# RELATIVE EXPORT STRUCTURES AND VERTICAL SPECIALIZATION: A SIMPLE CROSS-COUNTRY INDEX*

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## 1. INTRODUCTION

Over the last decade, international trade has grown on average by more than 8.5 per cent per annum in nominal terms. This paper addresses two types of issues raised by this striking feature of the world economy. Firstly, the entrance of new countries in the world trade system inevitably implied changes in relative export structures, which are interesting to map. Secondly, although the classical determinants of international trade are well-established in the literature, substantial effort has been made to understand the importance of vertical specialization activities, defined as the use of imported inputs to produce goods that are afterwards exported either as final goods or as intermediate goods.

One strand of the empirical trade literature is based on the computation of indices that aim to capture revealed comparative advantages. The most common is the index suggested by Balassa (1965), which uses the world export share in a given sector to “normalize” the respective export share of each country, being particularly suited to perform static analysis. In this article we propose an alternative indicator – the $B^*$– with properties suitable to perform a dynamic analysis and with a highly intuitive nature: the share of exports of a given sector in total exports of each country relative to the world unweighted average share. This indicator has shown up as an intermediate calculation in some papers, but it has never been highlighted or interpreted as an alternative index in its own right. For each product category, the behaviour of $B^*$ bears information on how the overall degree of international trade specialization has evolved over time and identifies the countries that are relatively more specialized in that category. We also argue that, for a country, a simultaneous high $B^*$ for exports and imports provides indirect evidence of vertical specialization.

The results are derived from the CEPII-Chelem database, which contains information on total world trade flows from 1967 onwards. The overall world trade flows are split into data from individual countries, when available for the entire sample period, or from groups of countries, comprising a total of 79 entities. We use a product breakdown based on four sectors following the OECD classification of manufacturing industries according to technology intensity: high-technology, medium-high-technology, medium-low-technology and low-technology. This classification is based on the analysis of R&D expenditure and output of 12 OECD countries in the period 1991-99 (see OECD (2005)).

The article is organized as follows. In the next section we present the $B^*$ index and discuss its properties, namely when compared with the Balassa index. In section 3 we examine how the relative export structures of G5 countries and China have changed since the late 60s using the product breakdown previously mentioned. In the period 2000-04 these countries are more specialized than the world unweighted average in high-tech and medium-high-tech goods (the only exception being China in me-

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dium-high-tech) and show a non-specialization status in low-tech and medium-low-tech sectors. However, sharp differences between countries exist at a more detailed level. The performance of the Chinese economy in high-tech sectors is specially striking: having started with a lower than average share in total exports, it reaches an export proportion that is more than twice the world unweighted average in the last years. On the contrary, there was a significant reduction of Chinese export proportion of low-tech goods when compared with the world unweighted average. In section 4, the computation of the $B^*$ index for both exports and imports and the imposition of a restrictive selection criteria allows us to identify the countries in which vertical specialization seems to be relevant. Conditional on this criteria, vertical specialization activities at an aggregate level were found in high-tech industries and, to a lesser extent, in some medium-high-tech (motor vehicles and electrical machinery) and low-tech sectors (textiles, clothing and footwear). These activities appear to have intensified in the last decade. In geographical terms, significant vertical specialization activities are predominantly identified in East Asia, but also in some countries of Europe and North Africa. Section 5 presents some concluding remarks.

## 2. MEASURING INTERNATIONAL TRADE SPECIALIZATION

### 2.1. The Balassa index

Assume that the world economy comprises $N$ countries and $m$ sectors. Country $i$ exports of sector $j$ are $x_{ij}$ and total exports of country $i$ are given by $X_i = \sum_{j=1}^{m} x_{ij}$. World exports of sector $j$ amount to $x_{Wj} = \sum_{i=1}^{N} x_{ij}$, while total world exports can be seen either as the sum of all sectors or as the sum of all countries, i.e. $X_W = \sum_{j=1}^{m} x_{Wj} = \sum_{i=1}^{N} X_i$.[1] Using relative export structures, the Balassa index can be written as:

$$B_{ij} = \frac{\frac{x_{ij}}{X_i}}{\frac{x_{Wj}}{X_W}} \text{ for all country } i = 1,2\ldots,N; \text{ and product } j = 1,2,\ldots,m$$

If the share of sector $j$ in total exports of country $i$ is higher than the equivalent share of sector $j$ in world exports, i.e. $\left(\frac{x_{ij}}{X_i}\right) > \left(\frac{x_{Wj}}{X_W}\right)$, then $B_{ij} > 1$ and country $i$ is classified as having a revealed comparative advantage in sector $j$. The simplicity and highly intuitive nature of the Balassa index explains its wide utilization. The author is simply using $\frac{x_{Wj}}{X_W}$ to "normalize" $\frac{x_{ij}}{X_i}$ and proposing a threshold level of 1. Besides this dichotomous feature, dividing countries between those that have and those that do not have a revealed comparative advantage, the Balassa index has also been used as a cardinal and ordinal measure, allowing comparisons between countries in a given sector or across sectors in a given country.[2] The index has a lower bound of $B_{ij} = 0$ in the extreme case where country $i$ does not export product $j$ $(x_{ij} = 0)$. In the other extreme situation where country $i$ is the only exporter in sector $j$ (international

(1) The definition of the "world" can also be interpreted as any well defined reference area and the number of products as any relevant basket. Balassa (1965) did not use the world as a whole, but an aggregate comprising 6 areas (European Common Market, USA, Canada, UK, Sweden and Japan). Primary products were also excluded from his analysis to ensure that trade patterns reflected comparative advantages and not the impact of subsidies, quotas and other special arrangements.

(2) The comparisons between countries in Balassa (1977) are only based on the rankings of the sectors. The author does not report levels and simply investigates the ranks of the different $j$ products for each country. Averages across selected groups of industries are also calculated. See also Ballance, Forstner and Murray (1987) and De Benedictis and Tamberi (2001, 2004).

monopoly), such that $\left(\frac{x_{ij}}{x_{Wj}}\right)=1$, the nature of the Balassa index implies that $B_{ij}=\frac{X_W}{X_i}$, thus dependent on the relative dimension of country *i*. Given that $X_i$ and $X_W$ are, in general, time varying, the upper bound does not only change across countries, but also through time.

### 2.2. A new international product specialization index – the *B* *

The international product specialization index suggested here simply uses a different "normalization", i.e. a different denominator. To evaluate the relative export specialization of country *i* in sector *j*, we suggest the use of

$$B_{ij}^{*}=\frac{\frac{x_{ij}}{X_i}}{\left(\overline{\mu_i}\right)_j}\text{ for all country } i=1,2,\ldots,N\text{; and product } j=1,2,\ldots,m$$

Where $\left(\overline{\mu_i}\right)_j\equiv\overline{\left(\frac{x_{ij}}{X_i}\right)}_j=\frac{1}{N}\sum_{i=1}^{N}\left(\frac{x_{ij}}{X_i}\right)_j$ is the average export share of sector *j* across the different *i* countries. Each country $i=1,2\ldots N$ has a particular share on sector *j* exports, $\frac{x_{ij}}{X_i}$, and $\left(\overline{\mu_i}\right)_j$ is the *un-weighted* average of this export share in all countries. As in Balassa index, if country *i* does not export product $j\left(x_{ij}=0\right)$, then $B_{ij}^{*}=0$. The suggested threshold for the new index is also 1. If the share of sector *j* in total exports of country *i* is higher than the average share of sector *j* in the *N* economies of the world, i.e. $\left(\frac{x_{ij}}{X_i}\right)>\left(\overline{\mu_i}\right)_j$, then $B_{ij}^{*}>1$ and this country is classified as being relatively more specialized in sector *j*. In the extreme situation where country *i* is an international monopolist in sector *j*, $B_{ij}^{*}$ is simply equal to *N*. This upper bound is not dependent on the relative dimension of country *i* and is not variable across time. In every period, the sum of all indices across countries within each sector *j* yields, by construction, the upper bound.[3] Thus, the value of each $B_{ij}^{*}$ can be interpreted as the contribution of each country *i*, in sector *j*, to *N*. The level of $B_{ij}^{*}$ is therefore clearly dependent on the number of countries or regions under consideration, requiring a wider set of information than the Balassa index.

This international sector specialization index also has the appealing feature that its mean within each sector (cross-country analysis) is always equal to 1, i.e. $\frac{1}{N}\sum_{i=1}^{N}B_{ij}^{*}=1$. If a given country *i* is relatively specialized in sector $j\left(B_{ij}^{*}>1\right)$, there must exist another country in the world that is not relatively specialized in the same sector $\left(B_{j,c\neq i}^{*}<1\right)$. Within a time dimension approach, if the level of $B_{ij}^{*}$ increases, this will have a unique interpretation: country *i* has become relatively more specialized in sector *j* than the average of the other countries and this outcome had to be achieved at the expense of lower specialization in some other country.

### 2.3. The Balassa index and the *B* *

The Balassa index has been subject to several critiques, leading some authors to propose several modified versions. For instance, Laursen (1998) suggests a transformation that produces a symmetric outcome, ranging from -1 to 1 and with a threshold of 0; Proudman and Redding (1997, 2000) suggest

(3) Note that if country *i* has an international monopoly in sector *j*, then its $B_{ij}^{*}=N$, while the indices of the remaining countries will be nil in this sector.

a transformation that results in a constant mean across the different sectors for a given country. Nevertheless, the popularity of the original index remains in place and the traditional Balassa index has been used extensively in the literature.[4]

As in the Proudman and Redding (1997, 2000) contribution, the product specialization index suggested here has a clear and well-defined link with the original Balassa index. After some algebra, it can be shown that:

$$B_{ij}^{*} = \frac{B_{ij}}{\left(\overline{B_i}\right)_j}$$

where $\left(\overline{B_i}\right)_j = \frac{1}{N}\sum_{i=1}^{N} B_{ij}$ is simply the cross-country unweighted average of $B_{ij}$. Thus, the original Balassa index of country *i* in sector *j* is just being "re-normalized" by the average index of sector *j* across countries. Therefore, if the outcome for a group of countries is clustered around similar levels, be it in the case of $B_{ij}^{*}$ or in the case of $B_{ij}$, such result only implies that the share of sector *j* in total exports is similar in these countries. Note also that if the objective is just to rank the countries across a given sector, there is no need to implement any "normalization". The share of sector *j* in total exports has sufficient information to provide an ordinal rank of the countries.[5] As in the case of the traditional $B_{ij}$ index, the value of the $B_{ij}^{*}$ will not be invariant with respect to the choice of sectoral aggregation, the geographical benchmark considered and the time length chosen. Nevertheless, there are also some important differences that should be highlighted.

One non-negligible difference between the two indices is that the country position relative to the threshold level may change in the two indicators. While the Balassa index "normalizes" $\frac{x_{ij}}{X_i}$ by $\frac{x_{Wj}}{X_W}$, which is a "weighted average" across countries, the $B_{ij}^{*}$ "normalizes" $\frac{x_{ij}}{X_i}$ by an "unweighted average", in which all countries have the same weight.

More precisely,

$$\frac{\frac{x_{ij}}{X_i}}{\sum_{i=1}^{N} \alpha_i \frac{x_{ij}}{X_i}} = \begin{cases} B_{ij}^{*} & \text{if } \alpha_i = \frac{1}{N} \quad \text{for each country } i, \\ B_{ij} & \text{if } \alpha_i = \frac{X_i}{X_W} \quad \text{for each country } i. \end{cases}$$

Another relevant difference between the two indices is that they not bear the same cardinal properties. In particular, the levels of the Balassa indices may not be easily comparable through time. Whereas the mean of the Balassa index may be changing in time, the mean of the $B_{ij}^{*}$ across countries in a given sector is always constant and equal to 1. The existence of this constant average and a fixed upper bound are relevant characteristics of the $B_{ij}^{*}$, as they facilitate direct comparisons of the magnitude of the different individual indices (cardinal measure).

The different characteristics of the two indices may be further clarified by a simple example. Assume that the world is made up of 2 countries (A and B) and 2 sectors (1 and 2). Country A exports $x_{A1}$ and $x_{A2}$, country B exports $x_{B1}$ and $x_{B2}$. At time $t = 0$, assume furthermore that both countries export a nom-

**(4)** See Hinloopen and Marrewick (2001) for a list of references, Widgrén (2005) for a recent application to selected Asian, American and European countries and Shafaeddin (2004) for a study on Chinese exports and imports. Richardson and Zhang (1999) map the US revealed comparative advantage by trading partner and Hinloopen and Marrewick (2004) analyse the dynamics of Chinese comparative advantage. De Benedictis and Tamberi (2001), who discuss in detail the characteristics of both the original $B_{ij}$ index and the above-mentioned alternative versions, end up using the original mean-variant formulation of the index. Vollrath (1991), who surveys alternative revealed comparative advantage measures, states that, among the measures using only exports, the traditional Balassa index is one of "the most satisfying".

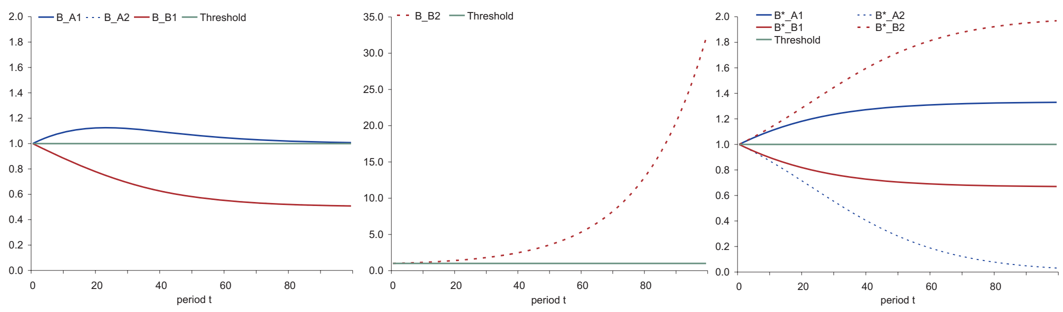
**(5)** For further details, see Amador, Cabral and Maria (2007).

inal value of 100 euros of each sector. At $t = 0$, therefore, $B_{ij} = B^*_{ij} = 1$, where $j = 1,2$ and $i = A,B$. Finally, assume that $x_{A1}$ grows 5% per period and that all other exports remain unchanged at 100 euros. In this case, world exports of sector 1 $\left(\text{i.e. } x_{w1} = x_{A1} + x_{B1}\right)$ are accelerating over time, reaching an export growth that is becoming closer to 5%, as $x_{A1}/x_{W1}$ tends to 1. On the contrary, world exports of sector 2 remain unchanged at 200 euros $\left(\text{i.e. } x_{w2} = x_{A2} + x_{B2} = 200\right)$. Chart 1 reports the outcome for both indices between $t = 0$ and $t = 100$. In terms of the Balassa indices – see Charts 1(a) and 1(b) – the first conclusion is that the levels, as already mentioned, are not easily comparable. Second, the relative nature of the index implies that its level increases in the case of country A in sector 1 (the only sector where exports are growing) will only be temporary (see the evolution of $B_{A1}$ in Chart 1(a)). Third, country B in sector 2 will not only exhibit sharper increases, but also an explosive trajectory (Chart 1(b)). Finally, $B_{A2}$ and $B_{B1}$ show an identical downward movement. Given the explosive trajectory of the $B_{B2}$, the sum (and the average) of all $B_{ij}$ also follows an explosive trajectory. As for the $B^*_{ij}$, on the contrary, the "normalization" used implies that the results are not only comparable, but symmetric and bounded across countries (Chart 1(c)). There are no explosive movements and the index reaches a permanent higher level in the case of country A in sector 1. Country B in sector 2 will also exhibit the highest increase, but this will be obtained at the expense of country A in sector 2. This symmetry also applies to sector 1. Finally, at each point in time, the sum of the $B^*_{ij}$ by sector remains unchanged at $N = 2$ (and the average at 1).

As previously mentioned, this new indicator – the $B^*$ – has shown up in intermediate steps in previous papers, but it has never been highlighted or interpreted as an alternative index in its own right. For instance, to flag industries that have major differences in the cross-country distributions of revealed comparative advantage, Yeats (1985) calculates an inequality index that coincides with the variance of the $B^*$. More recently, Hausmann, Hwang and Rodrik (2005) calculate a weighted average of per-capita GDPs, where the weights correspond to the revealed comparative advantage of each country in a given sector. It turns out that these weights are fully equivalent to a further transformation of the $B^*_{ij}$. In particular, the weights for the per-capita GDP of each country *i* within each sector *j* are simply given by $\beta_i = \frac{B^*_{ij}}{N}$, where $\sum_{i=1}^{N} \beta_i = 1$.[6]

### Chart 1

**THE BEHAVIOUR OF $B_{ij}$ IN COMPARISON WITH $B^*_{ij}$ BETWEEN t = 0 AND t = 100**




(a) Balassa indices (b) Balassa index $B_{B2}$ (c) $B^*$ indices

(6) Hausmann *et al.* (2005) called this quantitative index *PRODY$_j$*. It represents the income level associated with that product. Their rationale for using such weights was to ensure that country size did not distort the ranking of goods. Furthermore, the final objective is not to calculate these indices for each good, but to construct an index measuring the income/productivity level that corresponds to a country's export basket (which they call *EXPY$_i$*). This is done by calculating the export-weighted average of all *PRODY$_j$* for that country, where the weights are simply the shares of each product in the country's total exports. See Di Maio and Tamagni (2006) for a recent application of these indices to the Italian economy.

## 3. EXPORT SPECIALIZATION IN THE G5 AND CHINA

The technological content of exports from G5 countries and China will now be examined. The results are derived from the CEPII-Chelem database, which contains information on total world trade flows from 1967 onwards. The overall world trade flows are split into 79 entities, comprising individual countries when its data is available for the entire sample period. Otherwise, countries are grouped into different entities.[7]

Table 1 reports the relative export specialization of these six countries for the 2000-04 period, not only for the main technological categories, but also considering a second breakdown level that includes twenty more detailed sub-sectors. All $B^*$ indices higher than 2 are highlighted in the table. In the period 2000-04 the six countries selected are more specialized than the world unweighted average in high-tech and medium-high-tech goods (the only exception being China in medium-high-tech) and show below 1 specialization coefficients in low-tech and medium-low-tech sectors in this period. However, sharp differences between countries exist at a more detailed level.

The UK, US, Japan and China all have higher export shares of the high-tech category than the two biggest euro area countries. In particular, France and Germany have lower shares in “Office, accounting and computing machinery” and in “Radio, TV and communications equipment”. On the contrary, the large proportion of the high-tech category in Chinese exports results mainly from these two sectors, in particular “Office, accounting and computing machinery”, as Chinese exports of products like “Aircraft

### Table 1

RELATIVE PRODUCT SPECIALIZATION OF G5 COUNTRIES AND CHINA

***B**** Indices (based on average export values in the 2000-04 period)

| | US | France | Germany | UK | Japan | China |
|---|---|---|---|---|---|---|
| **High Technology Products** | **2.4** | **1.6** | **1.3** | **2.4** | **2.0** | **2.2** |
| Aircraft and spacecraft | 8.2 | 6.6 | 1.8 | 6.6 | 0.5 | 0.2 |
| Pharmaceuticals | 1.6 | 2.5 | 1.8 | 3.0 | 0.5 | 0.4 |
| Office, accounting and computing machinery | 1.7 | 0.8 | 1.0 | 2.4 | 2.0 | 4.2 |
| Radio, TV and communications equipment | 1.6 | 0.9 | 0.8 | 1.4 | 2.5 | 2.2 |
| Medical, precision and optical instruments | 3.8 | 1.7 | 2.4 | 2.5 | 3.4 | 1.5 |
| **Medium-high Technology Products** | **1.9** | **2.0** | **2.5** | **1.7** | **2.5** | **1.0** |
| Other electrical machinery and apparatus | 1.5 | 1.5 | 1.7 | 1.4 | 2.0 | 2.1 |
| Motor vehicles, trailers and semi-trailers | 2.0 | 3.0 | 3.9 | 2.0 | 4.1 | 0.3 |
| Chemicals excl. pharmaceuticals | 1.5 | 1.5 | 1.4 | 1.4 | 1.2 | 0.6 |
| Railroad equipment and other transport equip. | 1.5 | 1.5 | 1.8 | 0.7 | 5.5 | 3.4 |
| Other machinery and equipment | 2.5 | 1.9 | 3.1 | 2.1 | 2.9 | 1.4 |
| **Medium-low Technology Products** | **0.5** | **0.6** | **0.6** | **0.6** | **0.5** | **0.5** |
| Coke, refined petroleum prod. and nuclear fuel | 0.2 | 0.2 | 0.2 | 0.4 | 0.0 | 0.1 |
| Rubber and plastics products | 1.3 | 1.4 | 1.5 | 1.1 | 1.1 | 1.2 |
| Other non-metallic mineral products | 0.7 | 1.2 | 1.1 | 0.8 | 0.8 | 1.3 |
| Building and repairing of ships and boats | 0.1 | 0.4 | 0.2 | 0.2 | 1.3 | 0.4 |
| Basic metals | 0.4 | 0.6 | 0.6 | 0.5 | 0.6 | 0.3 |
| Fabricated metal products, excl. machinery | 1.2 | 1.3 | 1.9 | 1.3 | 0.9 | 2.0 |
| **Low Technology Products** | **0.4** | **0.5** | **0.3** | **0.4** | **0.1** | **0.9** |
| Other manufacturing and recycling | 0.7 | 0.6 | 0.6 | 0.7 | 0.5 | 2.3 |
| Wood, pulp, paper and printed products | 0.8 | 0.6 | 0.7 | 0.6 | 0.1 | 0.3 |
| Food products, beverages and tobacco | 0.4 | 0.7 | 0.3 | 0.4 | 0.0 | 0.2 |
| Textiles, textile products, leather and footwear | 0.2 | 0.3 | 0.2 | 0.2 | 0.1 | 1.3 |

**Sources:** CEPII-Chelem database and own calculations.

(7) The $B^*$ indexes for the 79 countries (or groups of countries) for each of the four main technological categories, sorted by the 2000-04 values of $B^*$, are shown in the appendix.

and spacecraft" and "Pharmaceuticals" are well below average. Besides China, the UK also has a high export share in "Office, accounting and computing machinery", while in "Radio, TV and communications equipment" the highest specialization coefficient is Japan's. The US has the highest specialization coefficient in "Aircraft and spacecraft" products, followed by the UK and France. These two countries have also a relatively higher proportion of "Pharmaceuticals" in total exports. The share of "Medical, precision and optical instruments" in total exports is especially relevant in the US, Japan, and, to a lesser extent, in the UK and Germany. Within the euro area, French exports have a higher overall share of high-tech goods than German exports, mainly due to "Aircraft and spacecraft" products.

As regards the main category of medium-high-tech, the highest export share is in Japan and Germany and the lowest in China. Japan, Germany and France have especially high export shares in "Motor vehicles, trailers and semi-trailers". The share of "Railroad equipment and other transport equipment", which includes bicycles and motorcycles, is well above world average in Japanese and Chinese exports. Exports of "Other machinery and equipment" are especially relevant in Germany, Japan and the US.

In terms of medium-low-tech industries, the relative importance of this broad category is very similar in all six countries analysed, and below world unweighted average. Nevertheless, some differences emerge at the second breakdown level. The six countries have above average exports shares in "Rubber and plastics products", slightly higher in France and Germany than in the other four countries. Exports of "Fabricated metal products, excluding machinery" are also important for these six countries, especially in Germany and China where the shares are around twice the world average. Japan is the only of these countries that is relatively specialized in "Building and repairing of ships and boats".

Finally, in the low-tech category, Japan has the lowest export proportion of these countries and China the highest, although both are below world unweighted average. However, while Japanese exports have the lowest specialization coefficient in all low-tech sub-sectors, China is the only country where a specialization status emerges, not in the broad category, but in "Textiles, textile products, leather and footwear" and in "Other manufacturing and recycling", which include goods like furniture, games and toys.

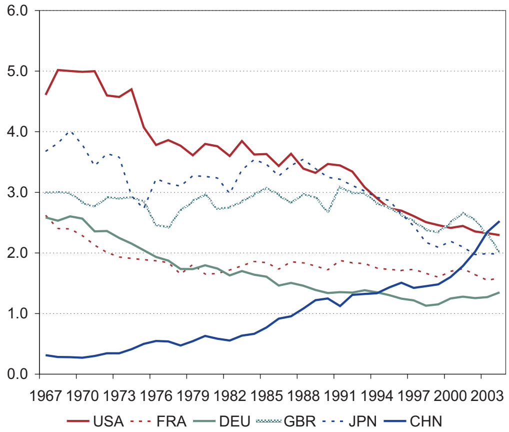
Chart 2 illustrates the relative export specialization of G5 countries and China by displaying the $B^*$ of each broad technological category over the period 1967-2004. The performance of the Chinese economy in high-tech sectors is specially striking: having started with a lower than average share in total exports, it shows the highest specialization coefficient of the six countries selected in the last years of our sample. This result is in line with the fact that China has an export basket that is significantly more sophisticated than what would be normally expected for a country at its income level and also that it has experienced a high rate of growth in the sophistication of its exports.[8] This pattern may be related with vertical specialization activities, based on inputs imported from other Asian countries.[9] Declining trends of $B^*$ in the high-tech category are visible in the USA (since the 70s), in Japan and in the UK since the early 90s, bringing the high-tech export share of these countries closer to, although still around twice, the world unweighted average. Following a decrease in the initial years of the sample, France and Germany have maintained their relative specialization in high-tech exports fairly stable in the last 20 years, but always below the other three developed countries considered.

**(8)** Rodrik (2006) uses the indicator constructed in Hausmann *et al.* (2005). The author provides evidence suggesting that the rapid increase in the overall sophistication of Chinese exports has been an important contributor to China's recent growth and emphasizes the role of production- and technology-oriented policies of the Chinese government.

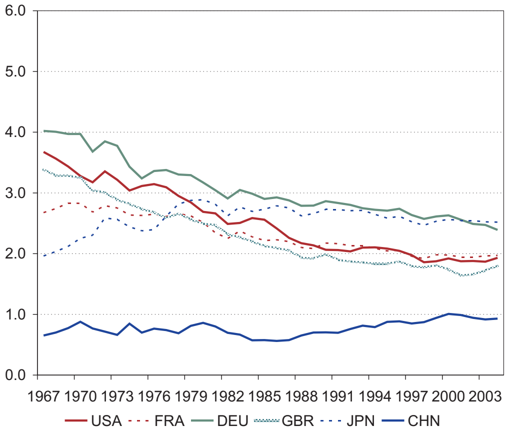
**(9)** Such products are mostly assembled in China with as yet little "Made in China" technology. Gaulier, Lemoine and Ünal-Kesenci (2005) conclude that China is used as an export base by some advanced Asian economies, which transfer to China the final production and assembly stages of some high-tech and medium-high-tech goods. The final products are then exported directly to the EU and the US markets.

### Chart 2

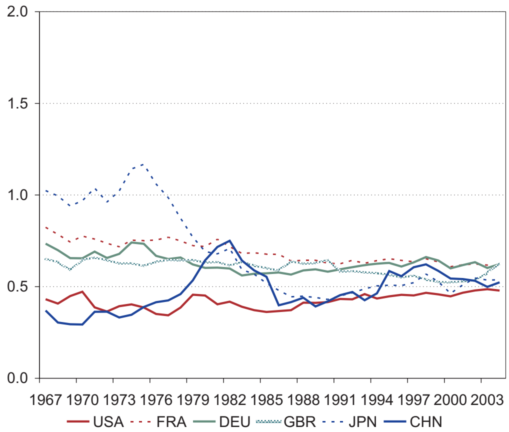
**THE $B^{*}_{ij}$ IN G5 COUNTRIES AND CHINA**



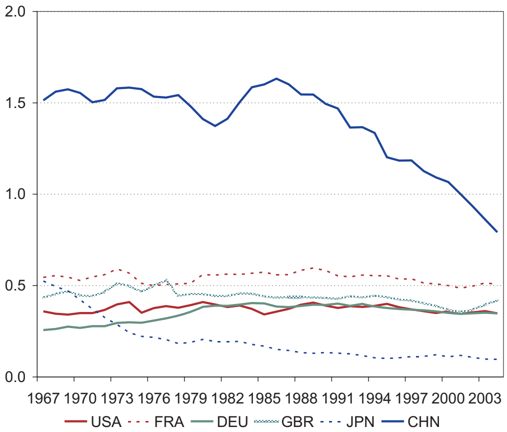

(a) High technology industries




(b) Medium-high technology industries




(c) Medium-low technology industries




(d) Low technology industries

**Sources:** CEPII-Chelem database and own calculations.

In the medium-high-tech category, there has been a gradual decline of the high specialization of Germany, the US, the UK and France since the beginning of the sample. In Japan, this reduction is less sharp and occurs after a clear increase until the end of the 70s. The share of medium-high-tech products in total Chinese exports has been increasing slowly since the 80s, but it is always much lower than in the other countries analysed.

The relative (non-)specialization of these six countries in medium-low-tech exports displays a very stable pattern in the last 20 years, more clustered around similar levels than in the other product categories.

Lastly, the most distinctive result in the low-tech category is the strong decrease in the specialization of Chinese exports relatively to the world unweighted average. After more than two decades of high specialization, a significant reduction was recorded from the mid 80s onwards. At present, China still shows a percentage of total exports in this category higher than in the other countries considered, but already below the world unweighted average. All other countries have always had a proportion of low-tech sectors in total exports clearly below the world average, with Japan showing the lowest value since the mid-70s.

## 4. SOME EVIDENCE ON VERTICAL SPECIALIZATION

One of the major factors underlying the high growth rate of international trade is the division of the production chain, with the different stages of production being performed in different countries.[10] An investigation on the importance of the vertical specialization phenomena across all countries of the world since the late sixties would typically require a substantial amount of information. In this section we compute the $B^*$ for both exports and imports to provide some evidence of relevant episodes of vertical specialization across countries since 1967.

The estimated kernel densities of $B^*_M$ for the four broad technological categories (Chart 3) reveal a degree of symmetry that is clearly in sharp contrast with the kernel densities[11] for $B^*_X$ (Chart 4), where specialization leads to strong asymmetries between countries. Therefore, assuming a priori that relative consumption preferences are not very different across countries, there is apparently no other major reason for one country to simultaneously export and import much more than the world average, other than the existence of important vertical specialization activities. In short, if $B^*_{ijX}$ and $B^*_{ijM}$ are both very high in sector *j*, we claim that the (traditional) intra-industry trade in sector *j* cannot be the sole explanation for such outcome and that international vertical linkages must play a very important role.

Several important caveats are posed to this strategy of identification. Firstly, it is necessary to establish a threshold for $B^*_{ijX}$ and $B^*_{ijM}$ to give us some confidence in terms of tracing situations of vertical specialization (and not simply ordinary intra-industry trade). Secondly, caution must be put on possible abnormal values of the indices and exclude situations where the phenomenon has only become important in a particular period. Thirdly, it is possible that some vertical specialization exists at a detailed product disaggregation, though not showing up at the more aggregate level. This is the case if the detailed product is not sufficiently relevant to affect the broad aggregate. Therefore, we are not identifying a necessary condition for the phenomenon to exist but only situations where the phenomenon is sufficiently important so as to emerge in this simple indicator. Finally, if country *i* is a major trade warehouse, imports are, to a large extent, simply associated with subsequent export activities. Such activities will show up in the $B^*_{ijX}$ and $B^*_{ijM}$, but should not be considered as vertical specialization.

For all countries in the database and for the two product breakdown levels, the threshold set for $B^*_{ijX}$ and $B^*_{ijM}$ was 2. Therefore, for each *j* category, we start by restricting the analysis to countries where the structure of exports and imports is at least twice the average of world countries in any of the selected five-year periods.[12] We excluded countries where large volatility is identified in the indicators due to specific observations (affecting the five-year average), which are typically associated with episodical operations that are very large relative to the size of the economy but have no structural interpretation. Residual categories of manufactured goods are also excluded from the analysis, given their typically irregular behaviour.

Conditional on the definition of the four broad categories, the analysis of the $B^*_{ijM}$ and $B^*_{ijX}$ indicates, in general, that: (i) the incidence of vertical specialization varies considerably among the different cate-

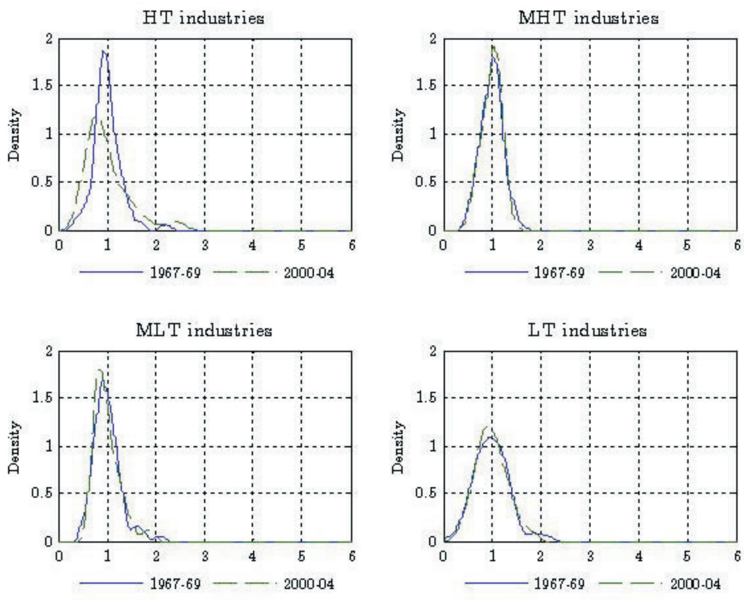
**(10)** This phenomenon has been labelled quite extensively in the literature: "slicing up the value chain", "outsourcing", "disintegration of production", "fragmentation", "multi-stage production", "intra-product specialization", "production relocation", "segmentation of production", etc. See Hummels, Ishii and Yi (2001) for a discussion.

**(11)** The Kernel density estimation is a method for adjusting probability density functions from the available observations. For further details, see Amador, Cabral and Maria (2007).

**(12)** These periods were 1967-69, 1970-74, 1975-79, 1980-84, 1985-89, 1990-94, 1995-99 and 2000-04.

## Chart 3

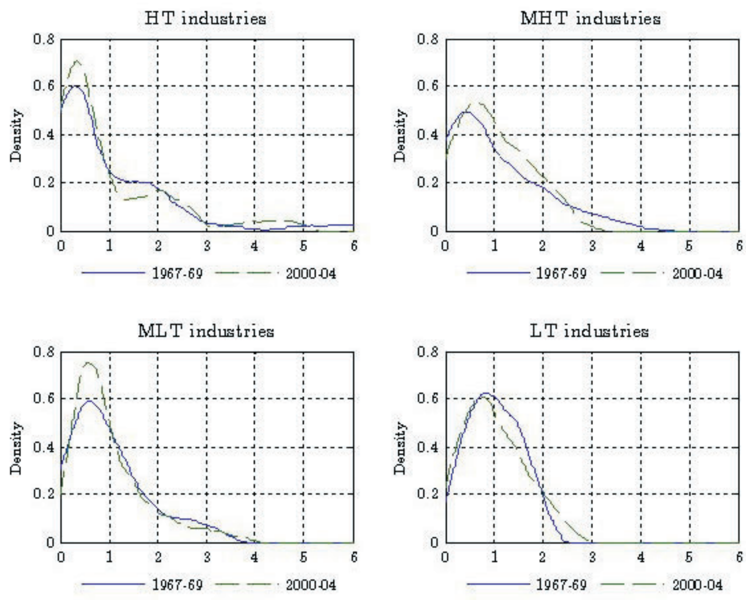
**ESTIMATED KERNEL DENSITIES – $B_M^*$**




**Sources:** CEPII-Chelem database and own calculations.

## Chart 4

**ESTIMATED KERNEL DENSITIES – $B_X^*$**




**Sources:** CEPII-Chelem database and own calculations.

gories; (ii) there is a marked regional pattern; and (iii) the phenomenon has intensified substantially over the last decade.

Table 2 lists the $B^*_M$ indices of the top 5 countries in each broad technological category in the period 2000-04 and the corresponding $B^*_X$ indices. It reveals that vertical specialization seems to be predominant in the high-tech category. The countries where these vertical specialization activities are more relevant are Malaysia, Philippines, Singapore, Ireland and Taiwan. The medium-high-tech sector has some countries with high values for $B^*_{ijX}$ but with levels below the threshold value of 2 for $B^*_{ijM}$. This is even more marked in the medium-low-tech category. In fact, this category is dominated by manufacturing products with low transformation like oil products, rubber, other non-metallic minerals, basic metals, probably not suited to vertical specialization activities but very important in the export structure of some countries. Regarding low-tech industries, although the threshold of 2 for both the import and export sides is not reached in any country, there are some countries that exhibit relatively high figures, for instance in Bangladesh and Cambodia, which are commented bellow.

Using the simple indicator proposed in this article, the empirical evidence of vertical specialization in the high-tech category can be further explored by looking at the behaviour of both the $B^*_{ijX}$ and the $B^*_{ijM}$ over time (in the selected countries) and by investigating the products included in the second breakdown level of that category.

Vertical specialization activities are relevant in the high-tech category and have been developing since the beginning of the seventies (Chart 5(a) and 5(b)). With the exception of Taiwan, we find evidence of increased vertical specialization throughout the sample period, with some evidence of stabilization in the last decade. It is notable that Ireland is the only non-Asia country identified in this category. In Taiwan, there has been a decrease since the late sixties, partly resulting from the emergence of other players.[13]

At the second breakdown level of the high-tech category, important vertical specialization activities were found in all five sub-sectors, but particularly relevant in "Radio, TV and communications equip-

**Table 2**

TOP 5 RANKING OF $B^*_M$
(2000-04 average)

| **High Technology** | $B^*_M$ | $B^*_X$ | **Medium-High Technology** | $B^*_M$ | $B^*_X$ |
|---|---|---|---|---|---|
| Malaysia | 2.5 | 4.2 | Argentina | 1.5 | 1.1 |
| Philippines | 2.4 | 4.9 | Canada | 1.4 | 2.1 |
| Singapore | 2.4 | 4.3 | Venezuela | 1.3 | 0.8 |
| Ireland | 2.0 | 3.9 | Colombia | 1.3 | 1.1 |
| Taiwan | 1.9 | 3.0 | South African Union | 1.3 | 1.5 |

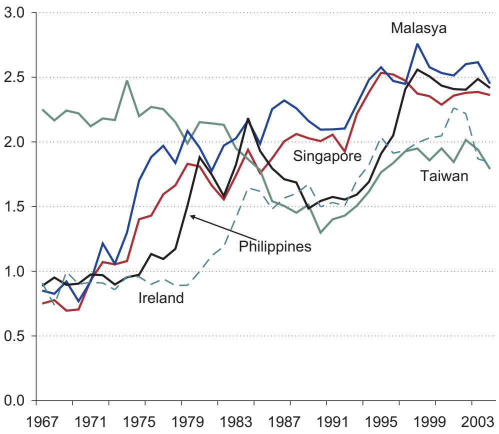
| **Medium-Low Technology** | $B^*_M$ | $B^*_X$ | **Low Technology** | $B^*_M$ | $B^*_X$ |
|---|---|---|---|---|---|
| Others in South Europe | 2.0 | 0.5 | Sri Lanka | 1.8 | 2.1 |
| Others in America | 1.9 | 1.4 | Bangladesh | 1.8 | 2.5 |
| African LDCs | 1.7 | 1.9 | Albania | 1.7 | 2.1 |
| Others in East Asia | 1.6 | 0.9 | Cambodia, Laos PDR | 1.7 | 2.5 |
| Cambodia, Lao PDR | 1.5 | 0.1 | Tunisia | 1.6 | 1.6 |

**Sources:** CEPII-Chelem database and own calculations.
**Note:** For details on the composition of the geographical zones, see Appendix C of Amador, Cabral and Maria (2007).

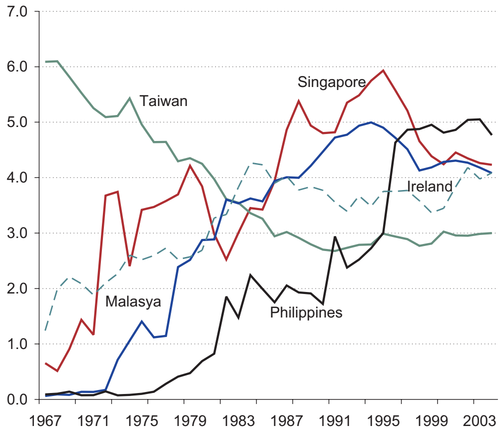
(13) Recall that, given the characteristics of the indicator, there is a mechanical decrease in one country when others emerge as exporters of the good.

## Chart 5

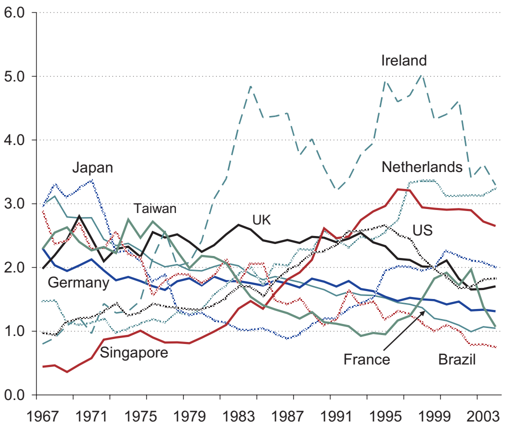
VERTICAL SPECIALIZATION IN HIGH TECHNOLOGY SECTORS



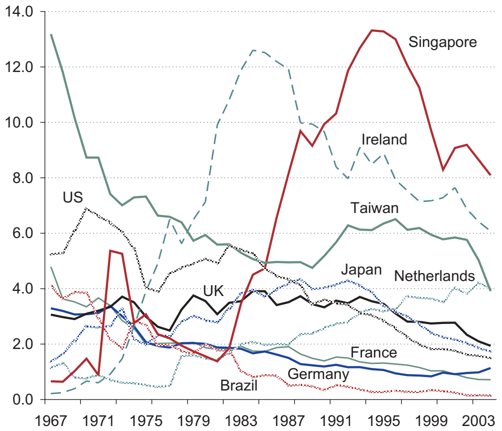

(a) High technology industries – $B^*_M$



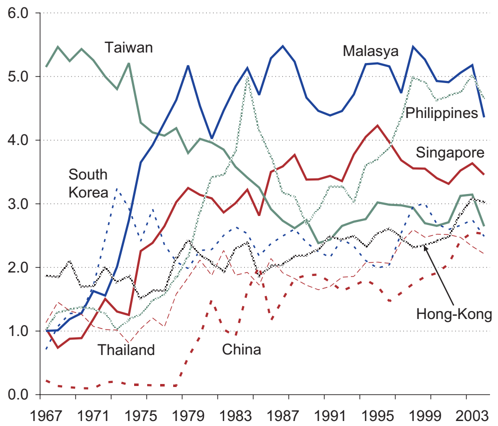

(b) High technology industries – $B^*_X$



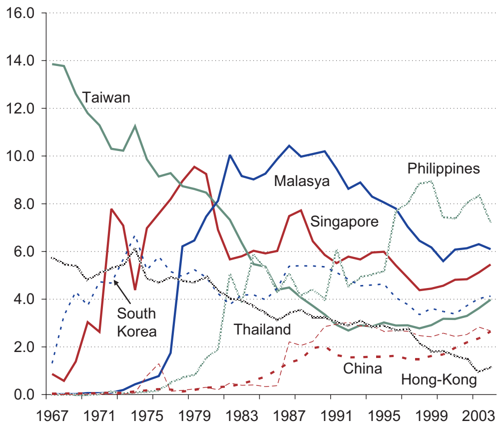

(c) Office, accounting and computing machinery – $B^*_M$




(d) Office, accounting and computing machinery – $B^*_X$




(e) Radio, TV and communications equipment – $B^*_M$

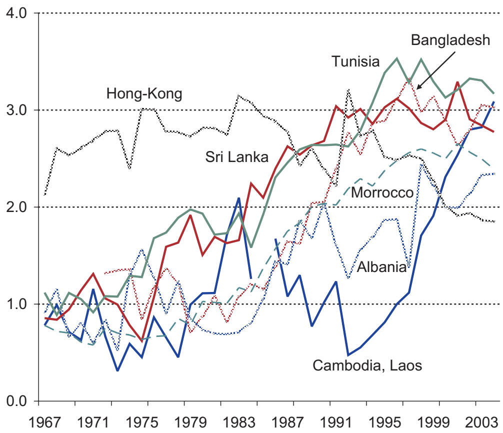



(f) Radio, TV and communications equipment – $B^*_X$

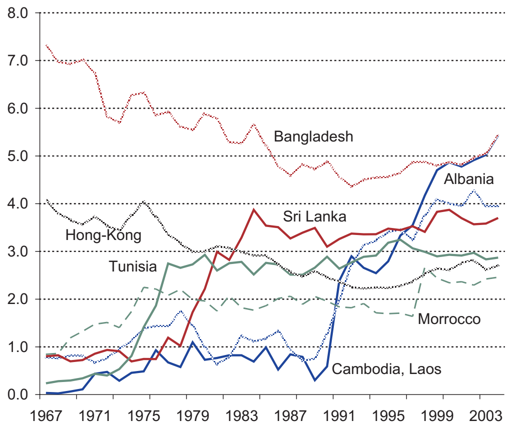
**Sources:** CEPII-Chelem database and own calculations.

## Chart 6

VERTICAL SPECIALIZATION IN TEXTILES, TEXTILE PRODUCTS, LEATHER AND FOOTWEAR




(a) $B^*_M$ index




(b) $B^*_X$ index

**Sources:** CEPII-Chelem database and own calculations.

ment" and in "Office, accounting and computing machinery". The latter is especially relevant for some Asian and European countries (Chart 5(c) and 5(d)). Taiwan is a traditionally important player in this sector but the importance of vertical specialization seems to be reducing compared with other countries. On the other hand, Singapore appears to have relevant vertical specialization activities since mid-eighties, with a small decline after the mid-nineties. Ireland recorded sharp increases until the mid-eighties but some decline in vertical specialization occurred afterwards, though maintaining high levels. The Netherlands shows a steady increase in the $B^*_M$ and $B^*_X$ indices during this period. Nevertheless, this country is a major European trade warehouse, so part of these transactions may not reflect vertical specialization activities. The other industrialized countries identified - US, France, Germany, UK and Japan - show stable or slightly decreasing vertical specialization activities in this category.

As for "Radio, TV and communications equipment" (Chart 5(e) and 5(f)), all countries selected are located in East Asia. Taiwan shows again a decreasing path in the relevance of vertical specialization activities, Malaysia holds an important position, though stabilizing after the mid-eighties, and a sizeable increase is observable in the Philippines and, to a lesser extent, in China.

Products included in the medium-high-tech category, like most machinery items, are typically characterized by a high degree of heterogeneity. This fact might explain why vertical specialization activities are not identified with this indicator at the aggregate level. However, the application of the chosen threshold of 2 for both $B^*_M$ and $B^*_X$ to the sub-sectors of the medium-high-tech category allows us also to detect some well known vertical specialization phenomena, like the "Motor vehicles, trailers and semi-trailers" sector in Canada and US and the effects of *maquiladoras* (labour-intensive assembly operations) on "Other electrical machinery and apparatus" in Mexico.[14]

Within low-tech categories, there is only significant evidence of vertical specialization activities in the "Textiles, textile products, leather and footwear" sector (Chart 6(a) and 6(b)). The countries where it is more important are Bangladesh together with Cambodia and Laos, the latter showing a sharp increase

**(14)** See Jones, Kierzkowski and Leonard (2002).

since the beginning of the nineties. It is interesting to note that vertical specialization in this sector appears to be also relatively important in North Africa, with countries like Morocco and Tunisia displaying upward trends.

## 5. CONCLUSIONS

In this article we introduced a simple cross-country index of international specialization – the $B^*$ –, which is suitable to characterize the relative world export structure and to identify the major changes observed since the late sixties.

The $B^*$ has a highly intuitive nature: it is simply the share of exports of a given sector in total exports of each country, normalized by the world unweighted average share. Given the characteristics of the $B^*$, the analysis was based on the comparison of different countries within a given sector, i.e. a cross-country analysis, whereas the more traditional approach on revealed comparative advantages and international product specialization focuses on the evolution of the export structure of a given country or group of countries, i.e. a cross-sector analysis.

In the 2000-04 period G5 countries and China are more specialized than the world unweighted average in high-tech and medium-high-tech goods (the only exception being China in medium-high-tech) and show a non-specialization status in low-tech and medium-low-tech sectors. The time-series analysis of the $B^*$ reveals that the performance of the Chinese economy in high-tech products is specially striking: having started with a lower than average share in total exports, it has reached an export proportion that is more than twice the world unweighted average in the last years. On the contrary, in the low-tech sector, a significant reduction was recorded from the mid-80s onwards, after more than two decades of high specialization. Nevertheless, China continues to present specialization in some low-tech subsectors, namely “Other manufacturing and recycling” and “Textiles, textile products, leather and footwear”.

The identification of relevant vertical specialization activities was accomplished by computing the $B^*$ for both exports and imports in the different sectors, for the 79 countries (or group of countries), and by setting a threshold of 2. Although we acknowledge that intra-industry trade may explain relatively high values of both $B^*$ indicators, it is hard to accept that such trade justifies import structures that are twice the world average. In such cases, vertical specialization activities must be the underlying explanation. Using these criteria, relevant vertical specialization activities at an aggregate level were found in high-tech industries and, to a lesser extent, in some medium-high-tech (motor vehicles and electrical machinery) and low-tech sectors (textiles, clothing and footwear). These activities appear to have intensified in the last decade. In geographical terms, significant vertical specialization activities are predominantly identified in East Asia, but also in some countries of Europe and North Africa.

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## Appendix (continue)

**$B^*_x$ VALUES FOR 79 COUNTRIES OR GROUPS OF COUNTRIES**
(Countries sorted by 2000-04 values of ***B****)

### High techonology

| | 1967-69 | | 2000-04 | | | 1967-69 | | 2000-04 | |
|---|---|---|---|---|---|---|---|---|---|
| | Rank | *B** | Rank | *B** | | Rank | *B** | Rank | *B** |
| Philippines | 60 | 0.11 | 1 | 4.91 | Poland | 9 | 2.24 | 41 | 0.45 |
| Singapore | 35 | 0.71 | 2 | 4.29 | India | 54 | 0.22 | 42 | 0.44 |
| Malaysia | 64 | 0.08 | 3 | 4.20 | Middle East, no OPEC | 19 | 1.59 | 43 | 0.44 |
| Ireland | 15 | 1.84 | 4 | 3.91 | Turkey | 67 | 0.03 | 44 | 0.42 |
| Others in South Europe | 28 | 0.92 | 5 | 3.80 | Gulf | 45 | 0.44 | 45 | 0.40 |
| Taiwan | 2 | 5.99 | 6 | 2.98 | Bolivia | 77 | 0.01 | 46 | 0.36 |
| Switzerland | 1 | 6.76 | 7 | 2.54 | Romania | 53 | 0.22 | 47 | 0.35 |
| South Korea | 23 | 1.15 | 8 | 2.43 | Former USSR | 30 | 0.89 | 48 | 0.35 |
| United Kingdom | 6 | 2.99 | 9 | 2.38 | Colombia | 33 | 0.79 | 49 | 0.34 |
| Israel | 29 | 0.90 | 10 | 2.38 | Bulgaria | 18 | 1.61 | 50 | 0.33 |
| United States | 3 | 4.89 | 11 | 2.36 | Others in East Asia | 46 | 0.37 | 51 | 0.33 |
| Thailand | 71 | 0.03 | 12 | 2.23 | Kenya | 44 | 0.44 | 52 | 0.31 |
| Hungary | 10 | 2.12 | 13 | 2.19 | Iceland | 73 | 0.02 | 53 | 0.30 |
| China, People's Rep. | 48 | 0.29 | 14 | 2.15 | Sri Lanka | 76 | 0.01 | 54 | 0.29 |
| Netherlands | 5 | 3.01 | 15 | 2.06 | South African Union | 47 | 0.37 | 55 | 0.27 |
| Japan | 4 | 3.86 | 16 | 2.04 | New Zealand | 65 | 0.06 | 56 | 0.25 |
| Mexico | 22 | 1.42 | 17 | 1.97 | African LDCs | 61 | 0.10 | 57 | 0.24 |
| Finland | 49 | 0.27 | 18 | 1.65 | Argentina | 36 | 0.70 | 58 | 0.23 |
| France | 8 | 2.46 | 19 | 1.63 | Uruguay | 41 | 0.58 | 59 | 0.22 |
| Sweden | 12 | 1.92 | 20 | 1.60 | Tunisia | 56 | 0.16 | 60 | 0.21 |
| Denmark | 17 | 1.71 | 21 | 1.51 | Others in Africa | 59 | 0.12 | 61 | 0.21 |
| Germany | 7 | 2.58 | 22 | 1.28 | Ecuador | 13 | 1.89 | 62 | 0.17 |
| Hong Kong | 11 | 2.07 | 23 | 1.23 | Paraguay | 79 | 0.01 | 63 | 0.14 |
| Indonesia | 66 | 0.04 | 24 | 1.22 | Pakistan | 51 | 0.23 | 64 | 0.13 |
| BLEU | 25 | 0.99 | 25 | 1.06 | Egypt | 55 | 0.19 | 65 | 0.11 |
| Austria | 21 | 1.47 | 26 | 0.93 | East Asian LDCs | 63 | 0.09 | 66 | 0.10 |
| Canada | 16 | 1.76 | 27 | 0.90 | Venezuela | 68 | 0.03 | 67 | 0.10 |
| Norway | 40 | 0.58 | 28 | 0.84 | Albania | 57 | 0.15 | 68 | 0.07 |
| Former Czechoslovakia | 20 | 1.57 | 29 | 0.80 | Chile | 72 | 0.02 | 69 | 0.06 |
| Brazil | 26 | 0.93 | 30 | 0.80 | Peru | 70 | 0.03 | 70 | 0.04 |
| Australia | 43 | 0.49 | 31 | 0.79 | Cote d'Ivoire | 50 | 0.24 | 71 | 0.04 |
| Italy | 14 | 1.88 | 32 | 0.75 | Bangladesh | 31 | 0.87 | 72 | 0.03 |
| Portugal | 27 | 0.93 | 33 | 0.73 | Nigeria | 78 | 0.01 | 73 | 0.02 |
| Spain | 39 | 0.63 | 34 | 0.72 | Saudi Arabia | 75 | 0.02 | 74 | 0.02 |
| Greece | 52 | 0.22 | 35 | 0.72 | Brunei Darussalam | 69 | 0.03 | 75 | 0.02 |
| Others in America | 37 | 0.67 | 36 | 0.70 | Cameroon | 32 | 0.79 | 76 | 0.02 |
| Morocco | 62 | 0.09 | 37 | 0.69 | Algeria | 58 | 0.14 | 77 | 0.01 |
| Former Yugoslavia | 38 | 0.64 | 38 | 0.65 | Libyan Arab Jamahiriya | 24 | 1.02 | 78 | 0.01 |
| Gabon | 42 | 0.51 | 39 | 0.58 | Cambodia, Laos | 74 | 0.02 | 79 | 0.01 |
| Vietnam | 34 | 0.78 | 40 | 0.51 | | | | | |

**Sources:** CEPII-Chelem database and own calculations.

## Appendix (continued)

**$B_x^*$ VALUES FOR 79 COUNTRIES OR GROUPS OF COUNTRIES**
(Countries sorted by 2000-04 values of $B^*$)

**Medium-high techonology**

| | 1967-69 | | 2000-04 | | | 1967-69 | | 2000-04 | |
|---|---|---|---|---|---|---|---|---|---|
| | Rank | B* | Rank | B* | | Rank | B* | Rank | B* |
| Japan | 12 | 2.05 | 1 | 2.54 | Middle East, no OPEC | 25 | 1.28 | 41 | 0.86 |
| Germany | 1 | 4.00 | 2 | 2.50 | Australia | 32 | 1.01 | 42 | 0.85 |
| Saudi Arabia | 70 | 0.06 | 3 | 2.31 | Gulf | 62 | 0.18 | 43 | 0.84 |
| Spain | 19 | 1.76 | 4 | 2.25 | India | 47 | 0.42 | 44 | 0.82 |
| Mexico | 29 | 1.07 | 5 | 2.22 | Venezuela | 69 | 0.06 | 45 | 0.79 |
| Former Czechoslovakia | 13 | 2.03 | 6 | 2.15 | Greece | 35 | 0.84 | 46 | 0.77 |
| Canada | 7 | 2.61 | 7 | 2.09 | Indonesia | 71 | 0.05 | 47 | 0.71 |
| BLEU | 11 | 2.06 | 8 | 2.03 | New Zealand | 68 | 0.11 | 48 | 0.64 |
| Austria | 16 | 1.88 | 9 | 1.98 | Cote d'Ivoire | 44 | 0.56 | 49 | 0.62 |
| France | 6 | 2.76 | 10 | 1.97 | Singapore | 45 | 0.53 | 50 | 0.62 |
| Hungary | 20 | 1.64 | 11 | 1.92 | Nigeria | 77 | 0.02 | 51 | 0.62 |
| Italy | 5 | 2.96 | 12 | 1.91 | Malaysia | 64 | 0.16 | 52 | 0.61 |
| United States | 2 | 3.55 | 13 | 1.89 | Ecuador | 72 | 0.05 | 53 | 0.61 |
| Switzerland | 4 | 3.16 | 14 | 1.82 | Kenya | 37 | 0.82 | 54 | 0.59 |
| Sweden | 9 | 2.29 | 15 | 1.79 | Egypt | 59 | 0.26 | 55 | 0.53 |
| United Kingdom | 3 | 3.32 | 16 | 1.72 | Others in America | 28 | 1.08 | 56 | 0.52 |
| Poland | 8 | 2.48 | 17 | 1.71 | Others in South Europe | 31 | 1.01 | 57 | 0.50 |
| Portugal | 39 | 0.72 | 18 | 1.51 | Chile | 58 | 0.26 | 58 | 0.49 |
| South African Union | 27 | 1.12 | 19 | 1.47 | Uruguay | 60 | 0.25 | 59 | 0.47 |
| South Korea | 55 | 0.29 | 20 | 1.47 | Philippines | 66 | 0.12 | 60 | 0.42 |
| Former Yugoslavia | 22 | 1.51 | 21 | 1.46 | African LDCs | 61 | 0.19 | 61 | 0.38 |
| Netherlands | 15 | 1.89 | 22 | 1.41 | Hong Kong | 48 | 0.42 | 62 | 0.37 |
| Denmark | 18 | 1.84 | 23 | 1.37 | Algeria | 10 | 2.21 | 63 | 0.35 |
| Brazil | 41 | 0.63 | 24 | 1.36 | Vietnam | 49 | 0.40 | 64 | 0.35 |
| Tunisia | 14 | 1.93 | 25 | 1.29 | East Asian LDCs | 73 | 0.04 | 65 | 0.34 |
| Ireland | 46 | 0.46 | 26 | 1.27 | Gabon | 54 | 0.34 | 66 | 0.33 |
| Finland | 36 | 0.83 | 27 | 1.23 | Others in East Asia | 57 | 0.27 | 67 | 0.28 |
| Taiwan | 21 | 1.61 | 28 | 1.22 | Paraguay | 33 | 0.90 | 68 | 0.25 |
| Turkey | 50 | 0.39 | 29 | 1.18 | Bolivia | 65 | 0.12 | 69 | 0.24 |
| Argentina | 43 | 0.56 | 30 | 1.13 | Cameroon | 53 | 0.35 | 70 | 0.21 |
| Colombia | 42 | 0.56 | 31 | 1.09 | Peru | 74 | 0.03 | 71 | 0.20 |
| Thailand | 76 | 0.02 | 32 | 1.07 | Iceland | 78 | 0.01 | 72 | 0.18 |
| Norway | 23 | 1.45 | 33 | 1.06 | Albania | 51 | 0.38 | 73 | 0.17 |
| Romania | 26 | 1.15 | 34 | 1.02 | Sri Lanka | 63 | 0.16 | 74 | 0.16 |
| Morocco | 30 | 1.06 | 35 | 1.01 | Others in Africa | 67 | 0.12 | 75 | 0.12 |
| China, People's Rep. | 40 | 0.71 | 36 | 0.95 | Pakistan | 52 | 0.38 | 76 | 0.11 |
| Former USSR | 24 | 1.34 | 37 | 0.93 | Bangladesh | 79 | 0.00 | 77 | 0.09 |
| Bulgaria | 17 | 1.88 | 38 | 0.93 | Cambodia, Laos | 75 | 0.02 | 78 | 0.02 |
| Libyan Arab Jamahiriya | 38 | 0.80 | 39 | 0.90 | Brunei Darussalam | 56 | 0.27 | 79 | 0.02 |
| Israel | 34 | 0.89 | 40 | 0.86 | | | | | |

**Sources:** CEPII-Chelem database and own calculations.

## Appendix (continued)

$B^*_x$ VALUES FOR 79 COUNTRIES OR GROUPS OF COUNTRIES
(Countries sorted by 2000-04 values of *B**)

**Medium-low techonology**

| | 1967-69 | | 2000-04 | | | 1967-69 | | 2000-04 | |
|---|---|---|---|---|---|---|---|---|---|
| | Rank | B* | Rank | B* | | Rank | B* | Rank | B* |
| Algeria | 60 | 0.35 | 1 | 3.61 | Spain | 41 | 0.77 | 41 | 0.77 |
| Libyan Arab Jamahiriya | 24 | 1.17 | 2 | 3.17 | Finland | 54 | 0.50 | 42 | 0.77 |
| Nigeria | 20 | 1.34 | 3 | 3.02 | Austria | 31 | 0.95 | 43 | 0.76 |
| Venezuela | 3 | 3.10 | 4 | 3.01 | Italy | 46 | 0.66 | 44 | 0.75 |
| Egypt | 66 | 0.26 | 5 | 2.60 | Indonesia | 5 | 2.75 | 45 | 0.72 |
| Gulf | 8 | 2.30 | 6 | 2.48 | Canada | 47 | 0.66 | 46 | 0.71 |
| Peru | 14 | 1.64 | 7 | 2.29 | Sweden | 38 | 0.82 | 47 | 0.70 |
| Former USSR | 17 | 1.50 | 8 | 2.27 | Netherlands | 43 | 0.76 | 48 | 0.68 |
| African LDCs | 10 | 2.19 | 9 | 1.94 | Taiwan | 53 | 0.50 | 49 | 0.65 |
| Chile | 4 | 2.85 | 10 | 1.88 | Portugal | 61 | 0.33 | 50 | 0.61 |
| Saudi Arabia | 1 | 3.16 | 11 | 1.78 | Germany | 45 | 0.69 | 51 | 0.61 |
| Norway | 19 | 1.42 | 12 | 1.74 | France | 39 | 0.78 | 52 | 0.61 |
| South African Union | 34 | 0.93 | 13 | 1.65 | Albania | 25 | 1.16 | 53 | 0.56 |
| Kenya | 13 | 1.81 | 14 | 1.64 | United Kingdom | 48 | 0.62 | 54 | 0.56 |
| Australia | 42 | 0.77 | 15 | 1.52 | Hong Kong | 70 | 0.22 | 55 | 0.55 |
| Cameroon | 18 | 1.46 | 16 | 1.44 | China, People's Rep. | 62 | 0.32 | 56 | 0.52 |
| Cote d'Ivoire | 51 | 0.55 | 17 | 1.42 | Japan | 30 | 0.98 | 57 | 0.52 |
| Bulgaria | 40 | 0.78 | 18 | 1.39 | Thailand | 23 | 1.19 | 58 | 0.51 |
| Colombia | 29 | 1.06 | 19 | 1.38 | Others in South Europe | 57 | 0.44 | 59 | 0.51 |
| Others in America | 16 | 1.54 | 20 | 1.37 | Denmark | 59 | 0.41 | 60 | 0.51 |
| Greece | 37 | 0.89 | 21 | 1.28 | Switzerland | 67 | 0.26 | 61 | 0.49 |
| Gabon | 44 | 0.74 | 22 | 1.13 | New Zealand | 76 | 0.07 | 62 | 0.47 |
| Middle East, no OPEC | 21 | 1.33 | 23 | 1.12 | United States | 58 | 0.43 | 63 | 0.47 |
| Former Yugoslavia | 36 | 0.90 | 24 | 1.10 | Hungary | 50 | 0.56 | 64 | 0.45 |
| Poland | 35 | 0.91 | 25 | 1.09 | Uruguay | 68 | 0.25 | 65 | 0.42 |
| Romania | 26 | 1.15 | 26 | 1.06 | Malaysia | 7 | 2.59 | 66 | 0.42 |
| Former Czechoslovakia | 27 | 1.10 | 27 | 0.99 | Sri Lanka | 12 | 2.09 | 67 | 0.40 |
| Others in Africa | 33 | 0.94 | 28 | 0.98 | East Asian LDCs | 69 | 0.25 | 68 | 0.39 |
| Turkey | 55 | 0.48 | 29 | 0.93 | Mexico | 32 | 0.95 | 69 | 0.38 |
| Iceland | 74 | 0.11 | 30 | 0.91 | Israel | 56 | 0.46 | 70 | 0.34 |
| Others in East Asia | 28 | 1.06 | 31 | 0.90 | Morocco | 64 | 0.31 | 71 | 0.34 |
| Bolivia | 2 | 3.11 | 32 | 0.88 | Vietnam | 11 | 2.16 | 72 | 0.34 |
| Argentina | 73 | 0.15 | 33 | 0.86 | Tunisia | 49 | 0.56 | 73 | 0.32 |
| Brazil | 65 | 0.30 | 34 | 0.85 | Paraguay | 77 | 0.03 | 74 | 0.19 |
| South Korea | 72 | 0.18 | 35 | 0.83 | Philippines | 71 | 0.19 | 75 | 0.19 |
| Brunei Darussalam | 6 | 2.72 | 36 | 0.80 | Pakistan | 75 | 0.09 | 76 | 0.13 |
| India | 52 | 0.53 | 37 | 0.79 | Ireland | 63 | 0.32 | 77 | 0.10 |
| BLEU | 22 | 1.25 | 38 | 0.78 | Cambodia, Laos | 15 | 1.60 | 78 | 0.06 |
| Singapore | 9 | 2.28 | 39 | 0.78 | Bangladesh | 79 | 0.00 | 79 | 0.04 |
| Ecuador | 78 | 0.01 | 40 | 0.77 | | | | | |

**Sources:** CEPII-Chelem database and own calculations.

## Appendix (continued)

**$B^*_x$ VALUES FOR 79 COUNTRIES OR GROUPS OF COUNTRIES**

(Countries sorted by 2000-04 values of ***B****)

**Low techonology**

| | 1967-69 | | 2000-04 | | | 1967-69 | | 2000-04 | |
|---|---|---|---|---|---|---|---|---|---|
| | Rank | *B** | Rank | *B** | | Rank | *B** | Rank | *B** |
| Cambodia, Laos | 40 | 0.97 | 1 | 2.50 | Denmark | 36 | 1.07 | 40 | 0.93 |
| Bangladesh | 2 | 1.88 | 2 | 2.47 | China, People's Rep. | 14 | 1.55 | 41 | 0.90 |
| Pakistan | 6 | 1.78 | 3 | 2.36 | Former Yugoslavia | 42 | 0.96 | 42 | 0.82 |
| Paraguay | 9 | 1.70 | 4 | 2.24 | Australia | 29 | 1.18 | 43 | 0.82 |
| Sri Lanka | 56 | 0.64 | 5 | 2.10 | Thailand | 27 | 1.23 | 44 | 0.81 |
| East Asian LDCs | 5 | 1.79 | 6 | 2.08 | Finland | 22 | 1.41 | 45 | 0.78 |
| Albania | 32 | 1.14 | 7 | 2.07 | Poland | 63 | 0.56 | 46 | 0.78 |
| Brunei Darussalam | 75 | 0.23 | 8 | 2.02 | Italy | 59 | 0.61 | 47 | 0.77 |
| Vietnam | 66 | 0.47 | 9 | 1.96 | Austria | 48 | 0.76 | 48 | 0.66 |
| Uruguay | 10 | 1.69 | 10 | 1.95 | Canada | 51 | 0.72 | 49 | 0.65 |
| New Zealand | 3 | 1.88 | 11 | 1.82 | South African Union | 37 | 1.06 | 50 | 0.60 |
| Others in Africa | 26 | 1.34 | 12 | 1.78 | Spain | 41 | 0.97 | 51 | 0.59 |
| Iceland | 1 | 1.89 | 13 | 1.76 | Netherlands | 49 | 0.74 | 52 | 0.59 |
| Bolivia | 78 | 0.03 | 14 | 1.72 | BLEU | 61 | 0.57 | 53 | 0.57 |
| Others in East Asia | 28 | 1.21 | 15 | 1.70 | Sweden | 52 | 0.69 | 54 | 0.55 |
| Ecuador | 7 | 1.78 | 16 | 1.67 | Norway | 55 | 0.66 | 55 | 0.55 |
| Tunisia | 35 | 1.10 | 17 | 1.58 | Egypt | 8 | 1.71 | 56 | 0.54 |
| Morocco | 20 | 1.48 | 18 | 1.54 | Others in South Europe | 25 | 1.34 | 57 | 0.53 |
| Hong Kong | 15 | 1.54 | 19 | 1.54 | France | 64 | 0.55 | 58 | 0.50 |
| Cameroon | 46 | 0.91 | 20 | 1.50 | Former Czechoslovakia | 57 | 0.62 | 59 | 0.47 |
| India | 17 | 1.51 | 21 | 1.44 | Former USSR | 58 | 0.62 | 60 | 0.46 |
| Gabon | 23 | 1.38 | 22 | 1.43 | Hungary | 38 | 1.01 | 61 | 0.42 |
| Argentina | 12 | 1.66 | 23 | 1.31 | Mexico | 39 | 0.98 | 62 | 0.39 |
| Cote d'Ivoire | 21 | 1.45 | 24 | 1.29 | United Kingdom | 68 | 0.45 | 63 | 0.38 |
| Indonesia | 74 | 0.26 | 25 | 1.26 | Malaysia | 72 | 0.33 | 64 | 0.38 |
| Middle East, no OPEC | 54 | 0.67 | 26 | 1.21 | Taiwan | 50 | 0.73 | 65 | 0.36 |
| Romania | 45 | 0.94 | 27 | 1.20 | United States | 71 | 0.35 | 66 | 0.36 |
| Turkey | 13 | 1.56 | 28 | 1.16 | Philippines | 4 | 1.80 | 67 | 0.36 |
| Others in America | 53 | 0.68 | 29 | 1.13 | Gulf | 67 | 0.47 | 68 | 0.35 |
| Portugal | 18 | 1.49 | 30 | 1.08 | Germany | 73 | 0.27 | 69 | 0.35 |
| Kenya | 60 | 0.60 | 31 | 1.06 | Ireland | 19 | 1.48 | 70 | 0.34 |
| Chile | 76 | 0.15 | 32 | 1.05 | South Korea | 11 | 1.68 | 71 | 0.32 |
| Greece | 30 | 1.18 | 33 | 1.05 | Switzerland | 69 | 0.39 | 72 | 0.32 |
| Bulgaria | 47 | 0.85 | 34 | 1.04 | Nigeria | 33 | 1.13 | 73 | 0.27 |
| African LDCs | 62 | 0.57 | 35 | 1.00 | Saudi Arabia | 79 | 0.01 | 74 | 0.17 |
| Brazil | 16 | 1.53 | 36 | 0.99 | Venezuela | 77 | 0.04 | 75 | 0.15 |
| Israel | 24 | 1.36 | 37 | 0.98 | Singapore | 70 | 0.37 | 76 | 0.11 |
| Colombia | 34 | 1.10 | 38 | 0.95 | Japan | 65 | 0.49 | 77 | 0.11 |
| Peru | 44 | 0.95 | 39 | 0.95 | Algeria | 31 | 1.15 | 78 | 0.03 |
| | | | | | Libyan Arab Jamahiriya | 43 | 0.95 | 79 | 0.02 |

**Sources:** CEPII-Chelem database and own calculations.