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# VALUE-ADDED TRADE AND REGIONALIZATION

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For nearly two decades, growth of international trade has been underpinned by the development of intermediate goods cross exchanges resulting from a new international division of labour. The share of trade in inputs, also called vertical trade, has dramatically increased. Simultaneously, there has been some fear of excessive regionalization in trade.

In this situation, the traditional trade measures based on the values of goods crossing borders are inappropriate to measure how self-centred are different regions. This paper suggests a new measure of international trade: “value-added trade”. Compared to “standard” trade, “value-added trade” is net of double-counted vertical trade and reallocates trade flows to input-producing industries. A database of value-added trade is made using the GTAP trade and input-output database for 66 regions (mostly countries) and 55 sectors in 1997 and 2001.

In 2001, 26% of international trade were "only" vertical specialization trade, up from 25% in 1997. The share of services in value-added trade is much more important than in standard trade. East Asia still relies more heavily on extra-regional final markets than North America or Europe.

Keywords: Globalization, Vertical trade, Regionalization

JEL: F15, F19

## Introduction

The recent development of regional trade agreements has sparked the fear of the emergence of antagonist regional trade blocs.[1] It is not actually clear that the spaghetti bowl of regional trade agreements really can have this kind of effects by itself.[2] Yet, it is clear that East Asia has recently experienced a growing regionalization of its trade.[3] It could be possible that its development is becoming more self-centred.

Yet, cross-border production networking, encouraged by extensive FDI flows has been an important part of this growing regionalization. In this context, international trade statistics fail to offer a good picture of trade integration and global division of labour because they cannot answer the question "who produces for whom?". Let us take an example. *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. Yet, no one should conclude that France is importing perfumes from China and is dependant for part of its cosmetic consumption on China.[4] Yet, that is what international trade statistics suggest. It would be more useful to restrict the measure of trade to goods and services intended for consumption. In our example, France does not export anything for Chinese consumption, as perfumes are consumed in France. China, for its part, only exports decoration to France. In some cases, that requires tracking goods through long supply chains. Suppose the pigments used for the decoration of these perfume bottles are imported to China from Japan. While trade statistics will indicate that they are imported from Japan to China, one would be wrong to believe that this pigment

[1] World Bank (2000).
[2] Baldwin (2006),Ethier (1998)
[3] Kwan (2001), Chortareas and Pelagidis (2004).
[4] Examples from Benhamou (2005), p. 19, 25 and 96.

trade has no bearing on the shape of the Franco-Japanese economic integration. Unravelling these long supply chains is impossible using simply trade statistics.

This paper advocates the study of regionalization using "value-added trade". Compared to "standard" trade, "value-added trade" is net of double-counted vertical specialization trade[5] and reallocates trade flows to the input-producing industries. This alternative measure of trade is all the more important since internationalisation of production plays a great role in the recent increase of international trade. Rising vertical specialization reinforces the divergence between value-added trade flows and standard trade statistics. There is a large literature on measuring vertical trade. Two broad methods have been employed. The first method measures vertical trade by looking at the fine composition of trade to isolate trade flows of parts and components.[6] This is useful and allows the examination of very fine-grained data, but cannot be extended to measure value-added trade. Another method uses both input/output data and trade data to measure the share of imports embedded in exports[7]. Our paper relies on this literature and extends it by suggesting a method not only to measure the share of vertical specialization trade in each country and industry's trade, but also to reconstruct value-added bilateral trade by industry for 66 regions. However, we are only able to do the computation for two years: 1997 and 2001.

The difficulty of the measuring value-added trade lies in taking into account all the stages of production of a final good in every country and every sector in order to track all the value-added contributions coming into its production. First, second, third… stage inputs must be isolated. This can only be done thanks to a coherent worldwide set of intermediate delivery matrices and bilateral trade matrices. The GTAP database has been built to run general

[5] Vertical trade sometimes designates intra-industry trade in goods of different qualities. This is not the object of this paper.
[6] Ng and Yeats (2003), Egger and Egger (2005), Athukorala and Yamashita (2006).
[7] Hummels, Rapoport, and Yi (1998), Hummels, Ishii, and Yi (1999), Hummels, Ishii, and Yi (2001); Yi (2003); Chen, Kondratowicz, and Yi (2005).

equilibrium analysis of the effects of international trade. It includes the necessary information.[8]

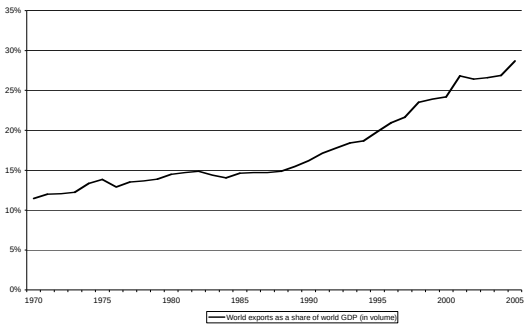
This paper presents a method to compute value-added international trade and re-examine the issue of regionalization. In a first section, the paper presents vertical specialization trade, and its existing measures. In a second section, it presents a method to compute value-added trade. In a third section, it presents some results for 1997 and 2001 and compares them to results obtained by other methods. It then compare the regionalization of Asian trade with regionalization in other parts of the world. This paper builds on an earlier application focused on France using a more aggregated database.[9]

## 1. Vertical specialization trade

The "second trade globalization" that started after WWII has clearly accelerated during the last two decades (graph 1). Measured in constant prices, the share of goods and services exports in world GDP has doubled from 1985 to 2005, whereas it grew only by 2 percent from 1970 to 1985. Today, exports in goods and services are equal to 30 percents of the world GDP. However, because of the prevalence of vertical trade, this does not mean that 30 percents of the world GDP are produced for consumption in other countries…

[8] Dimaranan (2006).
[9] Daudin, Rifflart, Schweisguth, and Veroni (2006).

**Figure 1: the expansion of world trade**




Source: CEPII (2007)

## 1.1. What is it?

There is vertical specialization of trade as soon as:[10]

- 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, integrating all intermediate goods coming in the production of the good. 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% (as in the case of Malaysia and Singapore). The other measure, called "value-added trade", measures trade net of vertical trade. It reallocates

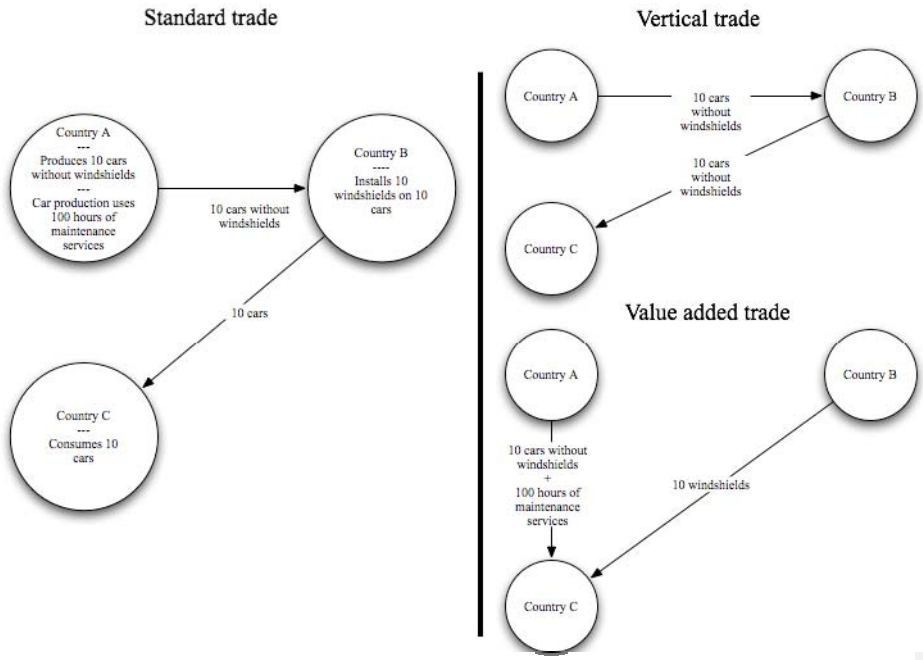
[10] Hummels, Rapoport, and Yi (1998).

the value added produced at the different stages of the production process to each of the participating countries and industry.

Vertical specialization introduces complementarities between countries, each one taking part in the development of the end product at a specific stage of the process. A country A produces a good *i* which will be exported towards B as intermediate input necessary to the production of a good *j*, which will be in turn exported towards a country C. At the end of the process, the product is sold as a final good for consumption or investment. “Standard” trade tracks all these exchanges. But trade in inputs is “only” vertical specialization trade. 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 (see Figure 2).

**Figure 2: 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 to become inputs to B's production and once when they are embedded into B's exports. The bottom right figure shows "value added" trade. This is obtained through three operations: first by removing vertical trade flows from standard trade flows; second by re-allocating vertical trade flows to the producer / consumer country pair; third by allocating trade flows to the industries that actually produce the value-added.

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 service 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 regionalization. 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 regionalization than one in which country B actually depends on country A for its final consumption. Applied to the study of Asian trade, the examination of value-added trade confirms and refines the result that despite its apparent regionalization, Asia's trade is still very dependent on external consumption.[11]

## 1.2. Why vertical specialization?

The Fordist organization of production put in place at the end of the World War II at a national scale has been transformed into a disintegrated process, where 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 most of the comparative advantages of each country. The segmentation of production processes has led to foreign outsourcing of some production activities.

[11] Athukorala and Yamashita (2006).

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 finally results 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 following the rise of economic liberalism and the multiplication of bilateral and multilateral trade agreements concluded within the framework of the GATT and the WTO. This had a larger effect on vertical specialization trade than on the other types of trade as the internationalisation of the production process implies an increase in the number of borders crossed by each goods.[12]

Micro-economic explanations of this movement give a by analysing the role of multinational entreprises (MNE) in trade of intermediate goods. They have been inspired by the new international trade theories integrating new findings in firm theory.[13] The stock of foreign direct investment (FDI) worldwide accounts for a quarter of world GDP today against 6-7% in the 1980s.[14] This growing FDI led to the expansion of multinational firm networks. Empirical evidence suggest that multinational firms have a leading role in the rise of vertical specialization trade, even if the actual link between vertical specialization trade flows and FDI is closely dependent on the inner strategy of each firm.

On this subject, Kleinert underlines there is a strong correlation between MNE production in a host country and the propensity of this country to import intermediate goods. However, the links between MNE production and the sale of inputs from the host country to the original country is less clear.[15] Hanson *et alii* show that American firms practising outsourcing import more intermediate goods if their subsidiary companies operate in countries where commercial

[12] Yi (2003).
[13] Jones (2000) ; Grossman and Helpman (2005), Ravix and Sautel (2007).
[14] UNCTAD (2005).
[15] Kleinert (2003).

costs, wages, and companies' taxation are weak.[16] Bardhan and Jaffee provide contrasting results, as they report that in the case of the United States, arm-length transactions dominate input trade flows even if network trade remains substantial.[17]

On the macro side, and to come back to the issue of regionalization, an already rich literature details the reasons behind the high intensity of vertical trade in regional trade in East Asia.[18] The first reason is a more favourable policy setting for international production (for example China applied a lower tax rate on profits made by foreign companies to attract FDI). Second, Asian countries are experiencing the benefits arising from the early entry into this from of specialisation, which started in the 80s when Japan started to delocalise the assembly stage in Korea, Taiwan or Singapore. Third, inter-country wage differentials have always been very high in Asia. When some countries develop faster and labour cost increases, production is moved to poorer countries in order to optimise the production cost. Fourth, trade and transport costs are relatively low within the region. And fifth, the region has specialised in products with increasing return to scale, taking advantage of the abundant labour force available.

### 1.3. How can it be measured?

Whatever the causes of vertical trade, it can be measured in two ways: either using very fine industrial classification or using input-output tables.

In the context of the SITC, Rev 3, the first method is possible for the goods belonging to categories 7 (machinery and transport equipment) and 8 (miscellaneous manufactured articles), in the five-digit SITC classification. It has been conducted by Athukorala and Yamashita for most countries in the world. They find that world trade in components

[16] Hanson, Mataloni Jr, and Slaughter (2005).
[17] Bardhan and Jaffee (2005).
[18] See the review in Haddad (2007).

increased from 18.5 percent to 22 percent of world manufacturing exports from 1992 and 2003.[19]

Yi and alii use the second method, as does this paper. They calculated international vertical specialisation trade, defined as the share of imported inputs in exports, using input-output matrices of 10 OCDE countries and a few emerging market economies (Ireland, South Korea, Taiwan and Mexico) [20]. 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.

But the definition of 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 to its export goods: the authors call this flow "VS1". While VS measures vertical specialization of a country from its use of imported inputs in its exports, VS1 measures it from the use of a country's exported goods as inputs to the importer's further exports. 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.

To avoid double-counting in the worldwide measure of vertical trade, this paper integrates in the definition of vertical trade only the part of VS1 that comes back to the country of origin, let us call it VS1*. A typical example is trade between the US and Mexico and Canada through "the motor vehicle industry[21]. In that case, VS1* is defined as the exports that are, further down the production chain, re-imported as inputs embedded in their consumed imports. This simply means that when the US import cars from Mexico, US made

[19] Athukorala and Yamashita (2006)
[20] Hummels, Rapoport, and Yi (1998), Hummels, Ishii, and Yi (1999).
[21] In Hummels, Rapoport, and Yi (1998), the authors give empirical evidence from case studies that the share of total trade that is vertical specialization based is larger than VS.

motors must be deducted from US imports measured in value added. In our paper, as in Yi [22], the total value of value added trade is equal to standard trade minus VS and VS1.

Our paper's method is similar to Hummel *et alii*'s, but we compute VS for many more countries in two years: 1997 and 2001. Furthermore, because we use world wide input-output tables reconciled with bilateral trade statistics, we can offer a measure of world trade in value-added.

## 2. How to compute trade flows in value added

### 2.1. GTAP database

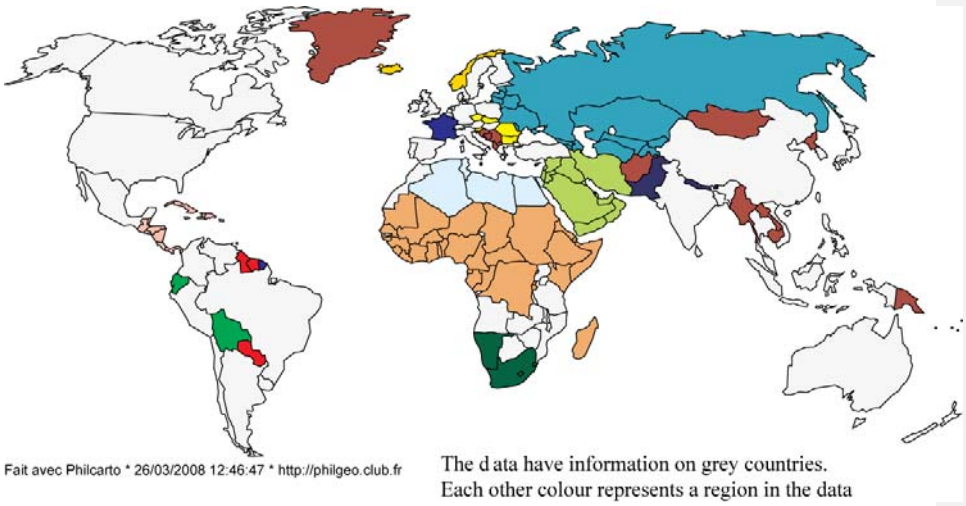
Computing international trade flows in value added requires the use of input-output tables and in particular of intermediate deliveries matrices reconciled with bilateral trade data. The first input-output tables had been developed by Leontief in the 1930s and set the foundations of the input-output analysis.[23] 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.[24] 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 more specific context of computable general equilibrium models. In this context, they must be reconciled with bilateral trade data. That 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 organisation and research centres among which the United Nations, WTO, the European Commission, OECD and CEPII. GTAP's goal is to improve the quality of

[22] Yi (2003), pp. 58-60.
[23] Leontief (1936).
[24] Shoven and Wholley (1992).

quantitative analysis of global economic issues within an economy-wide framework. It provides databases and programmes for computable general equilibrium models. We work with versions 5 (for 1997) and 6 (for 2001) of the GTAP database, which covers 57 sectors for 66 « regions » in 1997 and 87 « regions » in 2001 (countries or country groups) respectively. We work with 66 regions in both years. The database provides final demand and input-output tables differentiating domestic and imported intermediate deliveries 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.

**Map 1: The 66 regions used in the paper**




*We have country specific data on grey countries, but only regional data on coloured countries. Countries with the same colour belong to the same region.*

Original data come from national statistical offices, and hence its quality depends on their quality[25]. 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 also a source of difficulty. 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, interpolation of data on transport costs was necessary. 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[26]. In our appraisal of the database, we have not found defaults that could systematically bias the exercise we conduct in this paper.

## 2.2. Theoretical foundation of the calculation[27]

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 $j$.

[25] 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.
[26] For additional information, refer to http://www.gtap.agecon.purdue.edu
[27] This is extended in Daudin, Rifflart, Schweisguth, and Veroni (2006).

As a result, a well known result in input-output analysis links changes in the final demand of each product and production:

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

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.

$$VA = P - diag(P)A'i$$

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.[28] Hence, the value added vector *VA* associated with the final demand vector *FD* is equal to:

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

This can be extended to the case of a world including many inter-linked open economies. The world can be considered 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 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*.[29]

In the same way, we can write:

$$VA = P - diag(P)G'i = (I - G)^{-1} * FD - diag((I - G)^{-1} FD)G'i$$

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

[28] 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.
[29] See Hoen (2002), pp. 51-58 for a discussion of this method.

final usage statistics. It allows the computation of *VA* from which value-added trade values are extracted.

### 2.3. Some necessary hypotheses

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 in GTAP though and 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 the same independent of its use (as a final demand item or as an intermediate consumption). This assumption means that the share of Mexico is the same in the imported oil used by U.S. households and in the imported oil used as input in U.S. manufacture.

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 origin country, 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 is a reasonable assumption. However, because our industry aggregation is not very fine it might be the case that composition makes a difference between different use.

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 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. Results

## 3.1. Value-added trade in general

Our data suggest that vertical trade has developed faster that the total world trade between 1997 and 2001. The growth of vertical trade was 16% whereas the value added trade growth was to just 10%. It contributed to 35% of the increase of total trade. During this period, the share of vertical trade in total exports increased from 25,3 % to 26,3 %. Whereas "standard" openness rate is 22.6% in 2001, it is only 16.7 % in terms of value-added trade.

### *3.1.1. Comparing with previous measures*

Before developing our own results, we compare them with those found by Yi and his coauthors[30]. Our framework is very similar from theirs. We use the same definition of vertical trade and compute from input-output tables. The difference, however, is that our database is more exhaustive and we can compute the total vertical trade for all countries.

Yi et alii[31] calculated VS (i.e. the share of imported of inputs, including inputs for inputs, in exports) for 10 OECD countries and 4 emerging countries, using OECD Inputs-outputs

[30] Hummels, Rapoport, and Yi (1998), Hummels, Ishii, and Yi (1999), Hummels, Ishii, and Yi (2001); Yi (2003); Chen, Kondratowicz, and Yi (2005).
[31] Hummels, Ishii, and Yi (1999) tables 2 and 3, Hummels, Ishii, and Yi (2001), pp 84-85.

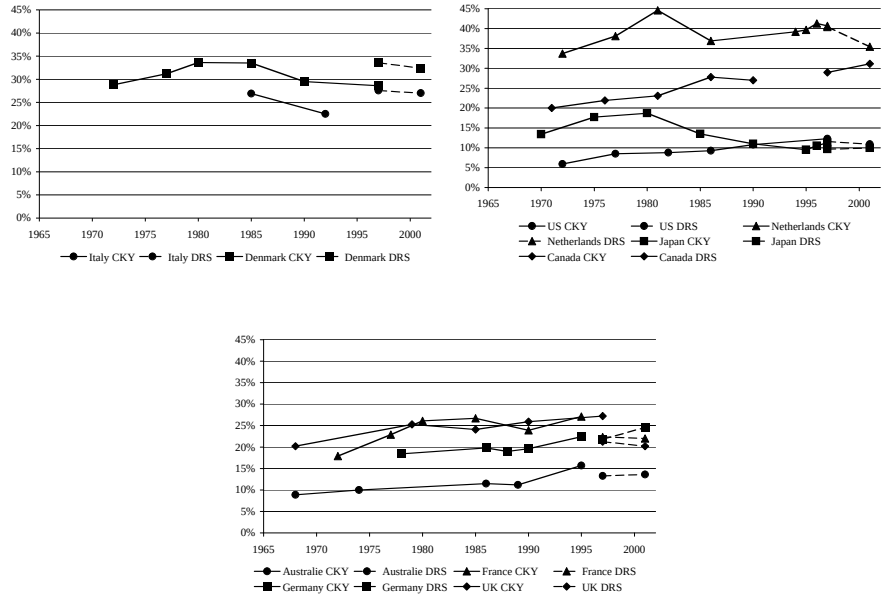
tables. Yi et alii[32] in an article published in 2005 extended the calculation to the end of the 1990s. For comparison purposes, we compute VS using the same method for all the countries in our sample: our data cover 1997 and 2001. The results are given in Figure 3.

Yi et alii. provide VS measures in 1997 for five countries: we can directly compare these with our own measures. "Our" VS is the same as theirs for Japan, Netherlands and the United-States. It is more important in Denmark (28% against 33%) and much less important in the United Kingdom (27% versus 21%). There are many possible explanations for the difference. The main one is that GTAP Input-Output tables are different from theirs. We also use a different industry classification. On the whole, the data do not indicate that we are measuring radically different things.

No same-year comparison is possible for the other OECD countries. Yet, our results are similar to theirs. The better integrated OECD countries in international vertical specialisation are Canada, Denmark and the Netherlands: imported inputs represent between 25 % and 35 % of their exports. The US, Japan and Australia export mainly their local production. The main European economies have a vertical specialization share of about 20-25 %. Our data follow the increasing vertical specialisation trend in Canada, the United States, Australia and Germany since the 1970. They also follow the trend of declining share of vertical trade in Japanese exports from 1980.

**Figure 3: Vertical specialization in OECD countries: comparing our results to Yi et alii's**

[32] Chen, Kondratowicz, and Yi (2005), p 42, table 2.




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

Comparisons for emerging countries (Ireland, Korea, Taiwan and Mexico) are less encouraging: "our" VS is quite different from Yi et alii's. That might be due to differences in data quality. Nevertheless, both measures that the share of vertical trade in their exports at a higher level then for most OECD countries.

Yi et alii [33] extrapolate their results to the rest of the world. They find that the share of vertical trade in world exports was equal to 22.7% at the end of the 1990s, against 15.9 % 25 years earlier (a more than 40 % increase). The contribution of vertical specialization trade in trade growth in the last 30 years is substantial: one third for France, more than half in Canada, the Netherlands and in Asian (Taiwan) or Latin America (Mexico) emerging countries.

[33] Hummels, Ishii, and Yi (1999), table 5.

Computing VS1 (exported intermediates embodied in importing countries exports) for 1997 and 2001 with the GTAP database gives different results from the method presented in Chen *et alii*. This is probably the results of using a full set of intermediate deliveries matrices.

VS1* is more interesting (exported intermediates embodied in further imports). We measure it as the difference between value-added trade plus VS and standard trade. In Japan, VS1* is very small (1.6 % of the total exports in 1997 and 2001). In the US, we have 7.9 % in 1997 and 9.9 % in 2001. Our results are compatible with Yi and alii[34] measure based on the US Mexico trade and US Canada auto trade only (8.2 % in 1997 for VS1*). That confirms a strong regional integration of the US with its two neighbours, in the framework of free trade agreement.

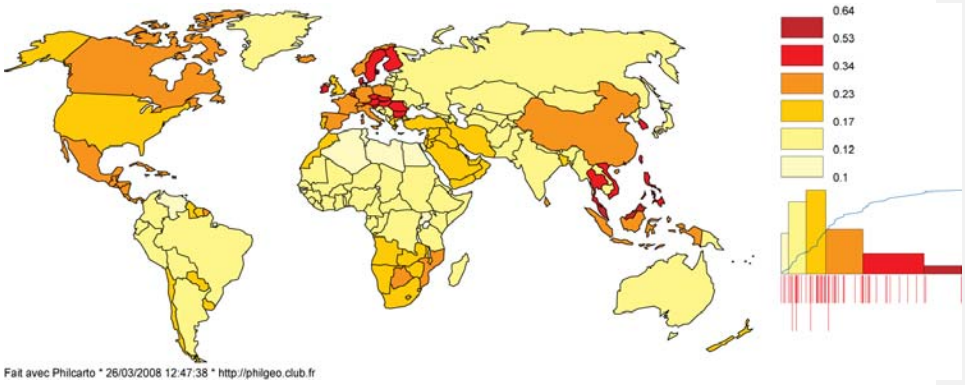
On the whole, our results are compatible with the ones found by Yi and his successive co-authors.

### *3.1.2. Value-added trade at the country level*

Map 2 gives the share of vertical exports in total exports for each country in the word. Exports of small countries have a bigger share of imported inputs. Vertical specialisation makes up to 40 % of exports in some Asian and European countries.

[34] Hummels, Ishii, and Yi (1999), Appendice III, p 33, table A2

**Map 2: Share of vertical exports in total exports**




The ranking of top exporters is not dramatically changed in value added trade. The US confirm their first position, increasing their share of world exports (from 13 % to 14 %). Japan remains third, but closer to Germany (second) and increasing the gap with China (fourth). Then follow France, the UK, Italy and Canada. The biggest "losers" are Belgium, moving from the 10$^{th}$ to the 16$^{th}$ position, and Singapore (18$^{th}$ to 32$^{nd}$). Among the "winners", the former soviet union moves up 4 places (17$^{th}$ to 13$^{th}$), while Mexico an Spain move to the front of South Korea.

**Table 1: 20 top exporters with standard and value added trade measures (exports as a share of total world exports in 2001)**

| | Standard | | Value added | | |
|---|---|---|---|---|---|
| | Share of world exports in % | Rank | Share of world exports in % | Rank | Change in share |
| **United States** | 13.0 | **1** | 14.0 | **1** | +7.5% |
| **Germany** | 8.9 | **2** | 8.8 | **2** | -1.0% |
| **Japan** | 6.6 | **3** | 7.9 | **3** | +19.1% |
| **China** | 5.6 | **4** | 5.9 | **4** | +6.5% |
| **France** | 5.0 | **5** | 5.2 | **5** | +3.6% |
| **United Kingdom** | 4.9 | **6** | 5.2 | **6** | +5.7% |
| **Italy** | 4.1 | **7** | 4.0 | **7** | -2.1% |
| **Canada** | 3.9 | **8** | 3.6 | **8** | -7.4% |
| **rest of Middle East** | 2.9 | **9** | 3.2 | **9** | +11.1% |
| **Belgium** | 2.6 | **10** | 1.6 | **16** | -37.6% |
| **South Korea** | 2.6 | **11** | 2.3 | **12** | -13.1% |
| **Mexico** | 2.4 | **12** | 2.5 | **10** | +3.0% |
| **Spain** | 2.3 | **13** | 2.3 | **11** | -0.9% |
| **Netherlands** | 2.2 | **14** | 1.9 | **14** | -13.2% |
| **Taiwan** | 2.0 | **15** | 1.7 | **15** | -15.1% |
| **Malaysia** | 1.8 | **16** | 1.5 | **18** | -21.0% |
| **former Soviet Union** | 1.8 | **17** | 2.1 | **13** | 18.2% |
| **Singapore** | 1.6 | **18** | 0.7 | **32** | -54.7% |
| **Switzerland** | 1.6 | **19** | 1.6 | **17** | +1.4% |
| **Hong Kong** | 1.4 | **20** | 1.4 | **19** | +1.1% |

Note: Trade from Hong Kong and the Netherlands is already modified in the GTAP database to re-allocate re-exports.[35]

### *3.1.3. Industrial classification*

Industrial shares are deeply modified in value-added trade. Remember that we reallocate exports according to the sector of origin of their inputs. That means that a number of mainly "non-tradable" sectors that are being used as inputs to the production of "tradable" goods increase their trade share.

Figure 4 illustrates this transfer from industry to the agriculture, raw materials and services. The trade in industrial goods is much more important when measured in standard term (75 % of total trade in 2001) than when it measured in value added term (52.5 % of total trade). At the opposite, the trade in primary sector and above all, in the services sector tend to increase when we proceed with the value added measure. The share of services drastically

[35] Gehlhar (2006).

increases from 17 % to 37 % of total trade. The primary sector (including agriculture and extraction processes) also increases when measured in value added: 7.5 % to 10 %.

**Figure 4: Share of different sectors in standard trade and value-added trad**

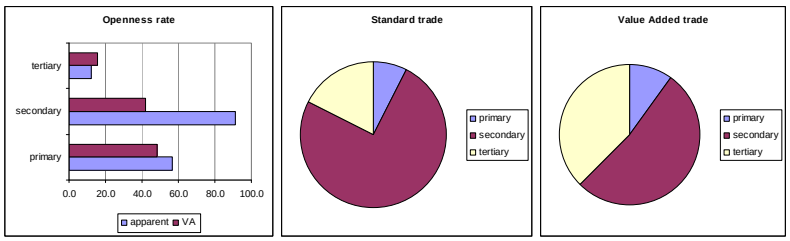



Table 2 shows the largest increase in trade share when one looks at value-added trade. Among agricultural sectors, the share of sugar cane or sugar beet is multiplied by 76, and that of raw milk by 68! These are extreme examples of commodities quasi exclusively traded as inputs in manufactured food products (sugar and dairy products respectively). The share of utilities increased as well: water is multiplied by 12, electricity by 8 and gas by 6, reflecting their role as inputs for the production of manufactured goods. This is also the case of services. The trade share of financial services is multiplied by 4, and that of trade, communication, recreational and other services multiplied by 3. Business services becomes the main sector in world trade (10 % of value added trade), before machinery and equipment.

Table 3 shows that many manufactured goods see their share largely reduced. The share of motor vehicles and parts is divided by 2.3, as there is a lot of “double counting” in this category. The same is true for petroleum and coal products, electronic equipment and many food products.

**Table 2: Sectors with share increasing the most in value added**

| | Standard | | Value added | | |
|---|---|---|---|---|---|
| | Share of total | **rank** | Share of total | **rank** | ratio |
| sugar cane, sugar beet | 0.0 | **54** | 0.1 | **54** | 75.7 |
| raw milk | 0.0 | **53** | 0.2 | **47** | 67.7 |
| water | 0.0 | **52** | 0.3 | **38** | 11.8 |
| electricity | 0.3 | **36** | 2.6 | **12** | 8.0 |
| gas manufacture, distribution | 0.0 | **50** | 0.2 | **41** | 6.5 |
| financial services nec | 0.8 | **24** | 3.3 | **10** | 4.2 |
| paddy rice | 0.0 | **51** | 0.1 | **51** | 4.2 |
| forestry | 0.1 | **43** | 0.5 | **34** | 3.6 |
| trade | 2.6 | **11** | 8.4 | **3** | 3.2 |
| communication | 0.6 | **29** | 1.8 | **18** | 3.0 |
| recreational and other services | 1.2 | **23** | 3.5 | **7** | 2.9 |
| bovine cattle, sheep and goats, horses | 0.1 | **47** | 0.2 | **43** | 2.6 |
| construction | 0.4 | **34** | 1.0 | **25** | 2.4 |
| fishing | 0.1 | **46** | 0.2 | **44** | 2.0 |
| business services nec | 5.3 | **5** | 10.2 | **1** | 1.9 |
| public admin. and defence, education, health | 1.6 | **20** | 2.9 | **11** | 1.9 |

Ratio = share of total in value added / share of total in standard trade

**Table 3: Sectors with share decreasing the most in value added**

| | Standard | | Value added | | |
|---|---|---|---|---|---|
| | Share of total | **rank** | Share of total | **rank** | ratio |
| petroleum, coal products | 1.5 | **21** | 0.6 | **33** | 2.5 |
| motor vehicles and parts | 7.7 | **4** | 3.3 | **9** | 2.3 |
| meat products | 0.5 | **32** | 0.2 | **46** | 2.3 |
| processed rice | 0.1 | **48** | 0.0 | **55** | 2.1 |
| bovine cattle, sheep and goat meat products | 0.3 | **35** | 0.2 | **50** | 2.1 |
| dairy products | 0.4 | **33** | 0.2 | **45** | 2.0 |
| electronic equipment | 12.0 | **2** | 6.0 | **6** | 2.0 |
| leather products | 1.3 | **22** | 0.7 | **31** | 2.0 |
| wearing apparel | 2.3 | **12** | 1.2 | **22** | 1.8 |
| transport equipment nec | 3.0 | **8** | 1.7 | **19** | 1.7 |
| food products nec | 1.9 | **16** | 1.1 | **24** | 1.7 |
| metals nec | 2.2 | **13** | 1.4 | **21** | 1.6 |
| machinery and equipment nec | 14.8 | **1** | 9.2 | **2** | 1.6 |
| wood products | 1.8 | **18** | 1.2 | **23** | 1.5 |
| manufactures nec | 2.7 | **10** | 1.9 | **17** | 1.4 |
| textiles | 2.8 | **9** | 2.2 | **15** | 1.3 |
| vegetable oils and fats | 0.2 | **40** | 0.2 | **48** | 1.3 |
| chemical, rubber, plastic products | 10.2 | **3** | 8.0 | **4** | 1.3 |

Ratio = share of total in standard trade / share of total in value added

As a result, the number manufacturing sectors belonging to the largest ten shares declines from 7 to 4 in value-added trade (see Table 4). The farm industry sector, the textile and the wood and paper which represents both about 5 % of the total trade loose between 0.3 and 2.3 percentage points. But the absolute change are much more important in other sectors. The trade share of electronics and other manufactures sector decreases from 29.5 % to 17.1%, the trade share of the chemical sector decreases from 17.5% to 13.5% and the trade share of the

metal and transport products sector decreases from 12.6% to 7.4%. This indicates that vertical trade is very important in these industries, confirming the results of Yi and their co-authors. As expected, the "implied" vertical share trade in these sectors' exports is larger with our method than theirs. This is because we re-allocate part of their exports to other domestic sectors, notably inputs, whereas they only remove imported inputs.

Comment [GD1]: Ces chiffres ne sont pas les mêmes que ceux de la table 2 : quesako ?

**Table 4: Export shares of the 10 industries in standard world exports and value-added word exports in 2001 (out of 55 sectors)**

| Standard trade | | Value-added trade | |
|---|---|---|---|
| machinery and equipment nec | 14.8% | business services nec | 10.2% |
| electronic equipment | 12.0% | machinery and equipment nec | 9.2% |
| chemical, rubber, plastic products | 10.2% | trade | 8.4% |
| motor vehicles and parts | 7.7% | chemical, rubber, plastic products | 8.0% |
| business services nec | 5.3% | transport | 6.2% |
| transport | 4.7% | electronic equipment | 6.0% |
| oil | 3.3% | recreational and other services | 3.5% |
| transport equipment nec | 3.0% | oil | 3.4% |
| textiles | 2.8% | motor vehicles and parts | 3.3% |
| manufactures nec | 2.7% | financial services nec | 3.3% |

## 3.2. What role for vertical trade in regionalization ?

The development of world trade has in some regions been concomitant with the intensification of regionalization. To what extend did the fragmentation of production processes contribute to regionalization? Table 5 shows the various degrees of regionalization in Europe, the euro area, East Asia, America (North and South) and Austral Africa, measured as the share of intra-regional to total exports (line 2). According to this indicator, the most regionalized trade is Europe's (61%) and the least regionalized is Austral Africa's (10%). However, this indicator is very sensitive to the size of the regions (first line of Table 5), the distance between trading partners and the size of the constituent countries, and therefore cannot be easily interpreted as a measure of the intensity of regionalization. In North America, regional trade would greater if the US were split into fifty or less states. Still, it is interesting to compare the degree of regionalization for vertical and value added trade (line 3 and 4). The share of intra-regional trade is much higher in vertical trade than in value added.

For example, 65% of East Asian vertical exports are sent off to other East Asian countries, while only 30% of value added exports are.

**Table 5 : The extent of regionalization and relative size of the regions, 2001**

| In % | Europe[36] | Euro area | East Asia[37] | North America[38] | South America | Austral Africa[39] |
|---|---|---|---|---|---|---|
| Total exports as a share of world exports | 40% | 28% | 25% | 20% | 3% | 1% |
| Share of regional exports in total exports | 61% | 41% | 40% | 45% | 19% | 10% |
| Share of regional exports in vertical export | 78% | 53% | 65% | 68% | 34% | 22% |
| Share of regional exports in value-added exports | 54% | 36% | 30% | 38% | 16% | 8% |
| Share of vertical exports in total exports | 30% | 31% | 28% | 24% | 15% | 18% |
| Share of vertical exports in regional exports | 38% | 39% | 46% | 36% | 28% | 40% |

The share of vertical exports in regional or total exports is a good comparative indicator of the intensity of vertical specialisation, as it does not depend directly on the relative size of the region. Not surprisingly, the share of vertical trade is much higher in intra-regional trade (line 6) trade than in total trade (line 5). Production processes integration is more intense between geographically close countries, or countries in a free trade area. East Asia is the region where the share of vertical trade in regional exports is the highest: 46%. This confirms the traditional literature on East Asian (see supra). The degree of dependence of East Asia on this form of regional integration is larger than for North America (36%) and Europe (38%).

Table 6 looks at the evolution of the degree of regionalization and the intensity of vertical trade between 1997 and 2001. Line 5 confirms the relative increase of vertical trade, but not at the same speed in all regions. Some regions have seen their share of vertical trade increase very fast in four years: East Asia (+7.2%), Austral Africa (+18%) and South America (+25%),

[36] Including the European Union at 25 (except the Baltic States), Switzerland, the rest of European Free Trade Area.
[37] Including China, Hong Kong, Indonesia, Japan, South Korea, Malaysia, the Philippines, Singapore, Thaïland , Taïwan and Vietnam.
[38] Including the United States, Canada, Mexico, Central America and the Caribbean
[39] Including Botswana, the rest of South African Custom Union (Lesotho, Namibia, South Africa and Swaziland), Malawi, Mozambique, Tanzania, Zambia, Zimbabwe, Uganda, Angola and Mauritius

while Europe has been fairly stable (+1.8%). In East Asia, vertical trade has risen by 24 % compared to 12.5 % for value added trade, and contributed to 40 % of total export growth over the period. The share of vertical trade in East Asian exports (28.2 %) is slightly higher than the world average (26.3 %) in 2001.

**Table 6: The evolution of vertical trade and regionalization**

| | Europe | Euro area | East Asia | North America | South America | Austral Africa |
|---|---|---|---|---|---|---|
| Growth of the share of regional trade in total exports (1997-2001) | -0.7% | -3.3% | -0.1% | +10% | -22% | +8.5% |
| Growth of the share of regional trade in vertical exports (1997-2001) | -1.5% | -5.6% | +3.2% | +3.1% | -16% | +8% |
| Growth of the share of regional trade in value added exports (1997-2001) | -0.6% | -2% | -5.3% | +12.5% | -26% | +2.2% |
| Growth of the share of vertical trade in regional exports (1997-2001) | +1% | -1.2% | +11% | -0.9% | +34% | +17% |
| Growth of the share of vertical trade in total exports (1997-2001) | +1.8% | +1.3% | +7.2% | +5.8% | +25% | +18% |

Table 6 also compares the evolution of the share of regional exports from 1997 to 2001 and gives some indication of whether relative regional integration has been deepening or not (line 1). Standard trade indicates that regional integration has been stable in Asia and Europe, decreasing in South America and increasing in North America and Austral Africa. Value-added trade suggest suggests that regionalization has decreased in East Asia and in South America and increased in North America (line 3). East Asia and South America has become more and more dependent on external consumption. In East Asia, intra-regional vertical trade has grown much faster (28 %) than value added trade (6.7 %) between 1997 and 2001, contributing to 75 % of the increase in intra-regional trade over the period. The intra-regional export share measured in value added has declined from 32.1 % to 30.4 % between 1997 and 2001, even if the degree of dependence on intra-regional imports has increased: intra-regional imports accounted for 48 % of total imports in 2001 compared to 43.7 % in 1997.

Examining value-added trade shows that apparent regionalization does not challenge the fact that the East Asian model of development is very much dependent on external markets.

Europe is in an intermediate situation: a fair share of its regional trade is linked to production fragmentation, but this is not growing.

### 3.3. How is production organised between East Asian countries?

The analysis of vertical trade flows helps understanding the patterns of production within East Asia. The first thing to notice is that bilateral trade balances can be misleading. Table 7 shows the bilateral trade balances of some Asian countries for standard and value added trade. If the overall balance of a country is unchanged by the calculation, bilateral trade balances can vary substantially. In China, which was in 2001 the main assembly base, the trade surplus with the US is reduced by more than 10% when measured in value added. At the same time, Chinese trade deficit with Korea and Taiwan is divided by half, as most of China's imports from Korea and Taiwan are used as intermediary products for final exports to the US. Korea and Taiwan both show a big surplus towards China and the US and a big deficit with Japan in standard trade. We find that for both countries two thirds of the deficit with Japan is only vertical trade, not intended for final consumption within the country. On the other side, the trade surplus towards China also shrinks dramatically, as most Taiwanese or Korean goods imported by China are not consumed there.

**Table 7: Bilateral trade balances (in million $)**

| **Standard trade** | **China** | **Japan** | **Korea** | **Taiwan** | **US** |
|---|---|---|---|---|---|
| China | 0 | -8 694 | 13 339 | 11 148 | -78 033 |
| Japan | 8 694 | 0 | -10 853 | -11 130 | -52 888 |
| Korea | -13 339 | 10 853 | 0 | -2 904 | -8 107 |
| Taiwan | -11 148 | 11 130 | 2 904 | 0 | -14 404 |
| **Value added trade** | **China** | **Japan** | **Korea** | **Taiwan** | **US** |
| China | 0 | -11 097 | 4 307 | 4 658 | -66 153 |
| Japan | 11 097 | 0 | -3 636 | -5 088 | -65 098 |
| Korea | -4 307 | 3 636 | 0 | -255 | -11 270 |
| Taiwan | -4 658 | 5 088 | 255 | 0 | -13 317 |

To check if these remarks can be extended to other groups of countries, we compare the variance of intra-regional trade imbalances in Table 8. It shows that the variance of bilateral intra-regional trade imbalances is always smaller for value-added trade than for standard

trade, suggesting that a fair share of regional trade disequilibria is linked to production fragmentation.

**Table 8: Variance of bilateral intra-regional trade imbalances**

| | East Asia | America | Europe | Austral Africa |
|---|---|---|---|---|
| Ratio between the variance of intra-regional bilateral trade imbalances in value-added trade and in standard trade (2001) | 42% | 64% | 45% | 35% |

## 3.4. Industrial repartition of trade

Standard trade statistics suggests that in 2004, both East Asia and Europe had similar global revealed comparative advantages. This assessment might not be true in value-added trade, as the importance of service trade imbedded in industrial trade is taken into account.

To check whether this is the case or not, we use the revealed comparative advantage index of the CEPII which is defined as follows.[40]

$$RCA_{ik} = \underbrace{\frac{1000}{X_i + M_i}}_{\text{Scaling factor: total trade of country i}} \bullet \left[ \underbrace{\left(X_{ik} - M_{ik}\right)}_{\text{Trade balance of country i in good k}} - \underbrace{\left(X_i - M_i\right) \bullet \left( \frac{X_{ik} + M_{ik}}{X_i + M_i} \right)}_{\text{Trade balance of country i in good k if there were no comparative advantages}} \right]$$

When this index is equal to zero, there are no comparative advantage : the trade deficit in this product could be simply computed from the total trade deficit and the share of the product in national trade. Higher than zero means a comparative advantage, lower than zero means a comparative disadvantage. Table 10 gives indices both for the total trade of a region (including intra-regional trade) and for extra-regional trade. The first group of indices should be interpreted as giving the mean comparative advantage of different countries in each region, weighted by exports. The second group of indices should be interpreted as giving the comparative advantage of the region as a whole.

[40] This is for example used in Arthus and Fontagné (2006).

Africa and South America both have typical primary producers profiles. North America only has a comparative advantage in service production. It is interesting to notice, however, that the East Asian comparative advantage is more specific when examined in value-added trade than when examined in standard trade. Standard trade suggests that both Europe and East Asia have a comparative advantage in industrial production. Value added suggests that, actually, Europe also has a comparative advantage in service production, whereas East Asia comparative advantage is only in industrial production.

**Table 9: Revealed comparative advantages**

| | | East Asia | Europe | North America | South America | Austral Africa |
|---|---|---|---|---|---|---|
| Total standard trade | Primary | -38 | -17 | -2 | 86 | 79 |
| | Secondary | 55 | 19 | -29 | -65 | -39 |
| | Tertiary | -17 | -2 | 31 | -21 | -40 |
| Total VA trade | Primary | -26 | -22 | -13 | 115 | 70 |
| | Secondary | 53 | 11 | -17 | -70 | -16 |
| | Tertiary | -27 | 11 | 29 | -45 | -54 |
| Extra-regional standard trade | Primary | -71 | -46 | -5 | 105 | 88 |
| | Secondary | 109 | 54 | -63 | -79 | -40 |
| | Tertiary | -38 | -8 | 68 | -26 | -48 |
| Extra-regional VA trade | Primary | -40 | -50 | -20 | 115 | 77 |
| | Secondary | 86 | 26 | -33 | -70 | -15 |
| | Tertiary | -47 | 24 | 54 | -45 | -61 |

Table 10 confirms this specificity of East Asia by looking at the correlation of the revealed comparative advantages for 55 sectors according to VA trade, weighted by the share of each sector in inter-regional trade.

**Table 10: Weighted correlations of revealed comparative advantages, VA trade, 55 sectors**

| | Austral Africa | South America | North America | East Asia | Europe |
|---|---|---|---|---|---|
| Austral Africa | 1 | | | | |
| South America | 0.61 | 1 | | | |
| North America | -0.57 | -0.40 | 1 | | |
| East Asia | -0.11 | -0.49 | -0.26 | 1 | |
| Europe | -0.47 | -0.52 | 0.17 | -0.06 | 1 |

## Conclusion

This paper contributes to the very important debate concerning the new dynamism of the international trade. Since the beginning of the 1990s, growing international trade is tied to a change in the content of traded goods linked to the development of a new production process based on a new international division of labour. In this context, it appears more and more difficult to understand trade with standard statistics. It would be very useful to understand the international production process enough to be able to answer the question "who produces what and for whom?". That should be done by reallocating 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 and 2001.

This approach allows us to examine a number of admitted facts about trade observed in the standard data. We focus on the regionalization process and the role of Asia in the expansion of total trade. Like Yi and his co-authors, we show the tight relation between the growth of world trade and the development of vertical trade. Between 1997 and 2001, the growth of vertical trade was 16% while the value added trade was just to 10%. The share of vertical trade in the total trade increases from 25.3% to 26.3%.

This move is not uniform in all regions. The integration of production processes is more intense between geographically close countries, or countries in a free trade area, than with the rest of the world. Vertical trade plays a particularly important role for the regional integration of Europe and East Asia. In these two regions, the share of intra regional trade is much higher in vertical trade than in value added trade. 65% of East Asian vertical exports are sent off to other East Asian countries, while only 30% of its value added exports are. Hence, East Asia still relies more heavily on extra-regional final markets for its production than North America and Europe. Regional trade imbalances in East Asia are actually much smaller when they are measured in terms of value-added.

Another striking aspect of our results is that manufactures are much less dominant in value-added trade than in standard trade. Apparently non-tradable inputs are often consumed in foreign markets after having been embedded in manufacture exports. This form of service exports is especially important for Europe and North America. Taking this into account shows that East Asia's revealed comparative advantage is only in industrial trade, whereas Europe's comparative advantage is both in industrial and service trade.

An obvious limitation of our work is that our latest data are only for 2001. Even if this is more recent that what was previously available, it is still too old to offer guidance on the most recent evolutions of world trade. 2001 was a very depressed year for world trade, and the role of China has since dramatically increased. We are waiting for the release of the version 7 of GTAP database to apply our method to 2004, making the analysis slightly more topical. More fundamentally, we hope both that our method will encourage the necessary data gathering to produce these data more quickly. We also hope that some of the qualitative results are still useful for anyone thinking about trade globalization: services are more important than they seem to be, regionalization can take different forms…

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