Vertical Specialization and Exports in ICT Manufactures

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Abstract
We examine the relationship between a country’s degree of vertical specialization (VS) and a country’s exports in Information and Communication Technology (ICT) manufactures. The statistical analysis includes 28 developed and developing countries that together account for the majority of world ICT exports. The results on the observed patterns and trends in VS and ICT exports suggest that VS may be an important country characteristic and factor of a country’s exports in ICT goods.

Keywords: Vertical Specialization, Information and Communication Technology (ICT), ICT Exports

JEL Classification: F10, F14

1. Introduction
The participation of developing countries in international production networks is thought to be responsible and explain the export expansion in ICT goods, in electronics and more general in high-tech products (e.g. Srholec, 2007; Lall et al., 2004; Mayer et al., 2002). In particular, this line of research emphasizes the finding that developing countries mostly specialize and participate in low-tech and labor-intensive segments of the production process of ICT and other high-tech manufactures.

1 I would like to thank Joao Amador and Sonia Cabral for kindly providing the data on vertical specialization.
At first glance, it seems that production fragmentation simply implies that low labor-cost countries should appear to increasingly export high-tech products, since they will tend to attract the labor-intensive assembly activities, whilst high-skilled and high-wage countries should appear to either show stagnating or even decreasing high-tech exports, since mainly the high-skilled and innovation-intensive activities (such as R&D) will be carried out in those countries (Srholec, 2007).

However, the phenomenon of production fragmentation and more precisely of vertical specialization is much more complex and there are global networks of various configurations. For instance, developing countries not only assemble final high-tech products but also produce intermediate goods which are exported to developed countries to be processed further and produce the final good which is then exported. There can be even several phases of back and forth processing trade between the countries involved in the production process, where each phase represents a particular production segment.

Furthermore, vertical specialization links exist also between developed countries. As a consequence, the above outlined simplified effect and pattern of production fragmentation on a country’s high-tech exports is less likely to prevail in the real world. In fact, vertical specialization tends to increase overall trade flows among trading partners (Baldone et al., 2007; Chen et al., 2005; Yi, 2003).

As the production fragmentation process continues, international production networks are becoming increasingly important in ICT goods. Therefore, the objective of this paper is to investigate to what extent vertical specialization in a country could be a contributing factor of a country’s exports in ICT manufactures. Our statistical analysis includes 28 countries, which account for over 97% of world ICT exports. In addition, the sample includes both developed and developing economies.

The rest of the paper is structured as follows. Section 2 briefly reviews the theoretical literature on production fragmentation and vertical specialization. Section 3 examines the trends and patterns of vertical specialization and ICT exports across our sample of countries. Additionally, a statistical analysis for the relationship between VS and exports in ICT goods is conducted, using our country sample. Section 4 concludes.

2. Literature Review

Generally speaking, international production fragmentation can be described as the phenomenon in which the production of a final good is fragmented or sliced into
several production stages which take place in different countries. The various intermediate goods, resulting from each production stage at a different location, are combined in the last stage to produce the final good. International trade in intermediate inputs plays a crucial role here, as it is an integral part of the overall production process. It constitutes a service link connecting all separate production blocks.

Global outsourcing and vertical specialization constitute prominent characteristics and features of this production fragmentation process. It has, however, to be noted that these concepts, though related, are not synonymous and in fact reflect different aspects of international production fragmentation. Outsourcing occurs in the case where a firm relocates the production of the intermediate components to another country (either to an affiliated firm or some other firm) and imports the intermediate inputs from that country.

Thus, the trade in parts and components that takes place in this case does not involve further processing and exporting-importing of the intermediate input. Additionally, it does not involve the exporting of the final good. Vertical specialization, on the other hand, involves the back and forth trade in parts and components for further processing by another country and the exporting of the intermediate good-in-process or the resulting final good. Thus, vertical specialization reflects the imported intermediate goods that are embodied in a country’s exports of intermediate or final goods.²

Theoretical analyses on the phenomena of trade in intermediate products and production fragmentation date back to the 1980s and 1990s (e.g. Sanyal and Jones, 1982; Jones and Kierzkowski, 1990) and have since been extended and examined further with an increasing interest (e.g. Kimura and Ando, 2005; Yi, 2003; Grossman and Helpman, 2002; Arndt and Kierzkowski, 2001; Deardorff, 2001).

Notably, vertical specialization has a number of important implications with regard to the traditional concept of comparative advantage, trade patterns, wages, and employment (Baldone et al., 2007; Molnar et al., 2007). Countries can no longer be thought of as producers of a particular final product, and hence appear to be specialized in the given commodity. On the contrary, specialization occurs in one or more segments of the overall production process.

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² For a discussion on this issue see, for instance, Hummels et al. (2001) or Chen et al. (2005).
The traditional comparative advantage scenario (Ricardian and H-O trade theory) still holds in this case, with the reformulation that the differences in cross-country labor productivities and in relative factor endowments are relevant for each of the individual separate production segments-blocks. More specifically, in the case where the different production segments require different labor skills, the fragmentation of the production process across different regions (countries) that exhibit different productivities and skills of their labor force generates Ricardian specialization patterns and gains from trade.

In the case where the production segments require factors in different proportions, the production fragmentation across countries that have different relative factor endowments creates H-O type of specialization. However, it has to be noted that with production fragmentation comparative advantage looses its traditional meaning as regards the production and exporting of final commodities. The above considerations show that production fragmentation can be beneficial for firms and promote economic efficiency, and may indeed constitute important motivations for production fragmentation to occur.

Production fragmentation is aided by falling trade barriers and transport and co-ordination costs which all reduce the cost of the necessary service links connecting the different production segments. Indeed, lower costs in transport and communications, and advances in information technology have contributed significantly to the recent expansion of the phenomenon of international production sharing.

As regards the labor market effects of production fragmentation, there seems to be a greater impact of vertical specialization based trade on the home labor market than traditional trade. Vertical trade is likely to have intra-industry as well as inter-industry effects on labor demand, since labor demand is affected in both, the industries in which the imports of goods-in-process occur, and in the industries that use all or some of those intermediate goods for the production of final goods (e.g. Feenstra and Hanson, 2003).

Most importantly to our empirical analysis, besides changing commodity compositions (intermediate and final goods) and trade patterns, production fragmentation and vertical specialization imply an increase in export flows in countries engaging in international production sharing. Firstly, this can occur because of the back and forth processing trade of goods-in-process that takes place. Secondly,
vertical specialization is associated with an increased specialization of a country in a particular segment which leads to increased productivity and export expansion. Increasing returns to scale are especially important in this type of specialization (Jones and Kierzkowski, 1990).

3. ICT Exports and Vertical Specialization

Figures 1 and 2 show the development in the share of ICT exports in total exports as well as in the Revealed Comparative Advantage (RCA) index between 2000 and 2007 for 29 countries, respectively. First, it is evident that some economies from South-east Asia, such as Singapore, Malaysia, Taiwan, and Korea, and some smaller countries (such as Ireland and Finland) show the highest ICT exports shares, indicating an especially high export concentration. These economies have RCA indices well above unity, revealing a strong export performance in the given product group relative to the world. Some advanced OECD economies (such as Japan, Netherlands, the US, Sweden, and the UK) show also high ICT export shares.

Figure 1: ICT export share in total exports, 2000 and 2007

3 The export data are obtained from the World Trade Organization international trade database.
Secondly and more interestingly, there seems to be a negative trend in most countries, except in China, Hong-Kong, and Portugal. It has to be noted that a closer examination of the data shows that ICT exports are increasing in almost all countries in absolute terms, but due to the higher export growth rates in the other product groups ICT exports in total exports are falling. Most importantly, China and Hong-Kong seem to have increased substantially their ICT export shares, while some OECD economies have witnessed a significant fall (especially the UK and Ireland).

Figures 3 and 4 report the cross-country vertical specialization trends over the 2000-2005 period. For identifying those trends and patterns across our sample of countries, we use the VS index developed by Amador and Cabral (2008) and their results. We

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4 Since it is a highly technical issue and cannot be discussed here, interested readers can find a detailed description of the measure and the methodology involved for calculating vertical specialization in Amador and Cabral (2008). We use their VS measure calculated from 33 components and parts, which are intermediate inputs mostly of electronics and machinery products. From a variety of measures, which include many more components, the VS index used in this paper (with only the 33 components) is more relevant for ICT goods. For an overview of different measures and indices related to the phenomena of international production fragmentation and vertical specialization see, for instance, Formentini and Iapadre (2008).

5 The data on vertical specialization for the countries in our sample have been kindly provided by Amador and Cabral (2008) upon request by the author.
employ this index because, by construction, it is a relative measure, suitable for international comparisons and cross-country studies. In addition, VS data calculated with this index are available for our panel of countries.

The first VS measure, shown in figure 3, is the value of imported intermediates used in the country’s exports in levels (millions of US dollars). The second VS measure, shown in figure 4, is this value expressed as a percentage of total imports. In general it seems that larger countries tend to exhibit higher VS levels than smaller countries. This is rather expected since a higher absolute value of intermediate imports will tend to be present in countries with a higher absolute value of exports; countries which tend to be the larger ones.

Figure 3: VS Level, 2000 and 2005

However, there are some notable exceptions to this: Singapore and Malaysia rank especially high in the list, whilst Brazil and India show a low ranking. Additionally, France and Germany fall rather in a medium ranking range. In 2000, the US exhibits by far the highest VS level, whereas in 2005 the US has been overtaken by China in this respect and ranks in second place. China has witnessed an impressive growth in
her vertical specialization level over 2000-2005. There seems to be a general upward
trend in most countries.

Figure 4: VS Index (share), 2000 and 2005

As regards vertical specialization trends in relative terms, it is evident that the South-
east and East Asian countries included in our sample exhibit the highest VS indices. According to these results, in recent years vertical specialization is a phenomenon
which is especially important in Malaysia, Singapore, and the two “Chinese economies” (mainland and Hong-Kong). Two European countries (Ireland and the
Netherlands) and two Latin-American countries (Brazil and Mexico) show also a
significant VS index.

From cross-examining the patterns and trends depicted in all those figures we have
some indication that countries that exhibit a high share of ICT exports in total exports
tend to exhibit also a high VS index. This could imply that there is a positive
correlation between the ICT export share and the VS index. Accordingly, we would
expect that highly vertically specialized countries exhibit a high ICT export share,
while countries with a low VS share show a low export share.
In order to examine this issue we conduct two correlation analyses. In the first analysis, the correlation between the ICT export level and the VS level is examined. The second analysis involves the examination of the correlation between the ICT export share in total exports and the VS share.

Figure 5: Correlation and simple regression analysis for ICT Export level and VS level for the year 2000

![Figure 5](image_url)

Figure 6: Correlation and simple regression analysis for ICT Export level and VS level for the year 2005

![Figure 6](image_url)
Figure 5 to 8 show the results of the two correlation analyses for the years 2000 and 2005, using our cross-country sample of 29 countries. In all of those four correlation analyses highly statistically significant Pearson correlation coefficients are generated. It is evident from figure 5 and 6 that there is a very strong linear correlation between the ICT export level and the VS level in both years 2000 and 2005 with correlation coefficients of 0.922 and 0.947, respectively. Additionally, it can be seen from the figures that a linear regression line has been fitted, and thus a simple regression analysis has been also conducted with ICT exports as the dependent variable. The coefficient of determination for this simple regression is also very high, indicating that over 85% and 89% of the cross-country variance in the ICT export level can be explained by the variability in the VS level in the years 2000 and 2005, respectively.

Figure 7: Correlation and simple regression analysis for ICT Export share and VS index (share) for the year 2000
Figure 8: Correlation and simple regression analysis for ICT Export share and VS index (share) for the year 2005

The correlation and simple regression analysis for the ICT export share and the VS index is shown in figures 7 and 8. It is apparent that there is also an extremely high correlation between export share and VS share in both years (2000 and 2005). Thus, the general picture emerging from cross-examining the results from the figures 1 to 4 seems to conform to the results of the correlation and simple regression analyses, shown in figures 5 to 8. Those findings may suggest that VS is potentially a significant determinant of exports in ICT goods. However, a formal econometric analysis on the cross-country export determinants is clearly needed, in order to shed some more light on this issue.

5. Conclusions
The paper has investigated and provided some evidence on the relationship between the extent of vertical specialization in a country and the country’s exports in ICT manufacturing goods. The results of the statistical analysis, which is based on a cross-country sample of 29 developed and developing economies, suggest that there may be an important role of VS for a country’s ICT exports. There are also some indications that the significance of this role of VS regarding ICT exports has increased over time (during our sample period 2000-2005). Although, a rigorous and formal econometric
analysis has clearly to be applied in order to investigate the subject matter further, those first findings seem to imply that a country’s extent of VS and participation in international production networks may increasingly become important with regard to its ICT exports.

References


