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WHO PRODUCES FOR WHOM IN THE WORLD ECONOMY?

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For nearly two decades, the share of trade in inputs, also called vertical trade, has dramatically increased. This paper suggests a new measure of international trade: "value-added trade". Like many existing estimates, "value-added trade" is net of double-counted vertical trade. It also reallocate trade flows to their original input-producing industries and countries and allows to answer the question "who produces for whom". In 2004, 27% of international trade were "only" vertical specialization trade. The sector repartition of value-added trade is very different from the sector repartition of standard trade. Value-added trade is less regionalized than standard trade.

Keywords: Globalization, Vertical trade, Regionalisation

JEL: F15, F19

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Introduction

The recent development of regional trade agreements has sparked the fear of the emergence of antagonist regional trade blocks.[2] It is not actually clear that the spaghetti bowl of regional trade agreements really can have this kind of effects by itself.[3] It is certain that, e.g. East Asia has recently experienced a growing regionalisation of its trade, suggesting his development is becoming more self-centred.[4] Yet, the already rich literature details the reasons behind the high intensity of vertical trade in regional trade in East Asia underlines, that its regionalization is exaggerated by the importance of vertical trade: Asia trade as a whole is still very dependent on demand from the other continents, especially America.[5] This is not easy to see in standard trade statistics.

Cross-border production networking (variously named de-localization, disintegration of production, fragmentation, global production sharing, international outsourcing, slicing up the value chain, processing trade…), encouraged by extensive FDI flows, has been an important part of recent globalization in general and regionalization in particular.[6] Different stages of production are spread across a range of production sites in multiple countries. This vertical specialisation of production is based on a new international division of labour moving away from the traditional division where production is split up between primary and manufactured goods. Segmentation of production is becoming increasingly subtle, maybe in order to make the best of the "kaleidoscope" comparative advantages of each country.[7] This new international division of labour has logically induced the acceleration of trade flows since the end of the 1980s as a growing number of inputs are crossing several borders. This resulted in a rapid expansion of trade in inputs, some of which are intermediate goods. The multiplication of input trade has been facilitated by the cut in tariff and nontariff barriers within the framework of bilateral and multilateral trade agreements: vertical specialization is

[2] World Bank (2000).
[3] Baldwin (2006), Ethier (1998).
[4] Kwan (2001), Chortareas and Pelagidis (2004).
[5] See the review in Haddad (2007).
[6] Feenstra (1998).
[7] Bhagwati and Dehejia (1994).

especially sensitive to trade costs, as it implies an increase in the number of borders crossed by each goods.[8]

In this context, it is well known that international trade statistics fail to offer a good picture of trade integration and global division of labour. They cannot answer the question "who produces for whom?". Let us take a different example from the canonical Barbie doll and Nike shoe to illustrate the point. The firm Burberry sends bottles of French perfume to Shanghai to be decorated with Scottish pattern before bringing them back to be sold on the French market. Standard trade statistics suggest that France is exporting perfume bottles to China and China exporting perfume bottles to France.[9] Yet, France does not export anything for Chinese consumption, as perfumes are consumed in France. China simply exports decoration for French consumption. Suppose the pigments used for the decoration of these perfume bottles are imported from Japan to China. This Japan-China trade flow does not mean that China consume Japanese products, as the final consumer is in France. Unravelling these long supply chains is impossible using simply trade statistics.

This paper examines how taking into account vertical trade changes the answer to the question "who produces for whom" in the world economy. It advocates the study of trade flows using "value-added trade".[10] Compared to "standard trade", "value-added trade" is net of double-counted vertical specialization trade.[11] This paper's contribution is to use coherent trade and input-output data from GTAP to reallocate trade flows to their original input-producing industries and countries. It computes value-added trade for 66 regions and 55 sectors in 1997, 2001, 2004. It also computes value-added trade for 113 regions in 2004.[12]

The difficulty of measuring value-added trade lies in taking into account all the stages of production of a final good in order to track the value-added coming into its production from each sector and each country. First, second, third… stage inputs must be isolated. This can only be done

[8] Yi (2003).
[9] Examples from Benhamou (2005), p. 19, 25 and 96.
[10] It has long been recognized that trade and GDP are not directly comparable because trade is not measured in terms of exchanged value-added: Irwin (1996), Feenstra (1998), Cameron and Cross (1999).
[11] Vertical trade sometimes designates intra-industry trade in goods of different qualities. This is not the object of this paper.
[12] Similar exercises using 1997 and 2001 GTAP data can be found in: Belke and Wang (2005), Daudin, Rifflart, Schweisguth, and Veroni (2006) and Johnson and Noguera (2009). All these researchers seem to have developed their methods independently.

thanks to a coherent worldwide set of intermediate delivery matrices and bilateral trade matrices. The GTAP database includes the necessary information.[13]

In a first section, the paper presents vertical specialization trade, and its existing measures. In a second section, it presents a method to compute value-added trade. In a third section, it presents some results on vertical trade and value-added trade and compares them to results obtained by other methods. It shows how much standard trade statistics give a distorted picture of the relative openness of different sectors. In a fourth section, it compares regionalisation in different parts of the world. It shows that Asia is not an exception in having an important part of its regionalization linked to vertical trade. The real exception is Europe, which regionalization is the less dependent on vertical trade.

1. Vertical specialization trade

1.1. What is it?

This paper follows the definition by Hummels, Rapoport, and Yi (1998). There is vertical specialization of trade (or "vertical trade" for short) as soon as:

- the production of a good follows a sequential process that can be broken down in several stages;
- at least two countries take part in this production process;
- at least one country imports inputs to produce the goods of which a fraction of the production is exported.

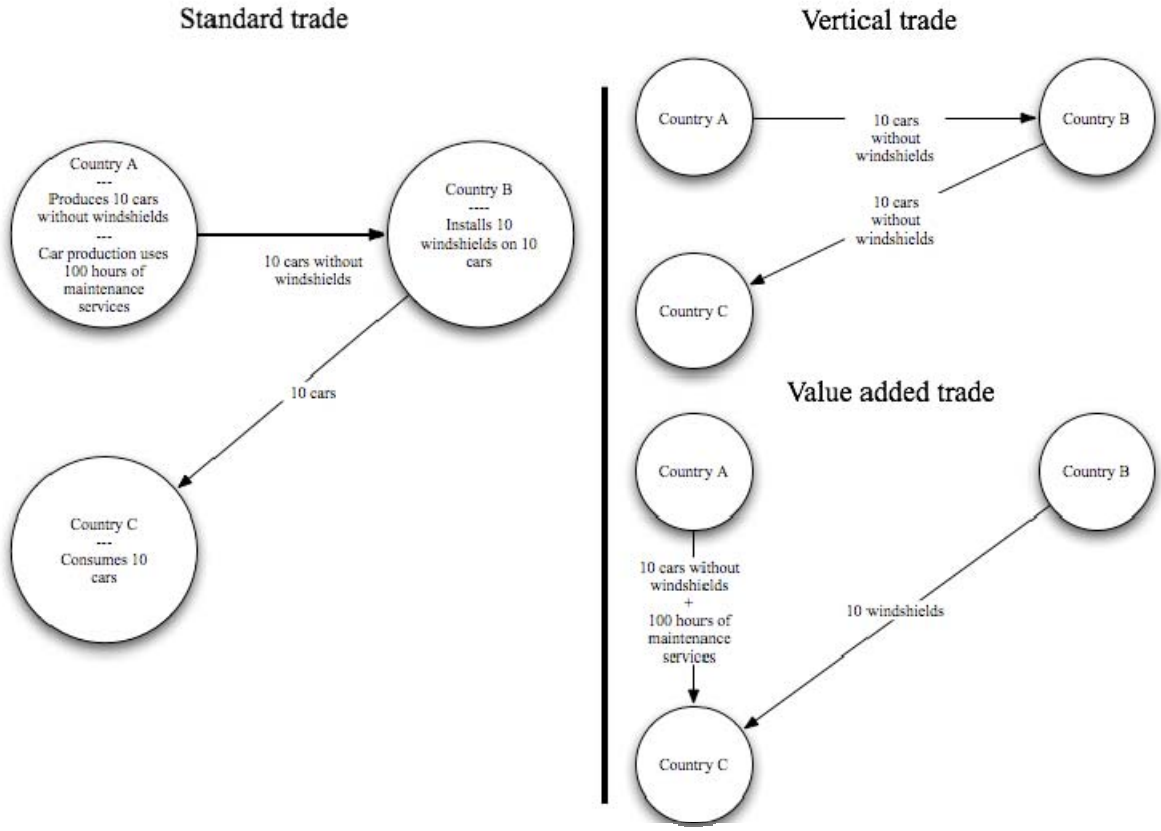
Based on that definition, two different measures of trade can be identified. The first one, which we call "standard trade", measures trade flows based on their market value when they cross borders. When exported goods contain a high proportion of imported inputs, their market value can be very high compared to locally produced value-added. This measure can lead to a very high export to GDP ratio, sometimes exceeding 100%[14] (as in the cases of Ireland and Singapore). The other measure, called "value-added trade", measures trade net of vertical trade and reallocates the value-added produced at the different stages of the production process to each of the participating countries and

[13] Dimaranan (2006).
[14] In our data, this is the case of Malta and Ireland (102%), Luxembourg (129%), Malyasia (133%) and Singapore (173%).

industry. Value-added trade corrects for that and measures only the trade flows between the producer and the final user.

Let us take the example of three countries A, B and C.

Figure 1: Three ways to look at the same trade flows



The left side of the figure shows total trade flows as they appear in standard trade statistics (for shorthand "standard trade"). The top right figure shows vertical trade. "Cars without windshields" are counted twice in standard trade statistics: once when they are exported from A to become inputs in B and once when they are exported from B for consumption in C. The bottom right figure shows "value-added" trade.

Value-added trade flows imply that country A does not actually trade with country B in the sense that no final user in country B utilizes goods from country A. All the final users of country A's exports are in country C. Similarly, the industrial picture of trade is changed. Standard trade flows suggest that country A does not export services. Yet, its services production is being consumed, once it is

embedded in cars, in country C. In that sense, country A is actually exporting services.

Value-added trade flows can change our assessment of regionalisation. Imagine that country A and country B are in the same region. Standard trade flows suggest that intra-regional trade flows are nearly as important as extra-regional trade flows. Yet, value-added trade flows suggest that intra-regional trade flows are nil in the sense that no one in country A or B is consuming goods produced in another country in the same region. Both countries are producing for country C's consumption. This is a very different case of regionalisation than one in which country B actually depends on country A for its final consumption.

1.2. How can it be measured?

Vertical trade can be measured in three ways.[15] The first way is to use firm surveys. But these are only available for a limited number of countries (notably the United States and Japan) and present a number of limitations. They have been used to study trade in intermediate inputs by multinational firms.[16]

A second method is to use fine industrial classification of trade.[17] E. g. Athukorala and Yamashita have measured vertical trade for most countries in the world in the context of the five-digit SITC, Rev 3 classification, by treating some goods belonging to categories 7 (machinery and transport equipment) and 8 (miscellaneous manufactured articles) as component inputs. They find that world trade in components increased from 18.5 percent to 22 percent of world manufacturing exports between 1992 and 2003.[18] This method cannot be extended to measure value-added trade.

The third and most traditional method is to use input-output tables.[19] The most extensive use of this method is by Yi and his various co-authors (these papers are subsequently referred as "Yi and alii").[20] They calculated international vertical specialisation trade, defined as the share of imported

[15] For a survey, see Feenstra (1998).
[16] Hanson, Mataloni Jr, and Slaughter (2005).
[17] E.g. Fontagné, Freudenberg, and Ünal-Kesenci (1996), Ng and Yeats (1999), Yeats (2001) (this paper also use data coming from special favourable treatment for re-imported domestically produced components), Ng and Yeats (2003), Egger and Egger (2005).
[18] Athukorala and Yamashita (2006).
[19] E.g. Fontagné (1991), Campa and Goldberg (1997).
[20] Ishii and Yi (1997), Hummels, Rapoport, and Yi (1998), Hummels, Ishii, and Yi (1999), Hummels, Ishii, and

inputs in exports, using input-output matrices of 10 OCDE and 3 non-OECD countries.[21] In their computation, Yi and alii take into account imported goods directly used as inputs for the production of exports, but also imported inputs used for the production of domestic inputs used in the production of exports: they call all these flows "VS" for vertical specialization trade. Hummels, Ishii, and Yi (2001) extrapolate their results to the rest of the world. They find that the share of vertical trade in world merchandise exports was equal to 18% in 1970 and 23.6% in 1990.[22]

But vertical trade is wider than VS. Purely domestic-produced exports can also be part of vertical specialization trade if they are subsequently used by another country as inputs in its own exports: Yi and alii call this flow "VS1". Computing VS1 is more difficult than computing VS. VS can be computing using solely the delivery matrix of the reporting country whether VS1 requires matching bilateral trade flow data with intermediate delivery matrices for all trading partners.[23] By construction, VS in the exports of country A is equal to VS1 in the exports of all other countries to country A. For the world as a whole, VS is equal to VS1.

One can further distinguishes the part of VS1 that comes back to the country of origin: VS1*. VS1* is defined as the exports that are, further down the production chain, re-imported as embedded inputs for final use. VS1* is the domestic content of invested or consumed imports. A typical example is trade in motor vehicles and parts between the US and Mexico and Canada. When the US import cars from Mexico for its own consumption, motors made in the US are part of VS1*. The total value of value-added trade is equal to standard trade minus VS and VS1*.[24] Total world vertical exports are equal to VS+VS1*.

Our paper's method is similar to Hummel et alii's, but we compute VS for many more countries in three years: 1997, 2001 and 2004. Furthermore, because we use world wide input-output tables reconciled with bilateral trade statistics, we can also compute VS1, compute VS1* and reallocate

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Yi (2001); Yi (2003); Chen, Kondratowicz, and Yi (2005).

[21] Hummels, Rapoport, and Yi (1998), Hummels, Ishii, and Yi (2001).

[22] Hummels, Ishii, and Yi (2001), table 1. Also see Hummels, Ishii, and Yi (1999), table 5.

[23] VS1 is computed from some case studies in Hummels, Rapoport, and Yi (1998) and from input-output tables in Hummels, Ishii, and Yi (1999).

[24] Something similar is found in Chen, Kondratowicz, and Yi (2005), pp. 58-60, though it seems that they confuse VS1 and VS1*.

vertical trade to its initial producer.

2. How to compute trade flows in value-added

2.1. GTAP database

Computing international trade flows in value-added requires the use of input-output tables and in particular of intermediate deliveries matrices reconciled with bilateral trade data. Leontief in the 1930s computed the first input-output tables and set the foundations of input-output analysis.[25] This branch of economics has in turn nourished general equilibrium modelling, allowing for the construction of simple computable economic models relying on the Leontief inverse matrix.[26] Such models make possible the analysis of direct and indirect effects of changes in one economic variable on all others. They have also been used for the study of international trade, in the context of Computable General Equilibrium Models (CGEM). In this context, they must be reconciled with bilateral trade data. This has been done by the GTAP project (*Global Trade Analysis Project*).

The project started in 1993 at Purdue University (United States). It associates 24 international organisations and research centres among which the United Nations, WTO, the European Commission, OECD and CEPII. GTAP's goal is to improve the quality of quantitative analysis of global economic issues within an economy-wide framework. It provides databases and programmes for CGEM. We work with versions 5 (for 1997), 6 (for 2001) and 7 (for 2004) of the GTAP database, which cover 55 sectors for 66 « regions » (countries or countries groups) in 1997, 87 « regions » in 2001 and 113 "regions" in 2004. We work both with 66 regions to compare each year's result and with 113 regions for 2004. The database provides final demand and input-output tables for each region. In each input-output tables, two full intermediate deliveries matrices are available: one for domestic inputs and one for imported inputs. It also provides information on bilateral international trade by industry (including service trade).

Original trade and input-output data come from national statistical offices, and hence its quality

[25] Leontief (1936).
[26] Shoven and Wholley (1992).

depends on their quality.[27] In spite of standardization efforts, statistical conventions differ among countries and some national statistical offices are too understaffed to produce reliable data. Making official data compatible with GTAP is difficult. Data exclusively on a single country, like input-output tables, are less reliable than trade data as they cannot benefit from double check with data from partner countries. Moreover, the GTAP team has imposed some assumptions in order to reconcile trade data. For example, it was necessary to interpolate some data on transport costs.

Furthermore, the input-output data used in GTAP are often for distant years and are not systematically updated between versions. E.g. input-output data for Italy are for 1992, India for 1994…[28] As a consequence, comparisons between different years can be misleading as the underlining structure of the economy is assumed to stay the same.

Lastly, reconciliation between input-output data and trade data is fraught with difficulty. Input-output data bear the brunt of the changes necessary for reconciliation because they are less reliable than trade data. The shape of input-output tables can sometimes be dramatically changed, but this happens mainly for small countries or regional aggregates: usage shares change by an average of 71% for Cyprus, 51% for Malta, 38% for "rest of SADC" in GTAP 6. In contrast, usage shares change by an average of 5% or less for all G7 countries, India, China, Korea, Brazil… Still, some individual changes in Germany and the United States are important.[29]

The GTAP team is conscious of such quality problems. Nevertheless, the database has been used by a network of more than 3,500 researchers for longer than a decade. The organisation of the GTAP project allows remarks to be systematically registered and integrated for the improvement of the database. The GTAP database is therefore a reference for experts and researchers in international trade.[30] Still, all these defects make the GTAP database a markedly inferior source for the computation of vertical trade than the data used up to now in the existing literature. However, the originality of this

[27] For example, we have stressed the importance of intra-firm trade. This kind of trade can bias our methodology if firms set their transfer prices in order to redirect their profits to countries where the tax burden is lower. According to IMF rules transfer prices must correspond to market prices in the country of origin and prices set by firms can be modified by customs and the tax authority. Some biases may however persist.
[28] See {Walmsley, 2008 #102}.
[29] McDougall (2006).
[30] For additional information, refer to http://www.gtap.agecon.purdue.edu

paper is not to compute the value of vertical trade, but rather to re-allocate input trade flows to their initial producers. The only way to do that is to use reconciled input-output and trade data, and GTAP is the best source that provides this information, as recognized by the community of CGE economists. One can only hope better quality data will arise in time.

2.2. Theoretical foundation of the calculation[31]

In the context of a closed economy, equilibrium between output and final demand requires that output is equal to the sum of intermediate deliveries and of final demand.

$$P=A*P + FD$$

Where P is a vector of output for each product, FD a vector of final demand for each product, A a matrix of input coefficients taken from the intermediate deliveries matrix. It consists of elements a_{ij}, defined as the amount of product i required for the production of one unit of product j.

This entails the following relation. This is a well-known result in input-output analysis which links the final demand of each product and production:

$$P =(I-A)^{-1}*FD \quad (1)$$

Where I is the identity matrix. Each output vector P is itself associated with a value-added vector VA which gives each industry value-added required by the output vector.

$$VA=P - diag(P)A'I \quad (2)$$

Where $diag(P)$ is the square matrix having the elements of P on its diagonal, A' is the transpose of matrix A and i is the summation vector, a column vector filled by 1s.[32] Hence, the value-added vector VA associated with the final demand vector FD is equal to:

$$VA = (I - A)^{-1}*FD - diag((I - A)^{-1}*FD)A'I \quad (3)$$

This can be extended to the international case of many inter-linked open economies. The world can be treated in the same way as a single economy where each sector in each country produces a specific product, which is produced nowhere else. There is an "extended" intermediate deliveries

[31] This is extended in Daudin, Rifflart, Schweisguth, and Veroni (2006).
[32] This last relation is easier to understand if one keeps in mind that $P-P*A$ is equal to the vector of total ouput not used as inputs for further production; this is not the same thing as value-added.

matrix *G* of dimension *number of products*number of countries* which gives the amount of product *i* from country *m* required per unit of product *j* in country *n*. G is similar to an usual domestic intermediate deliveries matrix where each pair *product*producing country* is treated as a different product or industry. [33]

As we have written (2) and (3), we can write:

$$VA = P - diag(P)G'i \quad (4)$$

$$VA = (I - G)^{-1} * FD - diag((I - G)^{-1} FD)G'I \quad (5)$$

Where *VA* and *P* are vectors of dimension *number of products*number of countries*. This formula allows the computation of the value-added production (*VA*) linked to the consumption or investment of some final product (*P*). Practically, *P* is taken from trade and final usage statistics. It allows the computation of *VA* from which value-added trade values are extracted.

2.3. Limitations

2.3.1. *Input-output coefficients*

However, the matrix *G* is unknown. As far as we know, no statistical institute diffuses such details. Data on whether inputs and final use goods are imported or domestic exist and are reported in GTAP though: they can be used to approximate *G*. This is what Hoen calls the "limited information multi-country input-output model".

The approximation is obtained, in the input-output tradition, by a fixed-proportion assumption. The assumption is that the share of each partner country in imported products is independent of its use (as a final demand item or as an intermediate consumption). This assumption means that the share of US grain is the same in imported grain used for final consumption in Mexico and imported grain used as inputs for Mexican food industry.[34] This is a severe approximation, as the origin of inputs used in exports is probably different from the origin of inputs used in domestic consumption. Multinational firms producing in process-heavy countries, like China, are more likely to import more foreign goods as inputs and export more than the average of the industry. This is encouraged by the existence of

[33] See Hoen (2002), pp. 51-58 for a discussion of this method and a formal discussion of the G matrix.
[34] This hypothesis is very common, and is used e.g. in Campa and Goldberg (1997) and Feenstra and Hanson (1997).

fiscal support to process activities, e.g. duty-drawbacks systems like in China and Vietnam or more generally "Export Processing Zones" (more than 3,500 exist in 130 countries[35]). This can also be encouraged by higher quality requirements in foreign markets. This issue has long been recognized[36]. It has been extensively studied in the case of China.[37] Koopmans, Wang and Wei show that the method we use underestimates by 50% the amount of imported content in Chinese exports.[38] Implementing their method to China and other countries in our data would require using more detailed trade statistics than the ones available in GTAP. This extension is past the ambition of this paper.[39] Rather than trying to measure finely vertical trade, the ambition of this paper is to give a first approximation of the effects of re-allocating input trade to its original producer. It must be kept in mind that this paper underestimates vertical trade throughout, especially for developing Asian countries.

2.3.2. Taking into account margin services

Data on foreign trade flows also need some price amendments. Imported goods volumes are measured by GTAP — for example in the intermediate deliveries tables — in import prices. Such prices include production prices, transport costs, insurance costs as well as taxes levied on imports. However, to make the link between imports and production in the country of origin, we must measure volumes of imported goods used as intermediate deliveries or as final demand at production prices. To transform import prices into production prices, we apply a constant ratio along the different usage of different goods. This is equivalent to assuming that that goods originated from the same country and from the same industry bear the same transport cost and the same import duties whatever their use in the importing country. This seems reasonable, except that our industry aggregation is not very fine.

The difference between import values and export – containing transport, maintenance and insurance costs and called *margin services utilisation* in the GTAP database. Ideally, we would like to

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[35] Singa Boyenge (2007). Countries with more than 500,000 workers in EPZs are: China (40 M), Indonesia (6 M), Bengladesh (3.4 M), Mexico (1.2 M), Philippines (1.1 M), Vietnam (1 M), Pakistan (0.9 M), UAE (0.6 M) and South Africa (0.5 M).
[36] Hummels, Rapoport, and Yi (1998).
[37] Chen, Cheng, Fung, and Lau (2005), Dean, Fung, and Whang (2007), Koopman, Wang, and Wei (2008).
[38] Koopman, Wang, and Wei (2008).
[39] It has been done in the case of China and Mexico in Johnson and Noguera (2009).

be able to allocate it to trade flows of the transport industry. However, there is no good way of doing that. The database does not indicate whether transport services linked to a trade flow were provided by a firm in the importing country, a firm in the exporting country or a firm in a third country. The only data available are the share of each country in the total supply of transport services linked to total international trade flows. We have therefore decided to exclude margin services trade from our computation.

3. Value-added trade in general

3.1. Comparing with previous measures

Before developing our own results, we compare them with those found by Yi et alii. Our frameworks are very similar: we use the same definition of vertical trade and work from intermediate delivery matrices. However, they do not use reconciled trade / input-output data and cannot reallocate vertical trade flows to their original producers. As such, they do not compute value-added trade.

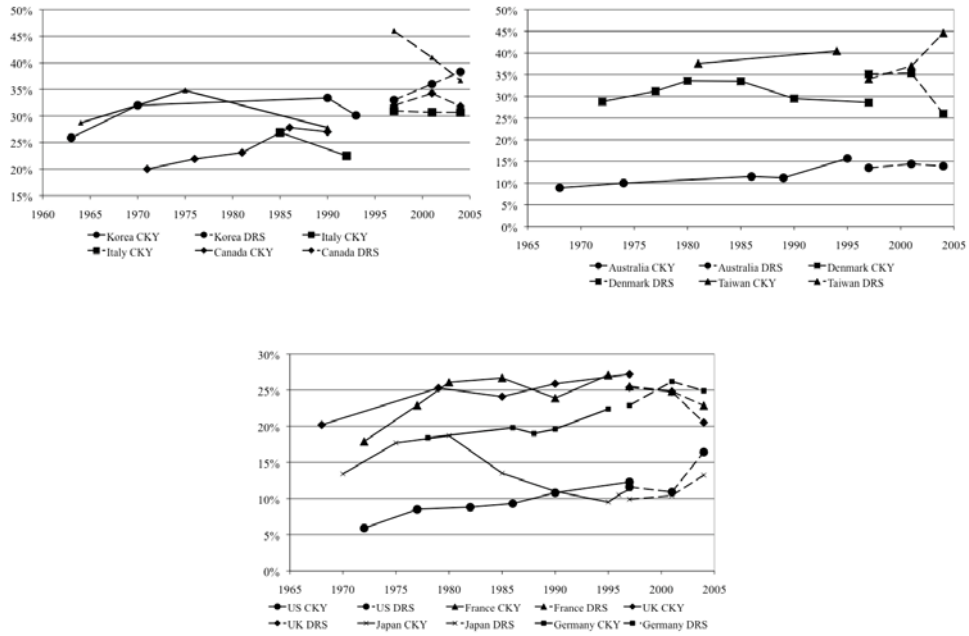
Yi and alii calculated the share of imported of inputs, including inputs for inputs, in merchandise exports (VS) for 10 OECD countries and 4 emerging countries, using OECD input-output tables up to the end of the 1990s.[40] For comparison purposes, we compute the same share using the same method for all the countries in our sample: our data cover 1997, 2001 and 2004. The results are given in Figure 2.

We do not diverge systematically in any way from the results by Yi and alii. Comparison is not possible for four countries, as the latest data from Yi and alii refers to before 1994 (Canada, Korea, Ireland and Italy). The difference between Yi and alii's results and ours is larger than two percentage points for only three countries (Australia, Denmark and Taiwan). The difference is smaller than two percentage points for five countries which are all the largest traders in the dataset: France, Germany, Japan, the United Kingdom and the United States. Differences are not correlated with the amount of change imposed on Input-Output table by the trade / Input-Output reconciliation process, nor do they

[40] Hummels, Ishii, and Yi (1999) tables 2 and 3, Hummels, Ishii, and Yi (2001), pp 84-85, Chen, Kondratowicz, and Yi (2005), p 42, table 2.

seem to be linked with the origin of Input-Output tables in GTAP.[41]

Figure 2: Share of imported inputs in merchandise exports: comparing our results to Yi and alii's



Sources: Hummels, Ishii, and Yi (2001), Chen and alii (2005), authors' calculations based on GTAP data for 1997, 2001 and 2004.

3.2. Value-added trade at the country level

Table 1 gives some measures of vertical trade and value-added trade by continent.

Table 1: Vertical trade per continent

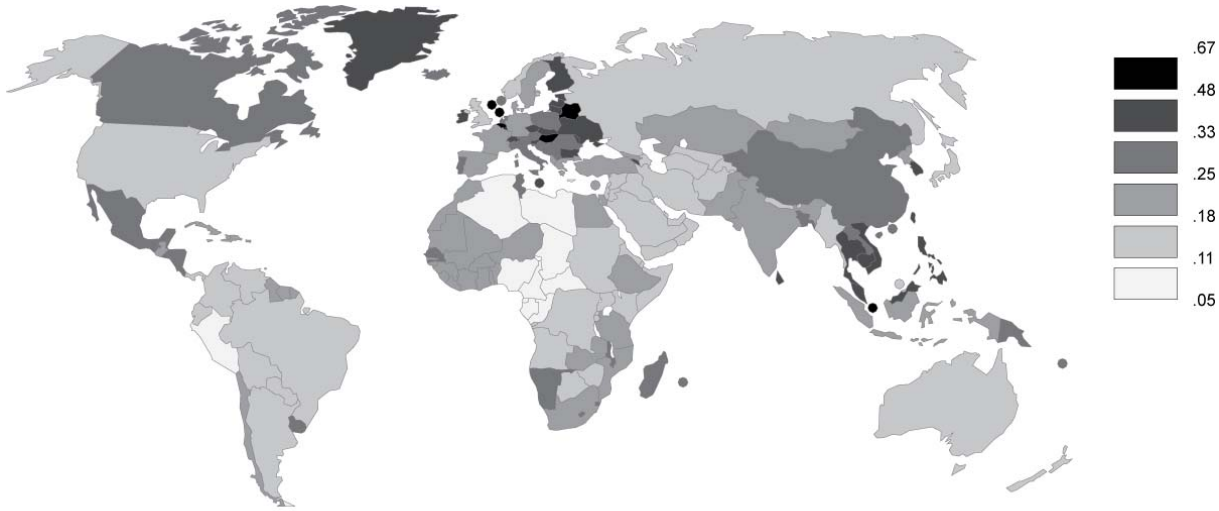
Country	Import content of exports (VS)	Exports used as inputs for further exports (VS1)	VS1/VS	Exports consumed or invested domestically (VS1*)	Share of vertical trade in total trade	Ratio of standard exports to GDP	Ratio of standard imports to GDP	Ratio of value-added exports to GDP	Ratio of value-added imports to GDP
Asia	30%	27%	0,90	0,9%	33%	29%	26%	20%	17%
America	18%	23%	1,24	5,1%	21%	13%	17%	10%	13%
Europe and peripheries	26%	25%	0,98	1,2%	27%	37%	36%	27%	26%
Africa	17%	26%	1,54	0,3%	18%	37%	34%	31%	27%
World	25%	25%	1,00	1,8%	27%	26%	26%	19%	19%

We will now go through this information in a cartographic way. The map might be difficult to

[41] McDougall (2006), table 19-4. Walmsley and McDougall (2006), table 11.A.1.

read: all the data are presented in Table 7 (in appendix). Map 1 gives the share of imported inputs in total exports (VS) for each country in the world. The world mean is 25%. Exports of small countries have a bigger share of imported inputs. 40 % of exports in some Asian and European countries are imported inputs. 67 % of Singapore's exports are. (Dutch and Hong Kong trade is already modified in GTAP to remove transit trade: this explains the relatively small values of their imported inputs in exports).[42]

Map 1: Share of imported inputs in total exports (VS)



Map 2 compares the ratio of exports that are further re-exported in partners' exports (VS1) over imported inputs in exports (VS). As worldwide VS1 and VS are equivalent, the world mean is equal to one. It suggests a division between two types of participation in the international disintegration of the production process. Some countries take part through the production of inputs for further exports (identified when VS1 is broadly higher than VS): primary producers (Former Soviet Union, Brunei, the Middle-East…) and producers of industrial inputs for processing countries (Japan, the United Kingdom, the United States…). Other countries are the final exporters of goods intensive in imported inputs (identified when VS is higher than VS1): Mexico, Canada, China, Eastern Europe and South-East Asia.

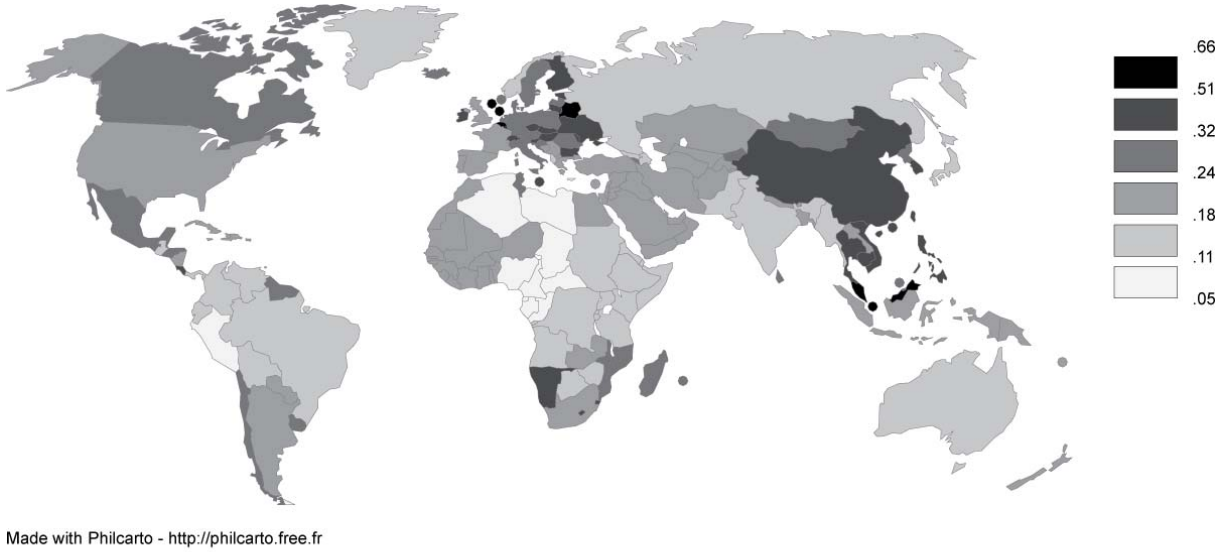
[42] Gehlhar (2006).

Map 2: VS1/VS by country

The geographical repartition of the domestic content of consumed or invested imports (VS1*) is less interesting as our data and method underestimate it. Our method makes it correlated with the square of each country's trade: this explains why VS1* is so important for the United States (8.9%) and for Germany (2.5%), Japan, United Kingdom, France, China … and has a world non-weighted mean of 0.4%.

Map 3, finally, gives the share of vertical trade for each country. This is equal to the ratio between VS+VS1* and the mean of exports and imports. The world mean is 27%.

Map 3: Share of vertical trade in total trade



Keeping this picture in mind is important to the answer of the question "who produces for whom" in the world economy. Standard trade statistics particularly overestimate the dependence of some countries on world trade for their own consumption and the demand of their products: this is the case for small open economies, China, some parts of Eastern Europe[43]…

3.3. Industrial classification

Table 8 (in appendix) gives the share of imported inputs in exports (VS), the share of exports used as inputs for further exports (VS1), and value-added trade per industry. Table 2 gives an extract of these data.As expected, exports of raw materials and semi-finished products are very often used as inputs to further exports: VS1 is higher than 40% for plant fibres, minerals nec and metals. Finished goods are intensive in imported inputs: VS is higher than 30% for petroleum and coal products, electronic equipment, motor vehicles and parts exports. Electronic equipment has both a high VS and a high VS1, suggesting higher vertical specialization.

[43] Because trade balances are not changed in value-added trade compared to standard trade: in absolute terms, differences in imports and exports between standard and value-added trade are exactly the same.

Table 2: Vertical trade per industry (2004)

Sector	Total exports (million $)	Exports as a share of total exports	Import content of exports (VS)	Exports used as inputs for further exports (VS1)	Value-added exports as a share of standard exports	VA exports as a share of total VA exports	VS1* as a share of value-added exports	Exports as a share of VA	VA exports as a share of VA
Agriculture	238,548	2.4%	9%	13%	113%	3.7%	1.2%	19%	21%
Raw materials	688,376	6.9%	6%	16%	98%	9.2%	1.3%	67%	65%
Primary sector	**926,925**	**9.2%**	**7%**	**15%**	**102%**	**12.9%**	**1.3%**	**40%**	**41%**
Farm industries	453,273	4.5%	13%	6%	40%	2.5%	1.1%	40%	16%
Textiles and al.	561,222	5.6%	21%	14%	40%	3.1%	1.7%	108%	44%
Wood and paper	361,023	3.6%	16%	16%	68%	3.4%	2.7%	41%	28%
Chemicals and metals	1,971,153	19.7%	17%	22%	51%	13.8%	3.5%	87%	45%
Metal and transport products	1,314,978	13.1%	19%	12%	42%	7.6%	3.5%	99%	42%
Other manufactures	2,662,092	26.6%	32%	26%	40%	14.7%	2.6%	121%	48%
Utilities	52,656	0.5%	10%	3%	186%	1.3%	3.2%	2%	4%
Secondary sector	**7,390,120**	**73.7%**	**19%**	**17%**	**47%**	**47.4%**	**2.9%**	**67%**	**32%**
Communication and trade	706,686	7.0%	13%	15%	182%	17.5%	2.4%	10%	17%
Business services	726,690	7.2%	7%	15%	167%	16.6%	2.7%	10%	17%
Other services	274,125	2.7%	5%	6%	120%	4.5%	1.5%	3%	3%
Tertiary Sector	**1,707,501**	**17.0%**	**9%**	**14%**	**166%**	**38.6%**	**2.4%**	**7%**	**11%**
Total	10,024,546	100.0%	**16%**	**16%**	73%	100.0%	2.5%	26%	19%

At the industry level, value-added trade cannot be computed as total trade minus vertical trade. In addition to the "usual" vertical trade effect (imports used in exports), value-added trade is reallocated to its initial producer industry. As a result, some sectors have more value-added trade than they have export trade: that means they are mainly traded as inputs in other goods. This is especially strong for the tertiary sector: total value-added exports in business services are 67% higher than standard exports. This is also true for utilities and some agricultural raw materials. Industries with high share of VS or VS1 have a small value-added trade compared to standard trade (metal and transport products and "other manufactures", including electronics). The value-added trade share of the secondary sector (47%) is much smaller than its share in standard trade (74%). On the other hand, the value-added trade share of the primary sector is higher: 13% against 9%. It is only the case for the value-added share of the tertiary sector: 39% against 17%. This is not a surprise and serves to check that our method gives the expected results.

As mentioned earlier, VS1* is underestimated and dominated by the trade of the United States and other large economies. Yet, it is interesting to compare it to value-added trade: VS1* is especially high for chemical and metals, metal and transport products and other manufactures suggesting that

these industries produce goods as inputs for re-imported assembly production in other countries.

Standard trade statistics give a wrong idea of the relative dependence on international demand of different sectors. Secondary exports are equal to 65% of secondary value-added, yet a large part of secondary exports are formed by embedded tertiary or primary value-added. As a result, secondary exports in value-added are equal to only 31% of secondary value-added. *A contrario*, tertiary exports in value-added are equal to 11% of tertiary value-added though tertiary exports are equal to only 7% of tertiary value-added. This must be taken into account to understand who produces for whom in the world economy.

4. What role for vertical trade in regionalisation?

To what extend did the fragmentation of production processes or the development of a final demand contribute to regionalisation? Table 3 shows some basic measures of the openness rate and the degree of regionalisation (measured as the ratio of regional exports on total exports) in the different regions of the world. According to these indicators, the most regionalized continent is Europe (69%). It is also the most open. The least regionalized one is Africa (10%). However, the ratio of regional trade on total trade is very sensitive to the size of the regions, the distance between trading partners and the dimension of the constituent countries, and therefore cannot be easily interpreted as a real measure of the intensity of regionalisation. For example, in America, regional trade would be greater if the US were split into fifty states.[44]

Table 3: The extent of regionalisation and relative size of the regions, 2004[45]

In %	Europe	America	Asia	Africa	ROW	World
Total exports as a share of GDP	35.9	13.4	29.4	37.3	42.0	26.1
Total exports as a share of world exports	43.8	19.2	28.0	2.8	6.2	100.0
Share of regional exports in total exports	69.1	50.6	47.1	9.5	11.3	100.0
Share of regional exports in value-added exports	63.7	44.9	36.5	7.4	8.4	100.0

To go further than these rough measures of regionalization, we need to use a regionalisation indicator that is not affected by the size of different countries. A number of indicators have been

[44] Iapadre (2006).
[45] Europe includes Turkey. ROW includes the former USSR (except the Baltic countries) and West Asia.

suggested to measure the "geographic neutrality" of trade. This paper generalizes to the bilateral case the symmetric trade introversion index used to measure regionalisation by Ledio Iapadre and the Regional Integration Knowledge System of the United Nation University of Bruges.[46] We call the resulting index the "Trade Intensity Bilateral Index" between region i and region j. $TIBI_{ij}$ ranges between -1 and 1. -1 means that region i does not export at all to region j. 1 means that regions i exports only to region j. 0 means that exports from region i to region j respect geographical neutrality. $TIBI_{ii}$ is equal to the STJ_i which measures the amount of regionalization for region i. Its exact construction in explained in appendix.

Table 4 shows TIBI between continents when measured in standard trade. The trade of all continents is regionalized. European trade is the most regionalized. At the other end of the scale, trade between Europe on the one hand and Asia and the America in the other hand is particularly small. Asia and America trade more with each other than they do with Europe.

Table 4: Trade Intensity Bilateral Index of standard exports, 2004[47]

	To Europe	To America	To Asia	To Africa	To ROW
From Europe	0.74	-0.54	-0.65	0.04	0.07
From America	-0.52	0.66	-0.15	-0.20	-0.21
From Asia	-0.60	0.03	0.66	-0.16	-0.13
From Africa	0.03	-0.05	-0.15	0.63	-0.18
From ROW	-0.25	-0.28	0.31	0.13	0.45

Table 5 gives the same information for value-added trade.

Table 5: Trade Intensity Bilateral Index of value-added exports, 2004

	To Europe	To America	To Asia	To Africa	To ROW
From Europe	0.63	-0.45	-0.53	0.03	0.07
From America	-0.41	0.50	-0.04	-0.14	-0.13
From Asia	-0.48	0.13	0.49	-0.12	-0.07
From Africa	0.01	-0.03	-0.09	0.49	-0.17
From ROW	-0.21	-0.19	0.32	0.11	0.25

Table 6 is the difference between Table 4 and Table 5. A negative (positive) difference means that the share of value-added bilateral exports in this region's total value-added exports is smaller (resp. larger) than the share of standard bilateral exports in this region's total standard exports. A negative (positive) difference in Table 6 implies that this particular trade flow is particularly intensive

[46] They name this index STJ. See Iapadre (2006) , p. 71 and http://www.cris.unu.edu/riks.
[47] The definition of each continent is dependent on the available data (see subsequent tables). Trade inside GTAP regions is not taken into account.

(non-intensive) in vertical trade. This can come from difference in VS (re-exported imports), VS1 (exports used as inputs for further re-exports) or VS1* (exports used as inputs for further re-exports in the original production country).

Table 6: Difference between the TIBI of value-added exports and the TIBI of standard exports, 2004

	To Europe	To America	To Asia	To Africa	To ROW
From Europe	-0.11	0.09	0.12	-0.01	0.00
From America	0.11	-0.16	0.11	0.06	0.08
From Asia	0.12	0.10	-0.17	0.04	0.06
From Africa	-0.02	0.02	0.06	-0.14	0.01
From ROW	0.04	0.09	0.01	-0.02	-0.20

Table 6 shows a general reversion to the mean, with the interesting exception of Asian exports to America. When trade intensity is positive in standard trade, it is reduced in value-added trade. When trade intensity is negative in standard trade, it is increased in value-added trade. World value-added trade is more geographic neutral. This is expected, as vertical trade is more sensitive to trade barriers.

Table 6 shows a negative difference for all intra-regional trade and a positive difference for nearly all extra-regional trade (except between Europe and Africa). That confirms that a relatively large share of regional trade is actually trade in inputs between countries involved in different stages of the production process for final consumption elsewhere. Considering past studies on the nature of Asian regionalisation, one would expect Asian regional value-added trade intensity to be much smaller than Asian regional standard trade intensity.[48] This is indeed the case, but not much more so than in America or Africa. The real outlier seems to be Europe: the slicing of the supply chain is less advanced there.

Past studies on Asian exports have also shown that America is an important final market for Asian goods: one would also expect that Asian value-added exports to America are relatively more important than Asia standard exports to America. Both of these are confirmed by Table 6, to the extent than exports from Asia to America are a striking exception to the general reversion to the mean between Table 5 and Table 6. They are even less geographic neutral in value-added trade than in

[48] Athukorala and Yamashita (2006).

standard trade, suggesting a strong dependence of Asian on American consumption. What is more original to this research is that Asia does not seem very exceptional in these regard, as the TIBI index is increased by a similar amount for all the trade between the Triad. The only intercontinental trade that is less intensive in value-added than in standard measures is between Europe and Africa.

Dividing the world into four *a priori* regions is a bit blunt. Table 9, Table 10, Table 11 give the same information for a finer regional classification. This allows a clearer view on which regions are integrated. E.g. African regionalisation excludes North Africa, which is more integrated with the Eurozone. The highest case of geographic non-neutrality is for trade between the USA and its NAFTA partners, but it is less striking in value-added trade than in standard trade. Austral Africa and South America are the next most introverted regions. The regions for which standard trade gives the most distorted answer to the question "who produces for whom" (measured as the mean of the absolute changes in TIBI between value-added trade and standard trade) are Sub-Saharan Africa excluding Austral Africa; Asia excluding China and Australasia; Eastern Europe; and Canada and Mexico.

Conclusion

This paper contributes to the debate concerning globalization, vertical trade and regionalization. Since the end of the 1980s, globalization is tied to the development of new international production processes based on a new international division of labour. In this context, it appears more and more difficult to understand the international division of labour with standard trade statistics. If one wants to understand the international production process enough to be able to answer the question "who produces what and for whom?", one must reallocate the value-added contained in trade in final goods to each country participating to its production. We do this using the GTAP database for 1997, 2001 and 2004.

The most obvious way to improve the results of this paper would be to improve the data it uses. The quality of the GTAP database is certainly difficult to improve upon. However, we have made a simplifying assumption that might have important consequences. We have assumed that, inside each sector, all production had the same imported content and the same pattern of use. As it is obvious in the case of multi-national firms affiliates, inside sectors, some firms are more intensive in imported

inputs and export more than other. Taking this into account would increase our estimate of vertical trade and hence decrease our estimate of value-added trade. By making its assumptions, this paper has under-estimated the effect of the international fragmentation of production on the patterns of the international division of labour.

Still, our results are worth commenting. For the first time, we study the effect of vertical trade on trade patterns for a database covering the entire world and the whole range of industries. Our results are compatible with past results by Yi and his co-authors. We go further, computing the share of imported inputs in exports (VS), the share of export used as inputs to further exports (VS1), the domestic content of imports (VS1*) and value-added trade for 113 countries or groups of countries and 55 sectors. The estimations have shortcoming. Yet, they have important consequences for the answer to the question "who produces for whom in the world economy". Services are much more dependent on external demand that the standard trade statistics suggest. Standard trade statistics give a wrong idea of the relative dependence on international demand of different sectors. Despite the fact that industrial exports are equal to 67% of industrial value-added, a large part of these exports embed tertiary or primary productions. As a result, only 32% of the world industrial value-added is actually consumed by foreign consumers. A contrario, 11% of the world service value-added is consumed by foreign consumers compared to service exports equal to only 7% of value-added. Looking at value-added trade decreases the amount of regionalization of world trade. For example, this paper confirms that Asia relies more heavily on extra-regional final markets than standard trade statistics suggest. This is also the case for America and Africa. European regionalization, though the highest among the four continents, is the less dependent on vertical specialization trade.

Appendix

Constructing the Trade Intensity Bilateral Index (TIBI)

Let us start with the index developed by the CEPII based on research on the structure of world trade in the 1960s and the 1970s: relative bilateral intensity of exports.[49] Its logic is similar to

[49] See Deutsch and Savage (1960), Drysdale and Garnaut (1982), Freudenberg, Gaulier, and Ûnal-Kensenci

Balassa's index of comparative advantages.[50] It is equal to:

$$\text{Relative Export Intensity}_{ij}\ (REI_{ij}) = (X_{ij}/\ X_{i.})/\ (X_{.j}/X) \quad (6)$$

Where X_{ij} are the exports from region i to region j, X are total world exports, $X_{i.}$ are total exports from region i and $X_{.j}$ are total exports to region j. REI_{ij} is the ratio between the share of exports to region j in the total exports of region i ($X_{ij}/\ X_{i.} = S_{ij}$) and the share of exports to region j in total world exports ($X_{.j}/X=W_j$). All REI_{ij} would be equal to one if all exports respected geographical neutrality, i.e. if exports from region i to region j were simply a function of the value of exports from region i and the value of exports to region j and no other factors (distance, currency union, free trade areas, common languages, colonial ties) played any role in determining bilateral world trade.[51]

Iapadre has shown that this kind of index has three problems: range variability, range asymmetry and dynamic ambiguity. We follow his solutions to solve them.

Range variability means that the maximum value of the index depends on the size of the regions under study. To solve that issue, we replace the denominator by the share of exports to region j in total exports from all non-i regions (the "rest of the world") rather than in total world exports.

$$I^1_{ij} = (X_{ij}/\ X_{i.})/\ (X_{rj}/X_{r.}) \quad (7)$$

Where X_{rj} is the amount of exports to region j in exports from the rest of the world excluding region i and $X_{r.}$ is the total exports of the rest of the world excluding region i. $X_{rj}/X_{r.}$ is the share of exports to region j in exports from the rest of the world excluding region i. Now the index can take any value from 0 to infinity.

Range asymmetry means that range is not symmetric around neutrality. I^1 ranges from 0 to 1 if trade is less important than expected and from 1 to infinity if trade is more important than expected. To solve that issue, we use the following index, which varies between -1 and 1 and has neutrality at 0 rather than 1.

$$I^2_{ij} = (I^1_{ij}-1)/(I^1_{ij}+1) \quad (8)$$

(1998), p. 66-68, Gaulier, Jean, and Ünal-Kesenci (2004)

[50] Balassa (1965).

[51] This is similar to the definition offered by Frankel in Frankel (1998). Yet, this measure does not correct for distance to measure regionalization. Looking at REI is similar to bilateral residual in a "gravity" equation using only exporter and importer dummies as explanatory variables to trade.

Dynamic ambiguity means that a change in the index might be in the same direction as the change in the complementary index measuring the intensity of trade between the region i and all non-j regions. To solve that issue, we first define this complementary index.

$$I^3_{ij} = (1-(X_{ij}/ X_{i.}))/(1-(X_{rj}/X_{r.})) \quad (10)$$

And we study as the "basic" index the ratio between I^1 and I^3, which we transform to correct for range asymmetry. Our final index, the "Trade Intensity Bilateral Index" is equal to:

$$TIBI_{ij} = (I^1_{ij}/ I^3_{ij}-1)/ (I^1_{ij}/ I^3_{ij}+1) \quad (11)$$

$TIBI_{ij}$ ranges between -1 and 1. -1 means that region i does not export at all to region j. 1 means that regions i exports only to region j. 0 means that exports from region i to region j respect geographical neutrality. $TIBI_{ii}$ is equal to the symmetric trade introversion index which measures the amount of regionalization for region i.[52]

Table 7: Vertical trade per country

Country	Import content of exports (VS)	Exports used as inputs for further exports (VS1)	VS1/VS	Exports consumed or invested domestically (VS1*)	Share of vertical trade in total trade	Ratio of standard exports to GDP	Ratio of standard imports to GDP	Ratio of value-added exports to GDP	Ratio of value-added imports to GDP
Australia	13%	28%	2.13	0.6%	13%	18%	19%	15%	17%
New Zealand	18%	16%	0.90	0.2%	19%	30%	29%	25%	23%
Rest of Oceania	27%	25%	0.92	0.1%	23%	42%	58%	31%	46%
China	30%	22%	0.73	1.4%	33%	40%	34%	28%	22%
Hong Kong	30%	22%	0.74	0.3%	32%	79%	68%	55%	44%
Japan	13%	29%	2.29	2.6%	16%	14%	11%	12%	9%
Korea	37%	29%	0.77	0.5%	40%	44%	38%	27%	21%
Taiwan	43%	31%	0.73	0.3%	48%	73%	56%	41%	25%
Rest of East Asia	21%	17%	0.83	0.0%	25%	53%	34%	42%	23%
Cambodia	39%	10%	0.25	0.0%	45%	87%	61%	53%	28%
Indonesia	21%	29%	1.38	0.5%	24%	35%	30%	27%	22%
Lao People's Democratic Republic	27%	23%	0.87	0.0%	23%	27%	36%	20%	29%
Myanmar	18%	27%	1.55	0.1%	17%	40%	41%	33%	34%
Malaysia	42%	32%	0.77	0.4%	51%	133%	89%	77%	33%
Philippines	43%	34%	0.80	0.1%	44%	61%	57%	35%	31%
Singapore	67%	32%	0.48	0.1%	66%	173%	179%	56%	62%
Thailand	40%	27%	0.67	0.2%	44%	75%	61%	45%	31%
Vietnam	38%	20%	0.53	0.2%	37%	74%	80%	46%	51%
Rest of Southeast Asia	18%	26%	1.48	0.0%	26%	88%	32%	72%	16%
Bangladesh	25%	12%	0.47	0.0%	24%	19%	22%	15%	17%
India	19%	22%	1.16	0.3%	17%	16%	20%	13%	16%
Pakistan	18%	19%	1.02	0.0%	14%	18%	28%	15%	25%
Sri Lanka	35%	14%	0.41	0.0%	31%	37%	46%	24%	33%
Rest of South Asia	21%	18%	0.90	0.0%	14%	21%	38%	16%	34%
Asia	**30%**	**27%**	**0.90**	**0.9%**	**33%**	**29%**	**26%**	**20%**	**17%**

[52] Iapadre (2006), p. 71, http://www.cris.unu.edu/riks.

Country	Import content of exports (VS)	Exports used as inputs for further exports (VS1)	VS1/VS	Exports consumed or invested domestically (VS1*)	Share of vertical trade in total trade	Ratio of standard exports to GDP	Ratio of standard imports to GDP	Ratio of value-added exports to GDP	Ratio of value-added imports to GDP
Canada	29%	14%	0.47	0.9%	31%	35%	33%	25%	23%
United States of America	14%	28%	1.93	5.9%	19%	9%	14%	7%	12%
Mexico	27%	13%	0.48	0.6%	28%	31%	30%	23%	21%
Rest of North America	38%	20%	0.52	0.0%	14%	19%	85%	12%	77%
Argentina	16%	21%	1.31	0.3%	19%	28%	18%	24%	14%
Bolivia	14%	25%	1.76	0.1%	15%	29%	27%	25%	23%
Brazil	13%	22%	1.67	0.6%	16%	20%	14%	17%	11%
Chile	22%	30%	1.37	0.1%	25%	43%	33%	34%	24%
Colombia	14%	19%	1.39	0.1%	14%	21%	19%	18%	17%
Ecuador	11%	16%	1.55	0.1%	11%	34%	30%	31%	26%
Paraguay	16%	29%	1.76	0.1%	18%	52%	41%	44%	32%
Peru	7%	28%	3.93	0.1%	8%	20%	16%	18%	15%
Uruguay	31%	18%	0.56	0.0%	30%	34%	37%	23%	26%
Venezuela	11%	21%	1.98	0.2%	14%	33%	17%	30%	14%
Rest of South America	24%	35%	1.42	0.0%	26%	70%	63%	53%	46%
Costa Rica	32%	20%	0.64	0.0%	37%	62%	44%	42%	25%
Guatemala	20%	13%	0.65	0.1%	16%	20%	32%	16%	27%
Nicaragua	26%	10%	0.40	0.0%	21%	43%	61%	32%	50%
Panama	16%	19%	1.20	0.0%	16%	30%	31%	25%	26%
Rest of Central America	27%	11%	0.41	0.1%	24%	40%	51%	29%	40%
Caribbean	22%	21%	0.91	0.1%	20%	26%	33%	20%	27%
America	18%	23%	1.24	5.1%	21%	13%	17%	10%	13%

Country	Import content of exports (VS)	Exports used as inputs for further exports (VS1)	VS1/VS	Exports consumed or invested domestically (VS1*)	Share of vertical trade in total trade	Ratio of standard exports to GDP	Ratio of standard imports to GDP	Ratio of value-added exports to GDP	Ratio of value-added imports to GDP
Austria	30%	26%	0.87	0.5%	29%	56%	59%	39%	42%
Belgium	56%	24%	0.43	0.3%	53%	78%	87%	34%	43%
Cyprus	23%	20%	0.84	0.0%	22%	46%	49%	35%	39%
Czech Republic	39%	27%	0.71	0.3%	38%	71%	72%	43%	45%
Denmark	24%	23%	0.94	0.4%	25%	48%	44%	37%	33%
Estonia	45%	26%	0.58	0.1%	42%	99%	115%	54%	70%
Finland	33%	26%	0.77	0.3%	36%	44%	38%	29%	23%
France	21%	24%	1.15	1.8%	23%	27%	28%	21%	22%
Germany	23%	25%	1.07	2.9%	28%	39%	34%	29%	24%
Greece	21%	23%	1.09	0.2%	18%	26%	37%	21%	31%
Hungary	48%	25%	0.51	0.1%	48%	65%	68%	34%	36%
Ireland	34%	27%	0.78	0.2%	41%	102%	70%	67%	35%
Italy	27%	22%	0.82	0.9%	27%	25%	26%	18%	19%
Latvia	36%	25%	0.71	0.1%	27%	38%	62%	24%	48%
Lithuania	38%	24%	0.63	0.1%	34%	47%	60%	29%	42%
Luxembourg	67%	27%	0.41	0.0%	64%	129%	143%	42%	56%
Malta	36%	28%	0.79	0.0%	38%	102%	92%	65%	55%
Netherlands	27%	25%	0.94	0.6%	28%	47%	46%	34%	33%
Poland	26%	25%	0.96	0.3%	24%	37%	44%	27%	34%
Portugal	26%	21%	0.82	0.2%	23%	32%	41%	23%	32%
Slovakia	42%	28%	0.67	0.2%	43%	69%	66%	40%	36%
Slovenia	37%	25%	0.66	0.1%	37%	55%	56%	35%	35%
Spain	22%	21%	0.96	0.8%	21%	27%	32%	21%	26%
Sweden	23%	25%	1.08	0.6%	26%	43%	36%	33%	26%
United Kingdom	18%	26%	1.43	1.5%	18%	25%	31%	20%	26%
Switzerland	34%	25%	0.75	0.3%	38%	48%	40%	31%	23%
Norway	14%	33%	2.30	0.5%	17%	39%	28%	33%	23%
Rest of EFTA	29%	23%	0.79	0.0%	28%	44%	49%	31%	36%
Albania	22%	22%	1.01	0.0%	14%	19%	41%	15%	36%
Bulgaria	39%	23%	0.59	0.0%	36%	53%	62%	32%	42%
Belarus	58%	21%	0.36	0.1%	54%	56%	65%	23%	33%
Croatia	28%	21%	0.74	0.1%	26%	47%	56%	34%	43%
Romania	30%	23%	0.78	0.1%	27%	37%	46%	26%	35%
Russian Federation	11%	38%	3.43	2.1%	14%	32%	25%	28%	20%
Ukraine	36%	27%	0.77	0.2%	35%	60%	61%	38%	39%
Rest of Eastern Europe	46%	17%	0.36	0.0%	33%	60%	108%	32%	81%
Rest of Europe	30%	25%	0.84	0.1%	20%	26%	53%	18%	45%
Kazakhstan	18%	36%	1.98	0.2%	20%	49%	41%	40%	32%
Kyrgyzstan	30%	31%	1.05	0.0%	25%	52%	72%	37%	57%
Rest of Former Soviet Union	16%	38%	2.32	0.3%	20%	57%	38%	47%	29%
Armenia	34%	25%	0.75	0.0%	25%	29%	48%	19%	39%
Azerbaijan	16%	31%	1.91	0.0%	11%	45%	86%	38%	79%
Georgia	24%	24%	1.01	0.0%	17%	33%	60%	25%	53%
Iran, Islamic Republic of	5%	34%	7.28	0.3%	5%	29%	25%	28%	23%
Turkey	23%	20%	0.88	0.2%	22%	28%	33%	22%	26%
Rest of Western Asia	16%	28%	1.79	0.9%	19%	49%	38%	41%	30%
Europe and misc.	26%	25%	0.98	1.2%	27%	37%	36%	27%	26%

Country	Import content of exports (VS)	Exports used as inputs for further exports (VS1)	VS1/VS	Exports consumed or invested domestically (VS1*)	Share of vertical trade in total trade	Ratio of standard exports to GDP	Ratio of standard imports to GDP	Ratio of value-added exports to GDP	Ratio of value-added imports to GDP
Egypt	21%	20%	0.96	0.0%	21%	29%	29%	23%	23%
Morocco	23%	17%	0.75	0.0%	22%	36%	39%	27%	31%
Tunisia	31%	18%	0.59	0.1%	30%	48%	50%	33%	36%
Rest of North Africa	8%	31%	3.78	0.3%	10%	42%	29%	38%	26%
Nigeria	6%	24%	3.71	0.4%	9%	57%	31%	53%	27%
Senegal	27%	19%	0.68	0.0%	19%	27%	52%	20%	45%
Rest of Western Africa	24%	25%	1.05	0.1%	20%	37%	54%	28%	45%
Rest of Central Africa	8%	31%	3.82	0.1%	10%	36%	23%	33%	20%
Rest of South Central Africa	15%	29%	1.95	0.1%	16%	57%	54%	49%	45%
Ethiopia	24%	18%	0.78	0.0%	15%	25%	54%	19%	48%
Madagascar	25%	18%	0.69	0.0%	28%	47%	38%	35%	26%
Malawi	29%	19%	0.65	0.0%	24%	44%	61%	31%	48%
Mauritius	30%	19%	0.65	0.0%	31%	73%	67%	51%	45%
Mozambique	24%	40%	1.66	0.0%	24%	36%	37%	27%	28%
Tanzania	20%	23%	1.15	0.0%	16%	21%	33%	16%	29%
Uganda	19%	27%	1.44	0.0%	18%	25%	27%	21%	22%
Zambia	22%	48%	2.18	0.1%	23%	39%	36%	30%	28%
Zimbabwe	30%	29%	0.95	0.1%	32%	57%	53%	39%	35%
Rest of Eastern Africa	15%	20%	1.38	0.1%	12%	22%	31%	19%	28%
Botswana	12%	26%	2.17	0.1%	13%	48%	39%	42%	33%
South Africa	19%	28%	1.48	0.9%	21%	30%	27%	24%	21%
Rest of South African Customs Union	31%	20%	0.65	0.2%	35%	76%	62%	52%	39%
Africa	17%	26%	1.54	0.3%	18%	37%	34%	31%	27%
World	25%	25%	1.00	1.8%	27%	26%	26%	19%	19%

Sources: GTAP 7. Authors' computations

Table 8: Vertical trade per industry

Sector	Total exports (million $)	Exports as a share of total exports	Import content of exports (VS)	Exports used as inputs for further exports (VS1)	Value-added exports as a share of standard exports	VA exports as a share of total VA exports	VS1* as a share of value-added exports	Exports as a share of VA	VA exports as a share of VA
Paddy rice	1,455	0.0%	10%	33%	507%	0.1%	0.7%	2%	11%
Wheat	20,845	0.2%	10%	14%	65%	0.2%	1.5%	46%	30%
Cereal grains nec	18,138	0.2%	9%	11%	74%	0.2%	1.5%	27%	20%
Vegetables, fruit, nuts	68,098	0.7%	7%	5%	91%	0.8%	0.6%	19%	17%
Oil seeds	23,290	0.2%	7%	15%	100%	0.3%	1.4%	38%	38%
Sugar cane, sugar beet	78	0.0%	7%	16%	4730%	0.1%	0.6%	0%	15%
Plant-based fibers	11,296	0.1%	10%	29%	111%	0.2%	2.7%	36%	41%
Crops nec	40,482	0.4%	11%	18%	100%	0.6%	0.9%	27%	27%
Bovine cattle, sheep and goats, horses	6,855	0.1%	12%	10%	189%	0.2%	1.0%	11%	20%
Animal products nec	18,393	0.2%	14%	19%	110%	0.3%	1.2%	14%	15%
Raw milk	290	0.0%	8%	9%	2931%	0.1%	0.7%	0%	12%
Wool, silk-worm cocoons	2,210	0.0%	15%	51%	121%	0.0%	1.0%	33%	40%
Forestry	12,998	0.1%	7%	21%	263%	0.5%	1.6%	13%	33%
Fishing	14,119	0.1%	7%	8%	105%	0.2%	1.1%	17%	17%
Agriculture	238,548	2.4%	9%	13%	113%	3.7%	1.2%	19%	21%
Coal	31,573	0.3%	7%	20%	114%	0.5%	2.4%	35%	40%
Oil	484,089	4.8%	6%	15%	98%	6.5%	1.0%	74%	72%
Gas	71,871	0.7%	7%	19%	108%	1.1%	1.7%	58%	62%
Minerals nec	100,844	1.0%	5%	16%	86%	1.2%	2.0%	64%	55%
Raw materials	688,376	6.9%	6%	16%	98%	9.2%	1.3%	67%	65%
Primary sector	926,925	9.2%	7%	15%	102%	12.9%	1.3%	40%	41%
Bovine meat products	27,371	0.3%	13%	7%	34%	0.1%	1.3%	45%	15%
Meat products nec	40,855	0.4%	16%	7%	30%	0.2%	1.2%	67%	20%
Vegetable oils and fats	44,009	0.4%	8%	5%	32%	0.2%	0.8%	131%	42%
Dairy products	43,036	0.4%	14%	6%	37%	0.2%	1.2%	36%	13%
Processed rice	8,083	0.1%	9%	4%	33%	0.0%	0.6%	27%	9%
Sugar	12,784	0.1%	10%	9%	43%	0.1%	0.8%	44%	19%
Food products nec	202,230	2.0%	15%	7%	42%	1.2%	1.3%	38%	16%
Beverages and tobacco products	74,905	0.7%	11%	4%	50%	0.5%	0.7%	28%	14%
Farm industries	453,273	4.5%	13%	6%	40%	2.5%	1.1%	40%	16%
Textiles	263,857	2.6%	20%	22%	48%	1.7%	2.5%	98%	47%
Wearing apparel	194,963	1.9%	21%	5%	33%	0.9%	0.6%	108%	36%
Leather products	102,403	1.0%	22%	11%	34%	0.5%	1.2%	150%	50%
Textiles and al.	561,222	5.6%	21%	14%	40%	3.1%	1.7%	108%	44%
Wood products	168,103	1.7%	16%	13%	51%	1.2%	2.2%	63%	32%
Paper products, publishing	192,921	1.9%	16%	20%	83%	2.2%	3.0%	31%	26%
Wood and paper	361,023	3.6%	16%	16%	68%	3.4%	2.7%	41%	28%
Petroleum, coal products	198,883	2.0%	22%	14%	33%	0.9%	1.7%	114%	38%
Chemical, rubber, plastic products	1,172,718	11.7%	16%	21%	50%	8.0%	3.9%	93%	47%
Mineral products nec	105,226	1.0%	18%	23%	72%	1.0%	2.6%	34%	24%
Ferrous metals	247,962	2.5%	14%	24%	65%	2.2%	3.4%	76%	50%
Metals nec	246,364	2.5%	17%	31%	47%	1.6%	3.3%	131%	62%
Chemicals and metals	1,971,153	19.7%	17%	22%	51%	13.8%	3.5%	87%	45%
Metal products	192,339	1.9%	15%	19%	81%	2.1%	4.3%	40%	33%
Motor vehicles and parts	865,977	8.6%	19%	10%	34%	4.0%	3.4%	139%	47%
Transport equipment nec	256,662	2.6%	20%	13%	42%	1.5%	2.5%	111%	47%
Metal and transport products	1,314,978	13.1%	19%	12%	42%	7.6%	3.5%	99%	42%
Electronic equipment	1,104,466	11.0%	28%	24%	34%	5.1%	2.4%	173%	59%
Machinery and equipment nec	1,376,467	13.7%	19%	16%	44%	8.3%	2.9%	107%	47%
Manufactures nec	181,159	1.8%	25%	14%	48%	1.2%	1.2%	66%	32%
Other manufactures	2,662,092	26.6%	23%	19%	40%	14.6%	2.6%	121%	48%
Electricity	27,445	0.3%	12%	20%	591%	2.2%	2.4%	4%	23%
Gas manufacture, distribution	5,658	0.1%	3%	9%	301%	0.2%	3.7%	6%	18%
Water	1,999	0.0%	7%	11%	750%	0.2%	3.3%	1%	11%
Construction	44,998	0.4%	11%	2%	146%	0.9%	3.0%	2%	3%
Utilities	52,656	0.5%	10%	3%	186%	1.3%	3.2%	2%	4%
Secondary sector	7,390,120	73.7%	19%	17%	47%	47.4%	2.9%	67%	32%

Sector	Total exports (million $)	Exports as a share of total exports	Import content of exports (VS)	Exports used as inputs for further exports (VS1)	Value-added exports as a share of standard exports	VA exports as a share of total VA exports	VS1* as a share of value-added exports	Exports as a share of VA	VA exports as a share of VA
Trade	210,328	2.1%	11%	16%	368%	10.6%	2.7%	4%	15%
Transports	435,559	4.3%	15%	15%	88%	5.2%	2.2%	30%	26%
Communication	60,798	0.6%	7%	12%	211%	1.7%	1.9%	7%	15%
Communication and trade	*706,686*	7.0%	*13%*	*15%*	182%	17.5%	2.4%	10%	17%
Financial services nec	109,050	1.1%	6%	13%	215%	3.2%	3.2%	6%	14%
Insurance	85,016	0.8%	6%	10%	81%	0.9%	2.0%	16%	13%
Business services nec	532,625	5.3%	7%	17%	171%	12.4%	2.6%	11%	19%
Business services	*726,690*	7.2%	*7%*	*15%*	167%	16.6%	2.7%	10%	17%
Recreational and other services	111,833	1.1%	7%	12%	105%	1.6%	1.5%	10%	10%
Public Administration, Defense, Education, Health	162,292	1.6%	5%	2%	126%	2.8%	1.5%	2%	3%
Dwellings	0	0.0%				0.1%	0.9%	0%	0%
Other services	*274,125*	2.7%	*5%*	*6%*	120%	4.5%	1.5%	3%	3%
Tertiary Sector	**1,707,501**	**17.0%**	**9%**	**14%**	**166%**	**38.6%**	**2.4%**	**7%**	**11%**
Total	10,024,546	100.0%	**16%**	**16%**	73%	100.0%	2.5%	26%	19%

Sources: GTAP 7. Authors' computations

Table 9: Standard TIBI

	Europe			America			Asia				Africa			ROW
Exports From \ To	**Euro Zone**	**Eastern Europe**	**North**	**United States**	**Other NAFTA**	**Rest of America**	**Japan**	**China and HK**	**Rest of East Asia**	**Rest of Asia**	**North**	**Austral**	**Sub-Saharan**	
Euro Zone[53]	0.50	0.41	0.42	-0.44	-0.66	-0.29	-0.57	-0.52	-0.57	-0.37	0.33	-0.11	0.02	0.00
Eastern Europe[54]	0.42	0.60	0.06	-0.52	-0.69	-0.49	-0.65	-0.70	-0.67	-0.55	0.08	-0.38	-0.27	0.31
Northern Europe[55]	0.34	-0.02	0.18	-0.13	-0.41	-0.23	-0.27	-0.44	-0.41	-0.02	-0.16	-0.05	-0.05	0.00
United States	-0.31	-0.47	-0.09	NA	0.91	0.43	0.27	-0.11	0.12	0.01	-0.09	-0.21	-0.06	-0.04
Rest of NAFTA[56]	-0.78	-0.80	-0.54	0.92	-0.49	0.01	-0.47	-0.57	-0.67	-0.55	-0.59	-0.67	-0.58	-0.67
Rest of America[57]	-0.28	-0.43	-0.28	0.37	0.05	0.78	-0.17	-0.15	-0.31	-0.36	0.11	-0.01	-0.02	-0.14
Japan	-0.47	-0.52	-0.41	0.23	-0.32	-0.21	NA	0.54	0.60	0.07	-0.35	-0.12	-0.21	-0.13
China and Hong-Kong	-0.34	-0.47	-0.27	0.30	-0.21	-0.14	0.52	0.01	0.25	0.10	-0.27	-0.17	-0.01	-0.12
Rest of East Asia[58]	-0.52	-0.47	-0.40	0.03	-0.44	-0.29	0.38	0.67	0.46	0.21	-0.38	-0.25	-0.01	-0.21
Rest of Asia[59]	-0.38	-0.50	-0.10	-0.01	-0.40	-0.25	0.37	0.12	0.22	0.59	-0.05	0.18	0.29	0.24
Northern Africa[60]	0.46	0.11	-0.28	-0.05	-0.42	-0.05	-0.45	-0.56	-0.58	-0.30	0.48	-0.57	0.08	-0.12
Austral Africa[61]	-0.18	-0.37	0.24	-0.28	-0.56	-0.36	0.07	-0.29	-0.16	0.23	-0.32	0.94	0.72	-0.09
Sub-Saharan Africa[62]	-0.11	-0.56	-0.33	0.32	-0.71	0.20	-0.13	0.15	-0.23	0.48	-0.15	0.49	0.55	-0.30
ROW[63]	-0.23	0.22	-0.39	-0.14	-0.72	-0.29	0.41	-0.10	0.25	0.38	0.13	0.21	0.05	0.45

*Intra-continental trade is coloured.

Source: GTAP 7. authors' calculations.

[53] Austria, Belgium, Finland, France, Ireland, Italy, Germany, Greece, Luxembourg, Netherlands, Portugal, Spain.
[54] Albania, Bosnia, Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia, Rumania, Turkey, Rest of Eastern Europe, Rest of Europe.
[55] Denmark, Norway, Sweden, Switzerland, United Kingdom, Rest of EFTA
[56] Canada and Mexico
[57] Argentine, Bolivia, Brazil, Chile, Columbia, Costa-Rica, Ecuador, Guatemala, Nicaragua, Panama, Paraguay, Peru, Uruguay, Rest of North America, Rest of South America, Caribbean.
[58] Cambodia, Indonesia, Korea, Laos, Malaysia, Philippines, Singapore, Thailand, Taiwan, Vietnam, Other East Asia.
[59] Australia, Bangladesh, India, Myanmar, New Zealand, Pakistan, Sri Lanka, Rest of South Asia, Rest of Oceania, Rest of South Asia.
[60] Egypt, Morocco, Tunisia, Rest of North Africa
[61] Botswana, Malawi, Mozambique, South Africa, Zambia, Zimbabwe, Rest of South African Customs Union.
[62] Ethiopia, Madagascar, Mauritius, Malawi, Nigeria, Senegal, Tanzania, Uganda, Rest of West Africa, Rest of Central Africa, Rest of East Africa, Rest of South-Central Africa.
[63] Armenia, Azerbaijan, Belorussia, Georgia, Iran, Kazakhstan, Kyrgyzstan, Russia, Ukraine, Rest of former Soviet Union, Rest of West Asia

Table 10: Value-added TIBI

Exports To / From	Europe			America			Asia				Africa			ROW
	Euro Zone	East	North	United States	Other NAFTA	Rest of America	Japan	China+ HK	Rest of East Asia	Rest of Asia	North	Austral	Sub-Saharan	
Euro Zone	0.41	0.36	0.36	-0.36	-0.58	-0.25	-0.48	-0.41	-0.46	-0.31	0.26	-0.08	-0.01	0.02
Eastern Europe	0.37	0.50	0.08	-0.42	-0.60	-0.40	-0.51	-0.55	-0.52	-0.43	0.08	-0.29	-0.21	0.28
Northern Europe	0.28	0.01	0.09	-0.08	-0.35	-0.20	-0.24	-0.34	-0.31	-0.05	-0.12	-0.04	-0.02	-0.01
United States	-0.22	-0.31	-0.02	NA	0.86	0.39	0.29	0.01	0.17	0.06	-0.04	-0.11	0.00	0.04
Other NAFTA	-0.69	-0.69	-0.50	0.86	-0.35	0.03	-0.37	-0.47	-0.51	-0.47	-0.50	-0.57	-0.49	-0.58
Rest of America	-0.23	-0.34	-0.25	0.32	0.02	0.69	-0.16	-0.09	-0.24	-0.28	0.11	-0.02	-0.04	-0.11
Japan	-0.36	-0.40	-0.30	0.29	-0.22	-0.15	NA	0.51	0.52	0.12	-0.29	-0.05	-0.16	-0.07
China+HK	-0.29	-0.39	-0.21	0.28	-0.17	-0.13	0.46	-0.06	0.21	0.06	-0.24	-0.12	-0.02	-0.09
Rest of East Asia	-0.38	-0.37	-0.28	0.13	-0.31	-0.19	0.38	0.54	0.28	0.19	-0.27	-0.14	0.04	-0.12
Rest of Asia	-0.33	-0.41	-0.08	0.02	-0.34	-0.24	0.33	0.14	0.23	0.48	-0.07	0.07	0.20	0.17
Northern Africa	0.37	0.15	-0.18	-0.04	-0.35	-0.08	-0.37	-0.47	-0.45	-0.28	0.35	-0.43	0.06	-0.12
Austral Africa	-0.14	-0.25	0.22	-0.19	-0.42	-0.30	0.01	-0.11	-0.17	0.18	-0.21	0.90	0.64	-0.12
Sub-Saharan Africa	-0.13	-0.42	-0.27	0.26	-0.42	0.15	-0.08	0.13	-0.13	0.41	-0.08	0.31	0.43	-0.27
ROW	-0.19	0.18	-0.28	-0.08	-0.52	-0.23	0.37	0.06	0.23	0.32	0.10	0.15	0.08	0.25

Intra continental trade is coloured.

Source: GTAP 7. authors' calculations.

Table 11: Value-added TIBI compared to standard TIBI

Exports To / From	Europe			America			Asia				Africa			ROW
	Euro Zone	East	North	United States	North less US	South	Japan	China+ HK	Rest of East Asia	Rest of Asia	North	Austral	Sub-Saharan	
Euro Zone	-0.09	-0.05	-0.06	0.07	0.08	0.04	0.10	0.11	0.12	0.06	-0.07	0.04	-0.03	0.02
Eastern Europe	-0.05	-0.09	0.02	0.10	0.10	0.09	0.14	0.15	0.15	0.11	0.00	0.09	0.06	-0.03
Northern Europe	-0.06	0.03	-0.09	0.05	0.06	0.03	0.03	0.10	0.10	-0.03	0.04	0.01	0.03	-0.01
United States	0.09	0.16	0.07	0.00	-0.05	-0.04	0.03	0.12	0.05	0.05	0.05	0.10	0.05	0.07
Northern America less US	0.09	0.11	0.04	-0.06	0.13	0.01	0.10	0.09	0.15	0.08	0.08	0.10	0.09	0.09
South America	0.04	0.09	0.03	-0.05	-0.03	-0.09	0.01	0.05	0.08	0.07	0.00	-0.01	-0.03	0.04
Japan	0.11	0.13	0.11	0.06	0.10	0.07	0.00	-0.02	-0.08	0.05	0.06	0.07	0.05	0.06
China+HK	0.05	0.08	0.05	-0.02	0.04	0.01	-0.06	-0.07	-0.04	-0.04	0.04	0.05	-0.01	0.03
Rest of East Asia	0.14	0.10	0.11	0.10	0.14	0.09	0.00	-0.13	-0.18	-0.02	0.10	0.11	0.05	0.09
Rest of Asia	0.06	0.09	0.02	0.04	0.06	0.00	-0.03	0.03	0.01	-0.12	-0.01	-0.11	-0.09	-0.07
Northern Africa	-0.08	0.04	0.10	0.01	0.07	-0.03	0.09	0.10	0.13	0.02	-0.13	0.13	-0.02	0.00
Austral Africa	0.05	0.12	-0.02	0.09	0.14	0.06	-0.06	0.19	-0.02	-0.04	0.12	-0.04	-0.09	-0.03
Sub-Saharan Africa	-0.01	0.13	0.06	-0.06	0.29	-0.06	0.06	-0.02	0.10	-0.07	0.06	-0.18	-0.12	0.03
ROW	0.04	-0.04	0.11	0.06	0.20	0.06	-0.04	0.16	-0.02	-0.05	-0.03	-0.06	0.02	-0.21

Intra continental trade is coloured.

Source: GTAP 7, authors' calculations.

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