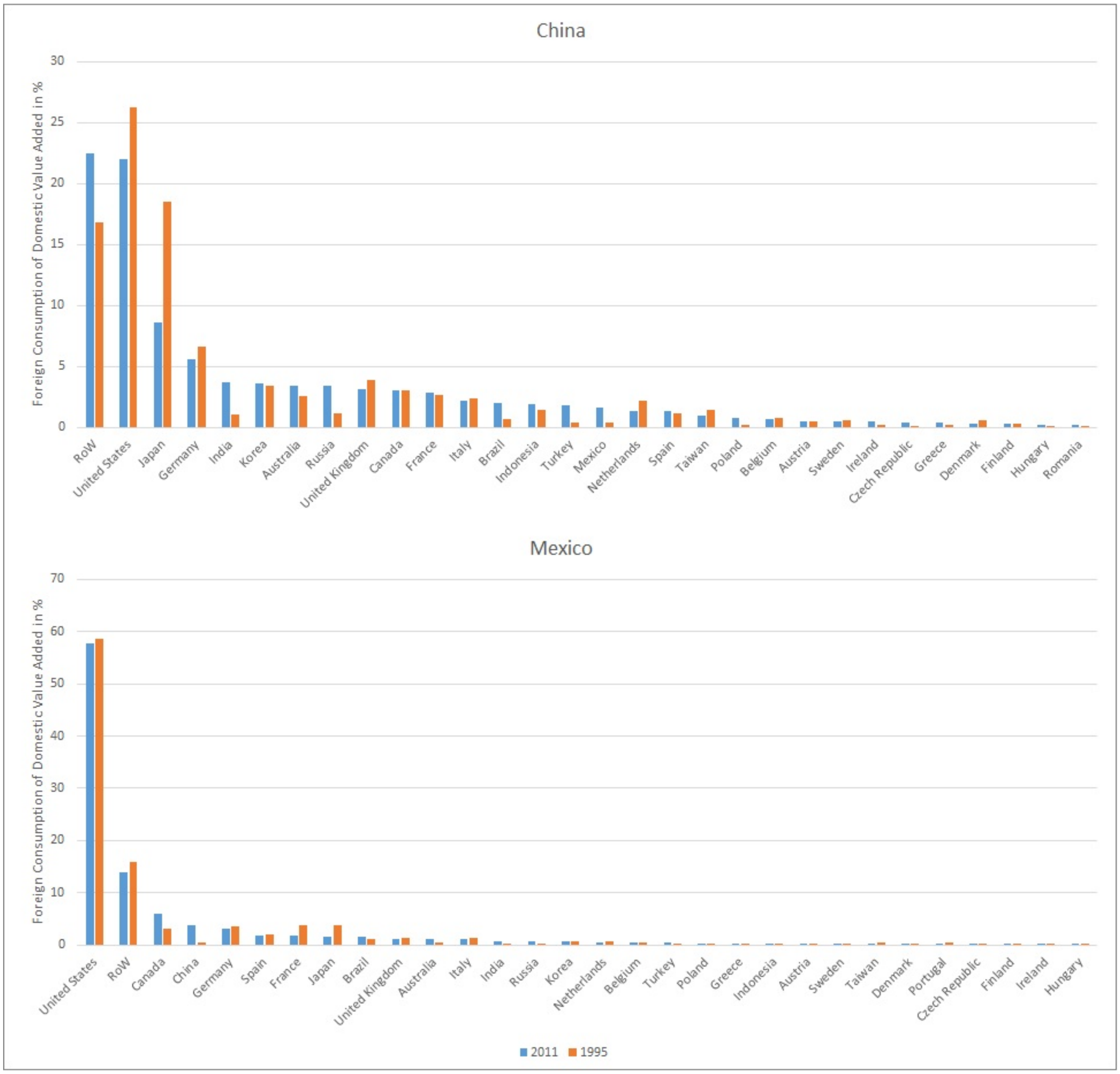
Tracking foreign consumption of domestic value added[19] is important to determine country interdependencies, for instance to evaluate the risk of spillovers after a shock. This implies that not only direct trade linkage, but also indirect trade relationships are taken into account. Consider the Boeing 787 Dreamliner example from the introduction: Jet engines for the Dreamliner are produced in the UK. If after assembly in the US the plane is exported to Australia, then traditional trade measures would not see the indirect link between the UK and

[19] In the following, "trade in value added" will be defined as "foreign consumption of domestic value added" and both terms will be used interchangeably.

Australia, even though Australia is the destination of final consumption of UK's value added. A recession in Australia may affect the engine production in the UK, even though both countries do not have a direct trade relationship. To disentangle intermediate and direct trade relationships simultaneously, equation 4 is used to compute the foreign consumption of domestic value added (FCDVA).

Figure 4 shows the destination of foreign domestic value added consumption for China and Mexico. The graphs for the other four NICs can be found in the Appendix (see Figure A5). The blue bars show the foreign country's share of domestic value added consumption in 2011; the orange bars show the same information for 1995. For instance, in 2011 the "Rest of the World" was the largest consumer of Chinese value added with a share of 22.5 percent in total foreign consumption followed by the United States (22 percent) and Japan (8.6 percent). Similar to the origin of foreign value added in exports of NICs, also the destination of foreign consumption of domestic value added seems to be largely driven by the classic gravity parameters size and distance. The three largest economies (except China) – the US, Germany and Japan – are among the top four foreign consumers of Chinese value added, emphasizing the role of economic size as a determinant for trade patterns. The fourth consumer is the "Rest of the World."

Figure 4. Foreign Consumption of Domestic Value added for China and Mexico by Partner Country – 1995 and 2011

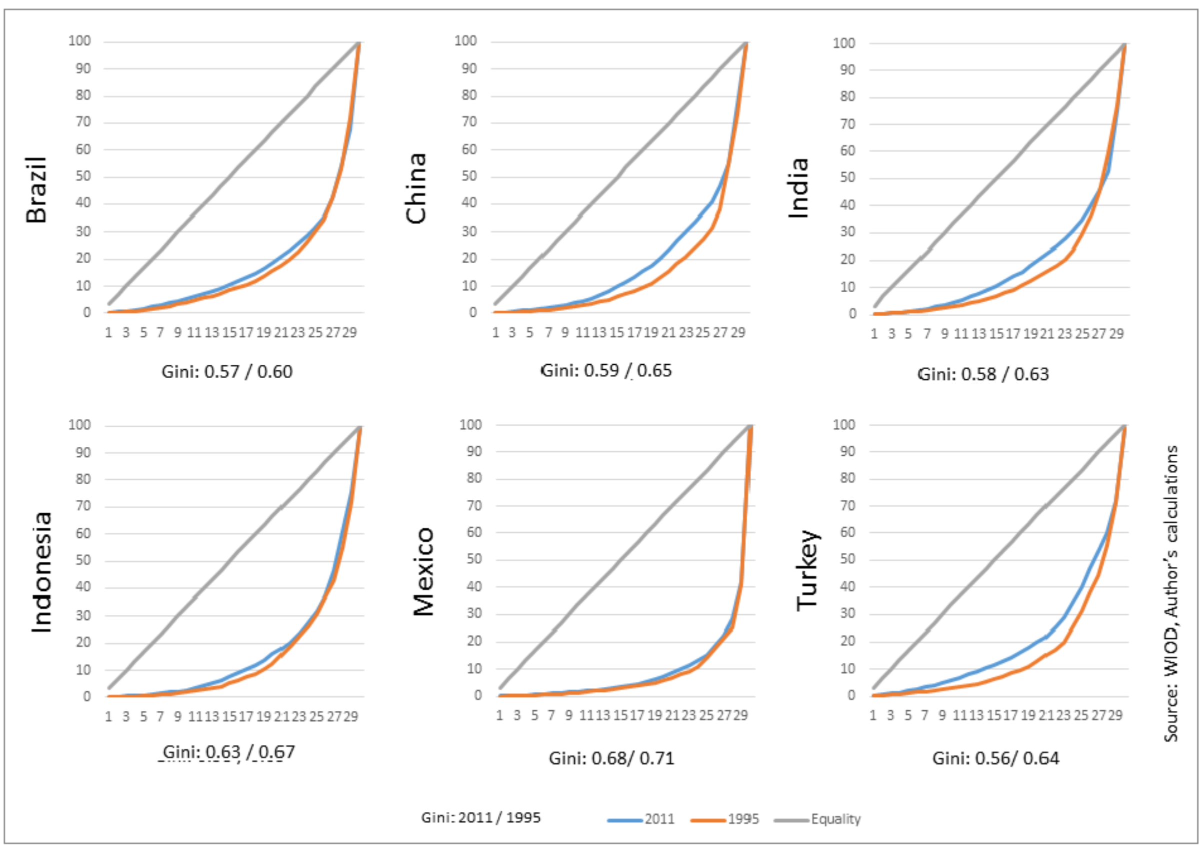


Source: WIOD, Author's calculations.

Even though still concentrated, the consumption of Chinese products is more dispersed in 2011 than in 1995. The patterns are similar for the other NICs: Consumption destinations generally were more dispersed in 2011 than in 1995. During that time span mostly other NICs increased their consumption share, whereas the highly industrialized economies decreased their share. The largest economies (particularly the US, China, Germany and Japan) demand the largest shares of value added generated by NICs, but also countries with geographic proximity are among the major consumers like Korea for China. Again Mexico is an extreme case. Almost 60 percent of foreign consumption of Mexico's value added takes place in the US. The common border, size of the countries, NAFTA membership and the Maquiladora system reinforce the US' position as Mexico's primary trading partner. Interestingly, from 1995 to 2011 the US' consumption share did not drop contrary to its share of foreign value added in Mexican exports. One explanation for this observation may be that production of intermediates that Mexico uses for final assembly took place in the US in 1995, but was outsourced to for instance China in 2011. Canada, the third NAFTA member is the second most important trading partner with a share of only about 6 percent in 2011. Mexico and India are the only two NICs for which the consumption share of the major trading partner (the US in both cases) remained fairly stable over the time of observation – or in the case of India even slightly increased.

Figure 5 takes a closer look at the concentration / dispersion of foreign consumption of NICs' domestic value added. For all six NICs the Lorenz Curve and the Gini coefficient indicate the concentration of the thirty largest destination countries of value added consumption. The thirty largest consumers cover more than 99 percent of total foreign consumption for all NICs.

Figure 5. Concentration and Gini of Foreign Consumption of Domestic Value Added – 1995 and 2011



Source: WIOD, Author's calculations.

Again, the blue line (and the first Gini value) shows the concentration for 2011, whereas the orange line (and second Gini value) captures the year 1995. The equality line indicates a scenario in which all foreign countries consume an equal share of domestic value added. This would be equivalent to a Gini value of zero. An increase in the concentration of the consumption destination shifts the Lorenz curve further away from the equality line and leads to a higher the Gini value (one in case of maximal inequality).[20] From all six NICs the foreign consumption of Mexico's value added is the most concentrated (both in 1995 and 2001). As shown, the US is the dominating consumer of Mexico's foreign value added. In 2011, Turkey shows the highest dispersion followed closely by Brazil, India and China. The reason for Turkey's lead position is the proximity to the EU and thus a variety of highly industrialized trading partners that demand Turkish value added in the closer proximity. For all countries the foreign consumption of domestic value added became more dispersed from 1995 to 2011.

This shows that a growing number of countries participate in international trade. Emerging markets (including the NIC) take over trading shares from industrialized economies. A good example for this development is Turkey (see also Graph A5 in the Appendix): In 1995, Germany was the dominating consumer of foreign Turkish value added consumption. Around 27.5 percent of total foreign Turkish value added consumption took place in Germany followed by the US with a share of 11.2 percent. From 1995 to 2011, the share for both countries more than halved. In 2011, Germany's share of foreign consumption of Turkey's value added accounted for 11.6 percent, the US' share for 6.3 percent. Instead, Poland, China, Brazil, Bulgaria, India and Mexico (in descending order) showed the highest increase in consumption shares. As a result, foreign consumption of Turkey's value added became more dispersed; the Gini decreased from 0.64 to 0.56. This finding has important implications for the risk of spillovers after a foreign shock. On the one hand, trade connection with a growing number of countries creates an environment, in which it is unlikely that foreign shocks are not (at least to some extant) passed on to the domestic economy. On the other hand, having trade connections and serving demand in a larger number of countries spreads the risks, and most likely mitigates the consequences compared to a scenario, in which only a few large markets are served. An example is the aftermath of the financial crisis of 2008, where demand from NICs and other emerging market economies was one of the main drivers for recovery.

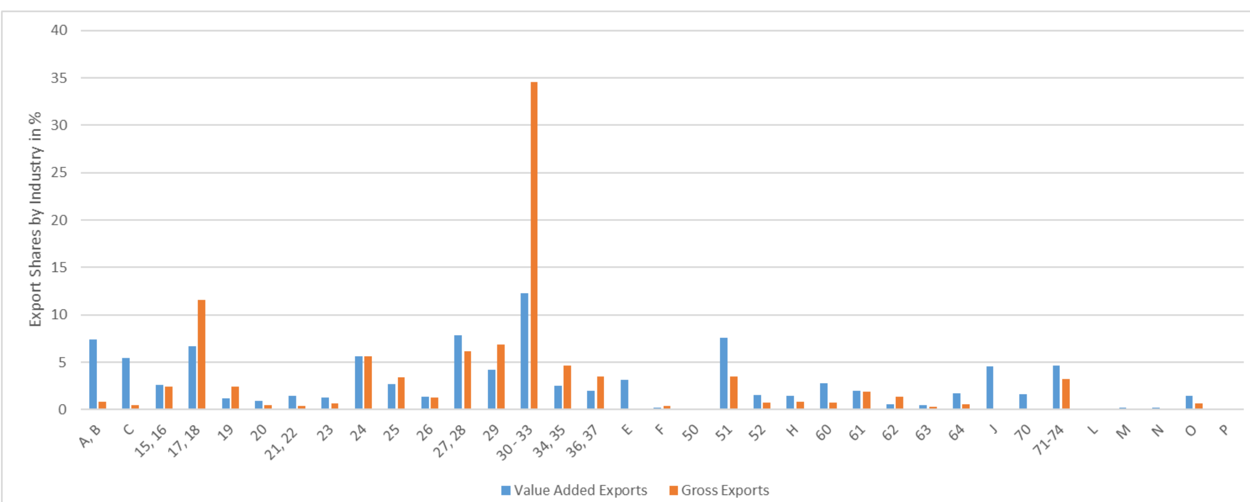
The following section analyses the industry structure of value added exports in NICs. Contrary to measures on a gross output basis value added trade can both account for foreign value added in gross exports and also for value added from different industries embodied in

[20] Note: As discussed previously, countries that are not covered by the data are modeled as the "Rest of the World." This includes many Asian, Latin American and Middle Eastern countries that are in close proximity to the NICs. For that reason, the Rest of the World is one of the major destinations of foreign consumption of NICs' domestic value added. Since the Rest of the World includes many countries, the Lorenz curve and the Gini shown here overestimate the concentration. Slicing up the Rest of the World in different countries would yield lower Gini values and a Lorenz Curve closer to the equality line.

one export industry. The differences between the two measurements are striking. Figure 6 shows the export shares measured in value added (blue) and on a gross basis (orange) for China in 2011. Gross output measures indicate a much higher relative importance of sector 30-33 (Electrical and Optical Equipment) by indicating that this sector accounts for 35 percent of China's total export value. On a value added basis, however, this sector is only responsible for around 12 percent of foreign Chinese value added consumption. The skill intensive electrical and optical equipment products show high shares of foreign value added. It is this industry in particular, where China does the final assembly but does not produce the components (see for instance the Ipod; Dedrick et al., 2010). For other sectors, the relative importance in trade is underestimated on a gross output basis. Similar results are obtained for the other five NICs (see Table A6 in the Appendix).

Primary and service industries show a higher relative importance when trade is measured in value added rather than on a gross basis. Primary goods are often embodied in the products of manufacturing industries. Services often take a supporting role in exporting and are indirectly exported by manufacturers. These findings have important policy implication and should raise the awareness that (trade) policies focusing only on sectors with a high relative gross share may lead to distorting outcomes. Evaluating the export industry structure purely on gross output information overestimates the relative importance of manufacturing industries for international trade – particularly for those with a high proportion of intermediate trade. The relative importance for service and primary sectors would be underestimated.

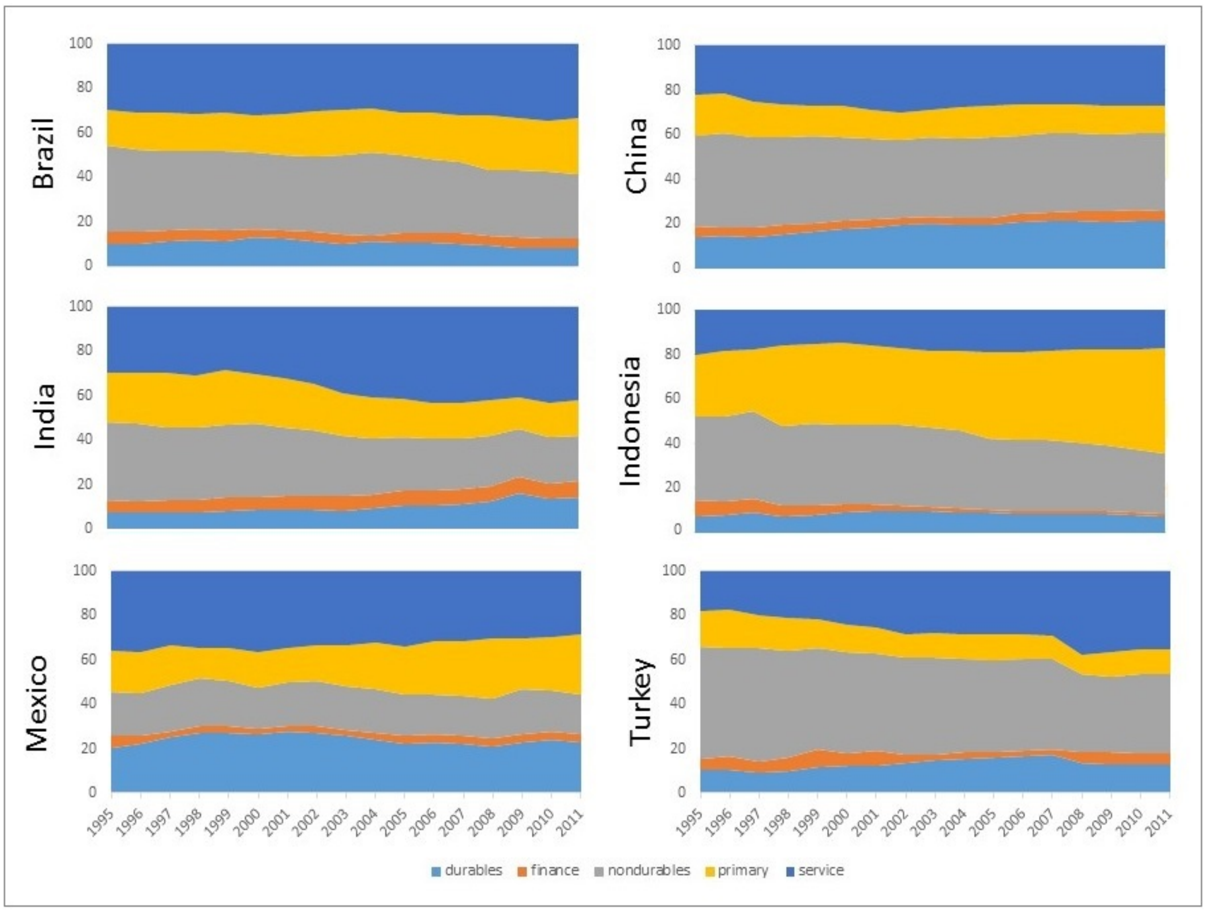
Figure 6. Foreign Consumption of China's Domestic Value Added Measured in Gross and Value Added Exports in 2011



Source: WIOD, Author's calculations; Industry classification: NACE Rev. 1, see Appendix XZ for a description.

Figure 7 shows value added export shares by industry category[21] for all six NICs from 1995 to 2011. The 35 industries are aggregated to primary (in yellow), durable (in light blue), nondurable (in grey), finance (in orange), and service (in dark blue) categories. The figure show that the industry structure of value added exports differs across the NICs. For instance, a huge share of Indian value added exports is generated by service and finance industries. From 1995 to 2011 both categories continuously increased the share and combined account for almost 50 percent of India's value added exports in 2011 (see Table A2 in the Appendix for the exact industry category shares in 1995 and 2011 and figure A7 in the Appendix for the disaggregated value added export shares of all 35 industries in 2011). For comparison, both categories only generate around 30 percent of total value added exports in China and Mexico in 2011.

Figure 7: Six NICs: Foreign Consumption of Domestic Value Shares by Industry Category – 1995 to 2011



Source: WIOD, Author's calculations.

[21] See Table A3 in the Appendix for a detailed overview of the industy categories.

The dominating role of services in value added exports is in line with India's role as a major service outsourcing destination (Liu and Trefler, 2008). China, on the contrary, is primarily an outsourcing destination for manufacturing. This is also reflected by the dominance of manufacturing industries in value added export shares. In 2011, durables and nondurables add up to a share of over 55 percent, more than for any other NICs. Turkey shows relatively high shares in services (35 percent) and nondurables (36 percent), but has the lowest share in primary products (11 percent). A high share in primary products can be an indicator that either countries are rather upstream in the value chain or are not integrated well in global value chains. Brazil, Mexico, and Indonesia show the highest value added share in primary products. Especially, the figure for Indonesia is striking. Around 47 percent of total value added exports originates from primary products, out of which mining accounts for 37 percent. This is in line with previous observations that both Brazil and Indonesia are not well integrated in global production. Even though mining also plays a crucial role for Mexico (close to 25 percent), Mexico also shows the highest share for durables (close to 23 percent). Despite the fact that the industry structure is rather diverse across the NICs, they also show some similarities: For all NICs, (except Mexico) nondurables was the major contributor of value added exports in 1995. This share decreased for all NICs by an average of 25 percent. Instead the share of services (except Mexico) and durables increased.

IV. Summary and Conclusion

One goal of this paper is to raise awareness of the limitations of traditional trade measures on a gross output basis in the light of increased vertical specialization and the dominance of trade in intermediates rather than final goods during the last two to three decades. To do so, this paper uses the WIOD to analyze the role of NICs in global value chains. The differences between measures on a gross output basis and value added basis are striking. The paper exemplarily shows this by measuring the relative importance of industries in exporting. Exports shares measured by both methods differed by more than 20 percent for some industries. These findings highlight the needs for more sophisticated world input output data to form a better understanding of how global production is organized.

Additionally, the paper provides insight into the role of NICs in global value chains. All NICs showed a huge increase in output, exports, imports and value added over the years of observations, underlining the increasing importance of NICs in global production. The origin of foreign value added embodied in exports became more diverse, and the same holds true for the destinations of value added exports. Generally, NICs' share of foreign value added in exports increased, whereas the share of industrialized countries decreased. Despite these similarities, the role of NICs in global production is fundamentally different in many respects. The findings of this paper support the idea that the phenomenon of "global" production sharing is limited to China, Europe, and North America. Brazil shows much larger shares of domestic value added in gross exports than the other NICs. The same holds true for Indonesia, which can be explained by its concentration on primary products. For China, India, Mexico and Turkey, increasing value added shares in gross exports are an indicator for increased participation in global production sharing. The reasons for this observation differ across the NICs. India is a main destination for service offshoring; almost 50 percent of India's value added exports originate in this sector. China concentrates on manufacturing products. The data give evidence for China's role as a final assembly destination, but also show that China's production of intermediates highly increased over the period of observation. Mexico's production is very much focused on the US, whereas Turkey concentrates on the European market.

The findings imply that policy advisors or makers should not attempt to conduct the same "one size fits all" policies across all NICs. Instead the role and position in global value chains should be carefully analyzed to give individual policy advice. For instance, policies for countries that are not well integrated in global production such as Brazil might focus on attracting foreign capital to increase global value chain participation, whereas policies for well-integrated countries such as India or China might focus on sustainable growth and learning from global value chains.

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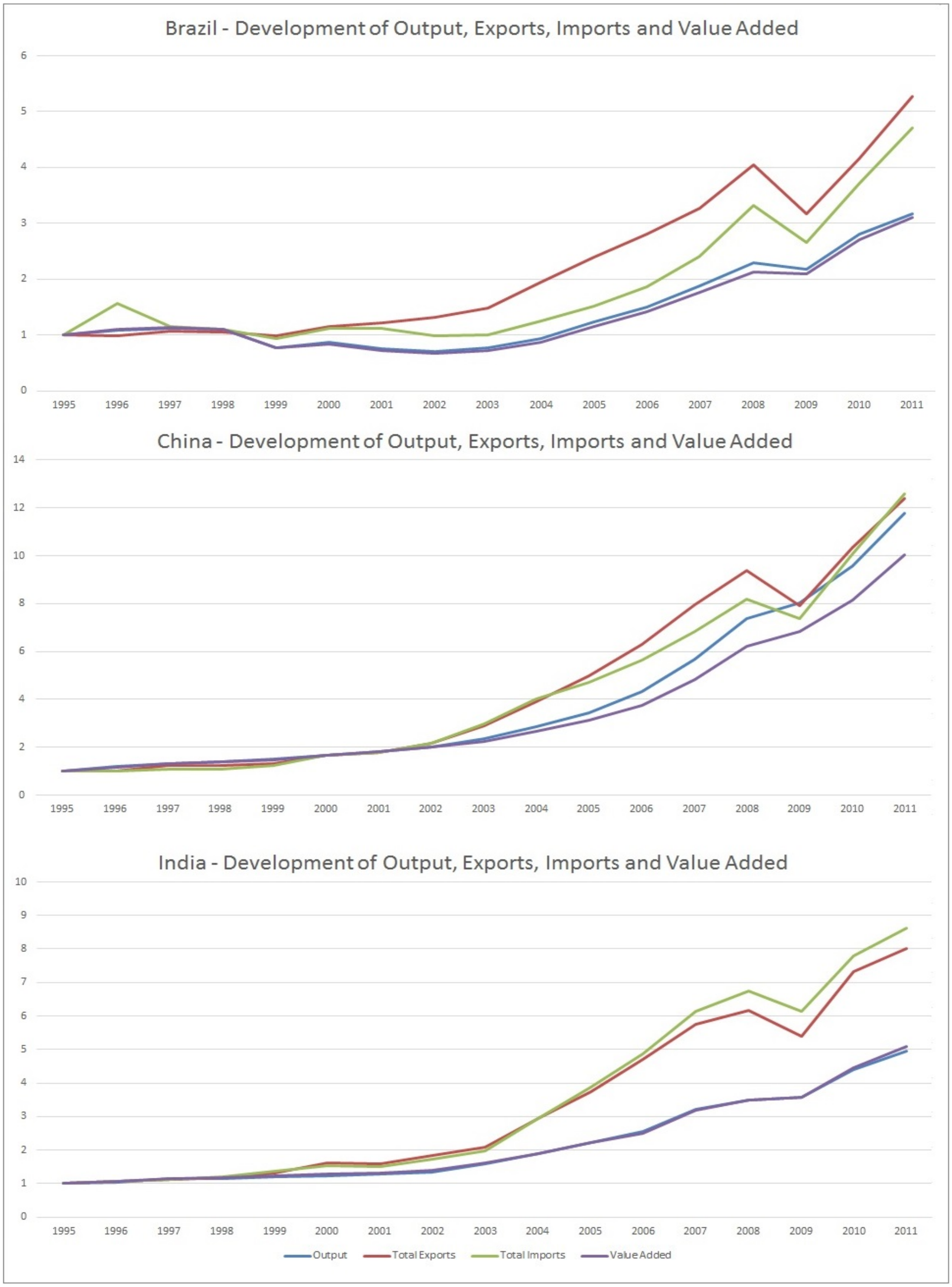
VI. Appendix

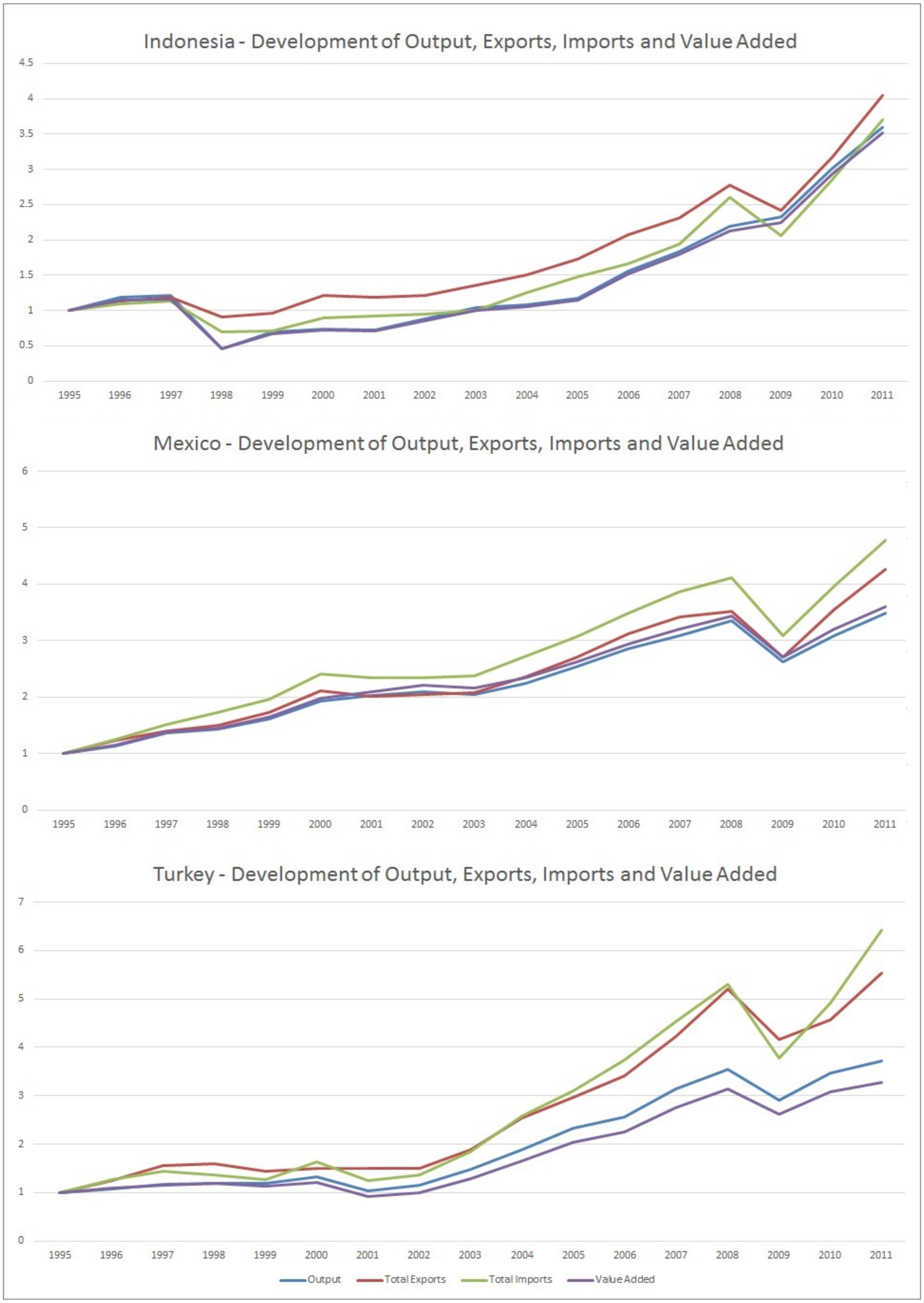
Figure A1. 787 Dreamliner Suppliers; Source: Boeing, Reuters

Figure A2. Output, Exports, Imports and Value Added for China, India and Indonesia from 1995 to 2011



Source: WIOD, Author's calculations.

Figure A3. Output, Exports, Imports and Value Added for Mexico, Brazil and Turkey from 1995 to 2011 Source: WIOD, Author's calculations



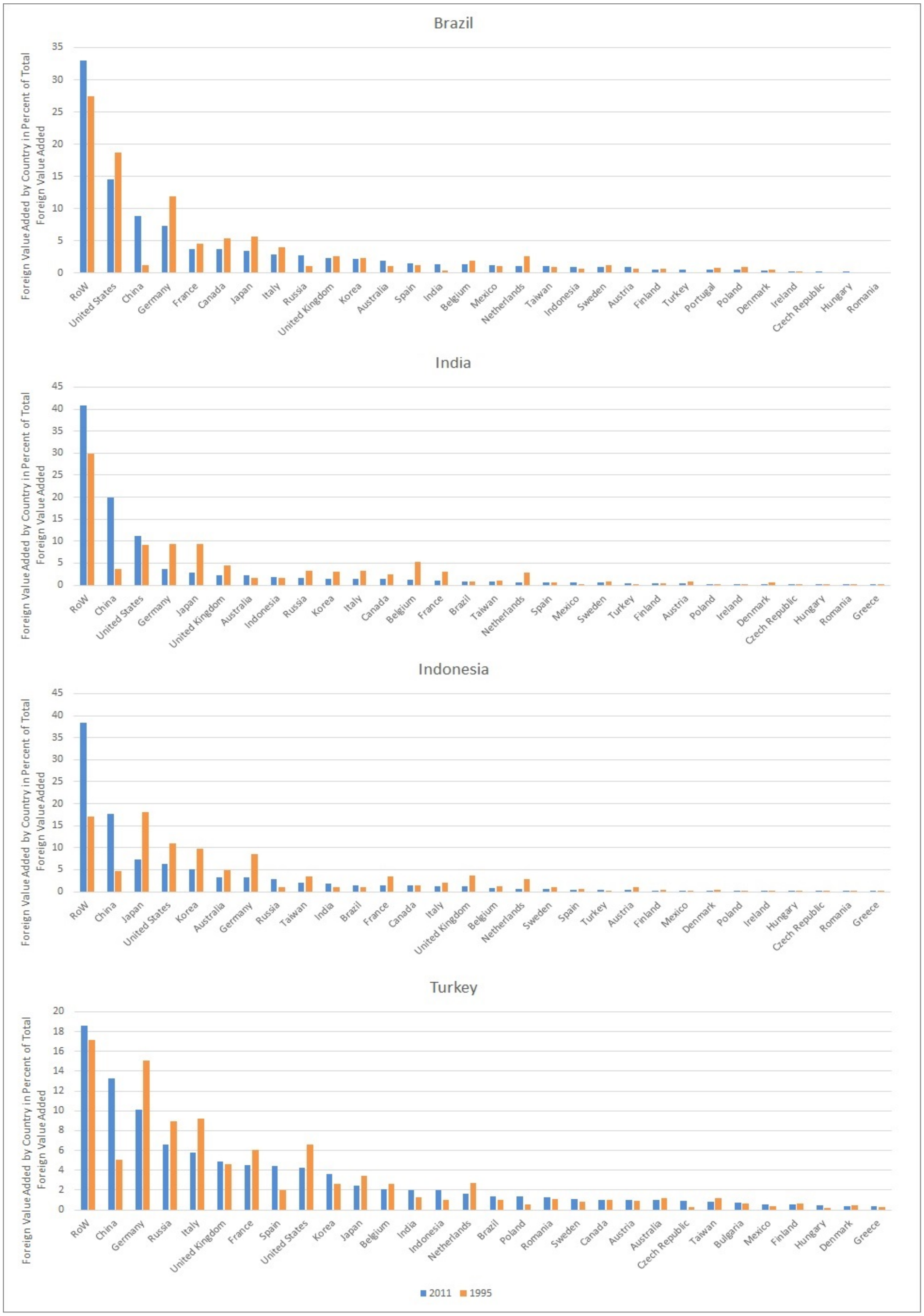
Source: WIOD, Author's calculations.

Table A1. Six NICs Growth of Final and Intermediate Imports and Exports from 1995 to 2011 (1995=1), Base Value 1995 in Brackets (in Million USD)

	Brazil	China	India	Indonesia	Mexico	Turkey
Final Exports	3.21 (13,453)	10.33 (91,728)	9.19 (17,445)	2.75 (15,862)	6.79 (31,769)	3.98 (16,452)
Intermediate Exports	5.05 (42,466)	14.84 (78,078)	7.18 (24,745)	4.58 (38,276)	4.35 (48,989)	7.67 (11,921)
Final Imports	4.05 (24,864)	7.32 (43,027)	9.05 (11,826)	3.31 (14,602)	6 (19,207)	9.43 (12,738)
Intermediate Imports	5.13 (38,761)	14.9 (99,119)	8.45 (31,916)	3.86 (38,246)	4.32 (52,507)	4.8 (23,570)

Source: WIOD, Author's calculations.

Figure A4. Foreign Value Added by Country in Percent of Total Foreign Value Added for Brazil, Indonesia, India and Turkey – 1995 and 2011



Source: WIOD, Author’s calculations.

Figure A5. Foreign Consumption of Domestic Value Added for Brazil, Indonesia, India and Turkey by Partner Country – 1995 and 2011

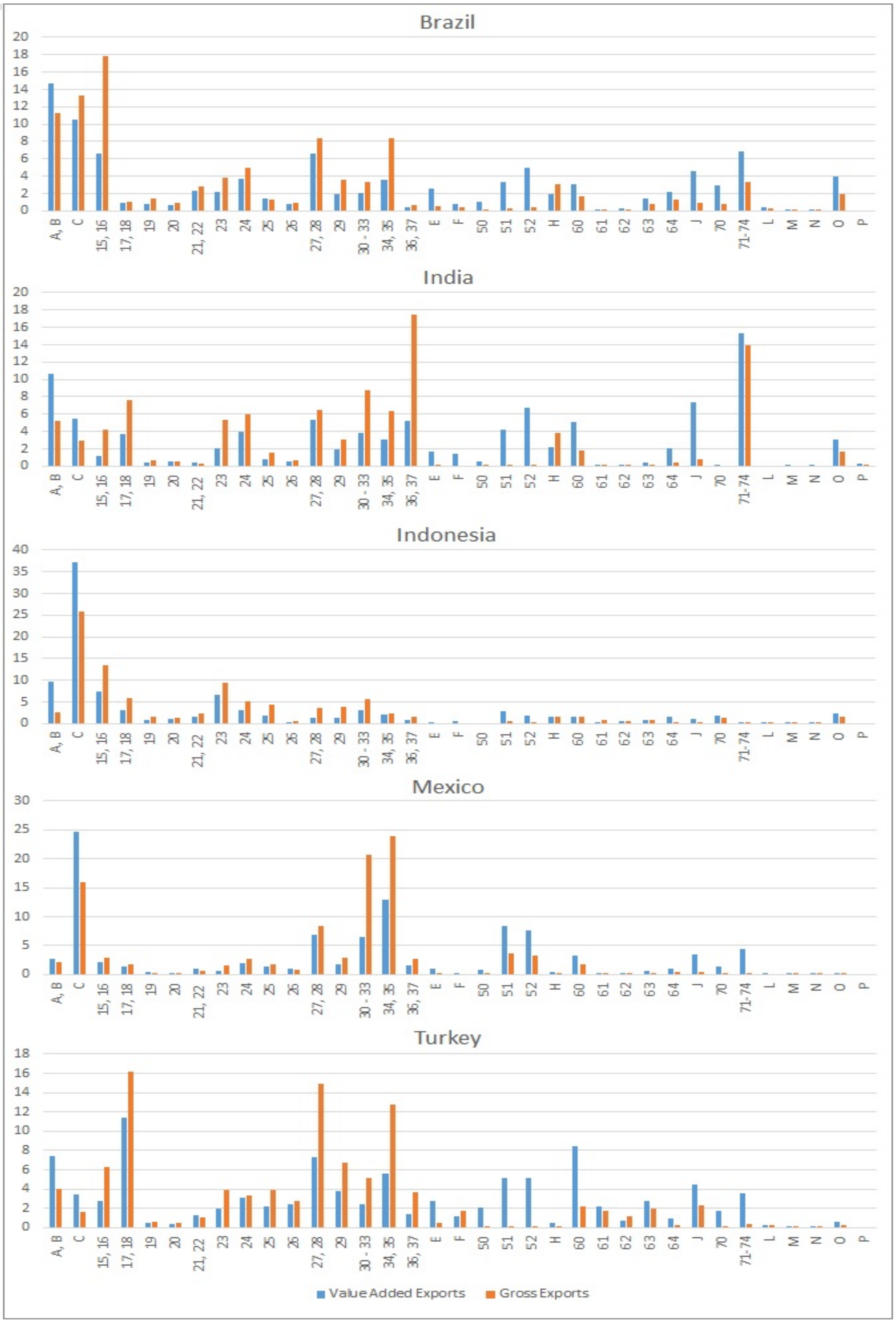
Source: WIOD, Author's calculations

Table A2. Six NICs: Foreign Consumption of Domestic Value Shares by Industry Category - 1995 to 2011

	Brazil	China	India	Indonesia	Mexico	Turkey
Primary	25.23	12.79	16.11	46.85	27.23	10.94
	(15.93)	(19.00)	(22.51)	(27.41)	(18.73)	(16.37)
Durables	7.94	21.00	14.11	7.31	22.79	13.19
	(10.09)	(14.16)	(7.81)	(7.19)	(20.26)	(10.42)
Nondurables	28.68	34.88	20.62	27.34	17.84	35.98
	(38.68)	(40.47)	(34.77)	(38.08)	(19.67)	(50.30)
Finance	4.62	4.53	7.36	1.19	3.56	4.49
	(5.32)	(4.50)	(5.46)	(7.24)	(5.57)	(4.94)
Service	33.52	26.79	41.8	17.32	28.58	35.4
	(29.98)	(21.87)	(29.44)	(20.08)	(35.77)	(17.97)

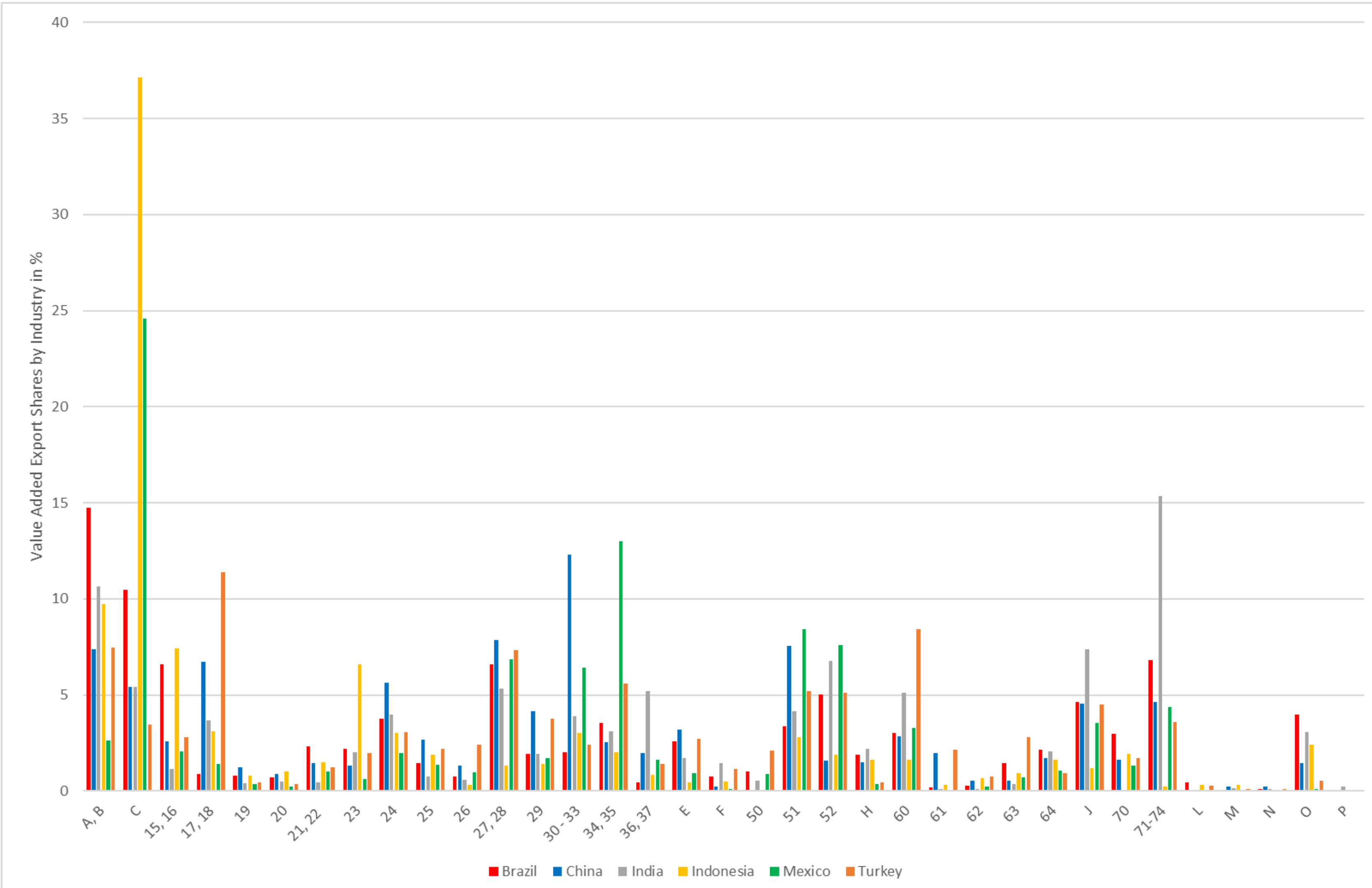
Source: WIOD, Author’s calculations.

Figure A6. Five NICs: Foreign Consumption of China's Domestic Value Added Measured in Gross and Value Added Exports in 2011



Source: WIOD, Author's calculations.

Figure A7. Six NICs: Foreign Consumption of Domestic Value Shares by Industry – 1995 to 2011



Source: WIOD, Author's calculations

Table A3. Industries and Industry Catergories

WIOD Number	Industry Code	Description	Category
1	A, B	Agriculture, Hunting, Forestry and Fishing	primary
2	C	Mining and Quarrying	primary
3	15, 16	Food, Beverages and Tobacco	nondurables
4	17, 18	Textiles and Textile Products	nondurables
5	19	Leather, Leather and Footwear	nondurables
6	20	Wood and Products of Wood and Cork	nondurables
7	21, 22	Pulp, Paper, Paper , Printing and Publishing	nondurables
8	23	Coke, Refined Petroleum and Nuclear Fuel	nondurables
9	24	Chemicals and Chemical Products	nondurables
10	25	Rubber and Plastics	nondurables
11	26	Other Non-Metallic Mineral	nondurables
12	27, 28	Basic Metals and Fabricated Metal	nondurables
13	29	Machinery, Nec	durables
14	30 - 33	Electrical and Optical Equipment	durables
15	34, 35	Transport Equipment	durables
16	36, 37	Manufacturing, Nec; Recycling	durables
17	E	Electricity, Gas and Water Supply	nondurables
18	F	Construction	service
19	50	Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel	service
20	51	Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles	service
21	52	Retail Trade, Except of Motor Vehicles and Motorcycles; Repair of Household Goods	service
22	H	Hotels and Restaurants	service
23	60	Inland Transport	service
24	61	Water Transport	service
25	62	Air Transport	service
26	63	Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies	service
27	64	Post and Telecommunications	service
28	J	Financial Intermediation	finance
29	70	Real Estate Activities	service
30	71-74	Renting of M&Eq and Other Business Activities	service
31	L	Public Admin and Defence; Compulsory Social Security	service
32	M	Education	service
33	N	Health and Social Work	service
34	O	Other Community, Social and Personal Services	service
35	P	Private Households with Employed Persons	service

Source: Industry classification: NACE Rev. 1.