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Determinants of Export Specialization in ICT

Products:

A Cross-Country Analysis

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Abstract

The paper examines the trends in world export specialization patterns in Information and Communications Technology (ICT) products during 2000-2006 for 29 countries. Additionally, the observed cross-country specialization patterns and the country-level determinants of ICT export specialization are investigated with a panel-econometric analysis. Instead of considering aggregated ICT exports, the descriptive and explanatory analysis examines export specialization in the three main ICT product groups (computers and office machinery, integrated circuits and electronic components, and telecommunications equipment). Results indicate that there have been some substantial developments in ICT export specialization across countries. Furthermore, our findings suggest that although comparative advantage factors (such as R&D and human capital) are significant determinants, other deterministic factors related to the new economic geography framework seem to be relatively more important.

JEL classification: F02, F10, F14

Keywords: Export Specialization, Information and Communications Technology (ICT)

1. Introduction

Over the last few years, economic integration in the world economy has proceeded with accelerating steps and now it encompasses an ever-growing number of countries, transforming the planet into a global market place and production system. As a consequence, a tendency towards increased export specialization across countries has been witnessed (Pham, 2008; Bastos and Cabral, 2007; Shott, 2004).

This tendency has been extended to ICT products in recent years. Two developments are believed to have facilitated changes in global specialization patterns in ICT products. On the one hand, the international fragmentation process that manufacturing production in ICT-related activities has undergone in recent years has created new patterns of comparative and competitive advantages across locations. On the other hand, the effective integration into the world economy and impressive export performance in ICT-related products of some emerging economies from South and East Asia has increased the number of global players.

The export volume of ICT products has been increased significantly. World exports in ICT products grew by 57% between 2000 and 2007 (for telecommunications equipment 95%) and amounted to 1,514 billion US dollars in 2007, representing about 20% of total world exports.¹ In terms of demand and value added, ICT goods are considered as one of the most dynamic products worldwide (UNCTAD, 2007). Moreover, there is evidence that suggests that countries with strong export specialization and performance in ICT-related products exhibit higher productivity and economic growth rates (Hausmann *et al.*, 2007; Rodrik, 2006; Farberger, 2000; Greenaway *et al.*, 1999).

Given these facts, developed and more recently developing countries pursue policies and devote national resources in order to promote industrial technological specialization and export high-tech products to the global market. However, even an increased export specialization in high-tech products does not necessarily indicate an enhanced technological production base and capability. This is because specialization can occur in low value-added and less technology-intensive activities in the value chain of the ICT product through the international production fragmentation process and outsourcing (Andersson and Ejeremo, 2008; Srholec, 2007; Yi, 2003; Hummels *et al.*, 2001). China is one good example of this kind of export specialization in ICT products

¹ World Trade Organization international trade database.

(Gaulier *et al.*, 2007; Lemoine and Unal-Kesenci, 2004; Lemoine and Unal-Kesenci, 2002).

On the other hand, it is believed that countries benefit even from this type of specialization due to technological spillovers and rising involvement in high-tech related products of domestic firms, which in the long-run promotes technological advancement of the local manufacturing base (Liu, 2008; Todo and Miyamoto, 2006; Lemoine and Unal-Kesenci, 2004). In any case, for many governments the local production and the exporting of high-tech consumer goods (such as ICT) has become one of the most important policy priorities. Knowledge of the cross-country structure of ICT export specialization within the world economy and the factors determining this structure may provide relevant information and policy implications to policy makers.

Therefore, the paper's objective is twofold: Firstly, to examine the patterns and dynamics of global export specialization in ICT products that have formed over the 2000-2006 period for 29 countries, which account of over 98% of world ICT exports; and secondly, to empirically explain the observed specialization patterns and analyze the country-level determinants of export specialization in ICT products.

The paper proceeds as follows. In Section 2, stylized facts and trends in world ICT exports are briefly presented. In Section 3, the patterns of ICT export specialization across 29 countries are examined separately for three ICT product groups (electronic data processing machines, integrated circuits and electronic components, telecommunications equipment) rather than considering overall ICT exports. In Section 4, the determinants of ICT export specialization (for each of the three ICT product groups) within the world economy are investigated econometrically. Finally, Section 5 summarizes the main findings and concludes.

2. Global ICT Exports

As it is evident from Figure 1, overall world ICT exports have increased steadily since 2001 and onwards. A similar temporal development is evident for each of the three main ICT product groups. World exports in electronic data processing machines (EDP) increased from US\$371 billion to US\$540 billion, whilst those in integrated circuits and electronic components (ICEC) rose from US\$307 to US\$413 billion. World exports in telecommunications equipment have clearly witnessed the strongest growth, rising from US\$288 to US\$560 billion between 2000 and 2007.

This export growth has been so significant that telecommunications equipment has become the ICT product group with the highest share in total ICT world exports. More specifically, from 29.8% in 2000 the share increased to 37% in 2007, making telecommunications exports the most significant in total ICT world exports (Figure 2). The second most important ICT product group in terms of total global ICT exports is electronic data processing machines with a share of 35.7% in 2007. Evidently, the relative importance of integrated circuits and electronic components has fallen considerably between 2000 and 2007. This ICT product group represents only 27.3% of ICT exports in the world.

As regards the development in the relative importance of ICT exports in total manufacturing exports, it can be seen from Figure 3 that there has been a decline in this respect between 2000 and 2007. In particular, total ICT exports in 2000 accounted for 36.8% of total manufacturing exports in the world, whereas in 2007 this share shrunk to 31.4%. However, global telecommunications exports gained in relative importance during this period.

The share of telecommunications products in total world manufacturing exports increased from 11% to 11.8%. The fall of ICT products relative to total manufacturing exports is attributable to the significant decline in the export share of ICEC products and EDP machinery. This, in turn, is a result of the impressive export growth that has been achieved in some non-ICT manufacturing products relatively to the export growth of those ICT product groups. ICT exports, however, still account for a large part (almost one-third) of total manufacturing exports in the world.

3. Patterns and Dynamics of ICT Export Specialization

The global ICT export specialization patterns across 29 countries over the 2000-2006 period are examined using export data from the WTO international trade database. Exports of ICT products are broken down to the three basic ICT product groups: (1) electronic data processing machines, (2) integrated circuits and electronic components, and (3) telecommunications equipment.

In this paper, export specialization within the world economy of each country is revealed by the Balassa index. This choice is based on the properties of the index (e.g. the relative nature of the measure and the relation to comparative advantage), which are suitable and provide the relevant information needed for the study. In addition, this index

is a well-known measure of export specialization and has been extensively used in the empirical literature. The export specialization index is defined by the following equation:

$$B_{ij} = \left(\frac{X_{ij}}{\sum_{i=1}^n X_{ij}} \right) \cdot \left[\left(\frac{\sum_{j=1}^m X_{ij}}{\sum_{i=1}^n \sum_{j=1}^m X_{ij}} \right) \right]^{-1} \quad (1)$$

where X denotes world exports and subscripts i, j, n , and m denote sectors (ICT product groups and other industries in the economy), countries, total number of sectors, and total number of countries in the country group (the world economy), respectively. The Balassa index is a measure of relative specialization, since it analyzes a country's export share of an industry relative to the corresponding export share of the world economy as a whole. This index takes values between zero and infinity and relates positively to a country's export specialization in a particular sector. Specifically, values larger than unity indicate strong relative specialization and comparative advantage. We calculate Balassa indices for each country, ICT product group, and year observation included in our sample.

The results are shown in Table 1. Turning first to electronic data processing machines, 13 countries exhibit a Balassa index above unity, indicating export specialization and revealed comparative advantage within the world economy (in 2000 as well as in 2006). In the beginning period, Taiwan, Singapore, and Ireland show the strongest export specialization with an index value above 3. In 2006, this ranking changes and China exhibits the highest specialization index, followed by Malaysia, Hong-Kong, and Ireland. Although the countries that have a Balassa index above unity in 2000 and in 2006 are the same, there have been some substantial developments and re-orderings with respect to the observed specialization patterns. More specifically, most countries with an index value greater than 1 witness a decline in export specialization, except the countries that show the 3 highest Balassa indices. This is also true for economies with low initial export specialization.

Regarding the global export specialization patterns and trends in integrated circuits and electronic components, 8 countries appear to be specialized and have a revealed comparative advantage in this ICT product group in 2000. This number increases to 10 in 2006. Singapore exhibits by far the strongest export specialization within the world economy throughout the period under investigation. Malaysia, Taiwan,

Korea, and Japan follow the list of countries with the highest indices in 2000, whereas in the end period this list is represented by Taiwan, Malaysia, Hong-Kong, and Korea. Temporal developments as well as shifting patterns across countries seem rather stable; though there are some notable exceptions (e.g. the case of Portugal).

Finally, in telecommunications equipment 15 countries initially exhibit a Balassa index above unity (though many are close to one), whereas in the end year this number falls to 11. Finland shows the strongest export specialization throughout the 2000-2006 period, although after 2005 there has been a significant drop in the country's index value. The next most specialized countries in 2000 are Sweden, Hong-Kong, Mexico, and Malaysia, whilst in 2006 this ranking changes to the following: Hong-Kong, China, United Kingdom, and Mexico. Most countries witnessed a significant change in their specialization index, but without having an impact on the country's characterization of specialization (changing the Balassa index above or below the threshold value of one). Exceptions to this are Austria, Denmark, France, Taiwan, and the US.

The general picture that emerges is that although there have been some substantial changes in the export specialization in some cases; there has not been a general reorganization of global export specialization patterns across countries. This is more clearly demonstrated and confirmed by the Spearman's rank correlation analysis reported in Table 2. The high and statistically significant positive rank correlation coefficients in each ICT product group indicate that the world export specialization dynamics across countries in those product groups have not changed in a fundamental way between 2000 and 2006. In other words, the countries that were the most specialized in 2000 tend also to be the most specialized in 2006. This is especially true for integrated circuits and electronic components and relatively less so for electronic data processing machines.

4. Determinants of ICT export specialization

4.1 Theoretical Base, Variables, and Hypotheses

The standard theoretical frameworks for analyzing and explaining cross-country trade specialization patterns are the Heckscher-Ohlin (H-O) and Ricardian trade models which together constitute the comparative advantage trade theory. In the first theory the pattern of comparative advantage is determined by the countries' relative factor endowments, whilst in the second by productivity differences. Instead of capital and labor, in Wood and Berge (1997) the model is re-specified by using human capital and natural resources

as production factors to account more accurately for manufacturing exports, as argued by the authors. As we investigate the determinants of export specialization in ICT products, the more suitable production inputs for determining comparative advantage across countries are technology-related.

More specifically, key-factors in this ICT-setting are likely to be R&D (knowledge capital) and human capital (skilled labor). Hence, in this ICT reformulated comparative advantage framework, the relatively R&D and human capital abundant countries will produce and export the good using these factors intensively (or in a dynamic setting an increase in those relative factor endowments results in an increase in ICT exports over time). Also, from the Ricardian view, an increased ICT-related technology input (R&D or human capital) will result in increased technology-production capabilities and improved productivity, resulting in enhanced comparative advantage, and thus increased export specialization. Thus, according to the comparative advantage setting, technology-related inputs are expected to have a positive influence on ICT export specialization.

In the more recent and alternative theoretical framework of the new economic geography (NEG), originating from the new trade theory, on the other hand, trade and specialization patterns are not determined by comparative advantage. Instead, this framework draws attention to increasing returns to scale, transport cost, agglomeration economies and domestic market size for the determination of location and specialization patterns. In the presence of economies of scale and transport costs, the production of a manufacturing good is located in the location with the larger market (of that good), which becomes a net-exporter of that good.

In our context, if ICT production is characterized by increasing returns, then, assuming positive international transport costs and market size differences, ICT firms will tend to locate in countries with a large ICT market. Hence, those countries will tend to specialize in and export ICT products (see, for instance, Grossman and Helpman, 1991). Furthermore, because of the existence of agglomeration economies within the industrial and high-tech sectors, countries, which exhibit large agglomeration economies due to a large industrial sector, will tend to attract more firms from other countries, resulting in greater export specialization.

The new economic geography stresses also the importance of a country's degree of international market access. Specifically, for our investigation, assuming that market access is also a relevant factor in the ICT case, the implication is that countries with good

market access internationally will tend to exhibit higher export specialization in ICT products than countries with little or no such access.

In our econometric analysis of the determinants of ICT export specialization, variables are included which proxy for the deterministic factors of the theoretical frameworks discussed above. Thus, though our analysis does not constitute a formal test of various competing trade theories, it sheds light on the relevance and relative importance of those frameworks in the ICT case. In addition, other determinants are included and tested. More specifically, the following explanatory variables are investigated:

- Comparative Advantage factors
 - R&D
 - Human Capital
 - Cost Competitiveness
- NEG factors
 - ICT Market Size (Home-market effect)
 - Agglomeration Economies
 - International Market Access
- General factors
 - ICT-related public infrastructure
 - Multinational firm activity

As already discussed, from the comparative advantage view R&D (*RD*) as well as human capital stock (*HC*) are expected to be positive determinants of ICT export specialization (*XS*). The R&D production input variable is proxied by the country's R&D expenditure as a percentage of GDP, whilst human capital stock is proxied by the country's number of researchers engaged in R&D-related research. Additionally, general domestic production cost conditions also determine comparative advantage through cost competitiveness (*CC*). This variable is proxied by the real effective exchange rate is expected to exert a negative effect on export specialization.

For the NEG's home-market effect in the ICT context, we include a country's ICT market size (*ICT*) as a positive determinant of ICT export specialization, which is proxied by a country's total ICT expenditure. In other studies the GDP is used, but here the market size must specifically reflect the domestic market size of ICT products.

Agglomeration economies (*AE*), which are proxied by a country's manufacturing size (value added), contribute to the attraction of ICT firms in one country, and thus are also considered as a positive deterministic factor of a country's export specialization in ICT products.

International market access (*IMA*) is also considered to exert a positive effect on a country's degree of ICT export specialization. This explanatory variable is proxied by a country's international openness index, defined by the following equation:

$$IMA_i = \frac{X_i + M_i}{GDP_i} \quad (2)$$

where X_i , M_i , and GDP_i denote total exports, total imports, and gross domestic product of country i , respectively.

Regarding our two general deterministic factors, ICT-related public infrastructure (*INF*), proxied by the number of telephone mainlines per people, and the importance of multinational firm activity within a country (*MF*), proxied by the inward FDI stock to GDP ratio, are both expected to be positively associated with a country's ICT export specialization. In the first case, infrastructure may facilitate the local production and/or intra-country distribution of ICT goods and thus contribute, as a general supply-capacity factor, to export specialization in those goods. In the second case, foreign affiliates of multinational firms within a country may be engaged relatively more in ICT production, and/or create technological spill-overs to domestic firms, leading to relatively more ICT-related production and specialization.

According to the above outlined hypotheses, the model to be tested is summarized as follows:

$$XS_{it} = f(RD_{it}, HC_{it}, CC_{it}, ICT_{it}, AE_{it}, IMA_{it}, INF_{it}, MF_{it}) \quad (3)$$

with

$$\frac{\partial f}{\partial RD} > 0, \frac{\partial f}{\partial HC} > 0, \frac{\partial f}{\partial CC} < 0, \frac{\partial f}{\partial ICT} > 0, \frac{\partial f}{\partial AE} > 0, \frac{\partial f}{\partial IMA} > 0, \frac{\partial f}{\partial INF} > 0, \frac{\partial f}{\partial MF} > 0$$

The dependent variable is the Balassa index of equation (1) in each of the three ICT product groups and the explanatory variables are the proxies discussed earlier. A detailed description of the variables and data sources is provided in the appendix.

4.2 Econometric Methodology

Our empirical analysis of the country-level determinants of export specialization in ICT products is based on a panel data econometric framework. In particular, for the model's general function shown in equation (3), a linear panel regression equation is chosen for estimation, which takes the following form:

$$\begin{aligned}
 XS_{it} = & \beta_0 + \beta_1 RD_{it} + \beta_2 HC_{it} + \beta_3 CC_{it} + \beta_4 ICT_{it} \\
 & + \beta_5 AE_{it} + \beta_6 IMA_{it} + \beta_7 INF_{it} + \beta_8 MF_{it} + \mu_i + \varepsilon_{it}
 \end{aligned} \tag{4}$$

where i stands for countries ($i=1,2,\dots,28$)², t denotes years (yearly observations: $t=2000,\dots,2005$), μ_i represents the unobserved country-specific effects, and ε_{it} is the stochastic error term. Since we analyze the determinants of export specialization in each of our three ICT product groups, three regression models are estimated.

The inclusion of the country-specific effects is particularly important in order to control for omitted variables bias as well as to account for unobserved individual heterogeneity. Hausman tests are conducted in order to reveal the appropriate panel specification (fixed or random effects). The null hypothesis of the Hausman test that the individual specific effects are uncorrelated with the regressors is clearly rejected in all of the tree models ($\chi^2(8)=30.2$ [p=0.000]; 21.1 [0.001]; and 27.3 [0.000]). Thus, one-way fixed-effects panel estimation is used for our models.

As heteroscedasticity is detected in all models, it is corrected by estimating the models with White-robust standard errors. Additionally, in order to control for the presence of serial correlation a first-order autoregressive term is included. On the other hand, collinearity diagnostics indicate there is no problem with multicollinearity, and thus we retain all explanatory variables in the model for estimation.

² Taiwan is dropped out from the analysis due to lack of data.

4.3 Results and Discussion

Our econometric results on the determinants of ICT export specialization in each of our three ICT product groups are reported in Table 3. In addition to the regular regression coefficients, standardized (beta) coefficients as well as elasticities are also shown. Turning first to the model for electronic data processing machines, it is evident that all regressors show the expected sign, with the exception of multinational firm activity. However, our hypothesis of a positive impact of MF must not be generally true, since inward FDI within a country may be concentrated in activities that are not related to electronic data processing machines. In fact, the statistically significant negative coefficient indicates that countries with a high FDI-GDP ratio exhibit lower export specialization. This in turn implies that a large part of the inward FDI stock of those countries might be concentrated in the non-ICT sectors.

Statistical significance at various levels is found in all explanatory variables. R&D expenditure, international market access, infrastructure, and agglomeration economies are highly statistically significant. On the other hand, the coefficient of human capital is only significant at the 10% level. Both fixed-effects tests (F and χ^2) show that the unobserved country-specific fixed effects are highly significant, indicating that besides the regressors included in the model unobserved factors play a role in the context of the model.

In order to examine the relative importance of the determinants of export specialization in electronic data processing machines and in the other two ICT product groups, we have also estimated standardized regression coefficients. The standardized coefficients, also referred to as beta coefficients, indicate the magnitude of the impact of an independent variable on the dependent variable, and thus show the relative importance of various explanatory variables of the model. More specifically, the beta coefficients, which are unit-free, show how many standard deviations the dependent variable moves on average when the independent variable moves one standard deviation.

According to our beta analysis, the most important determinant in the EDP model is found to be international market access. The beta coefficient indicates that an increase of one standard deviation in this variable results in an increase of about 0.44 standard deviations in the export specialization in electronic data processing machines. Agglomeration economies, R&D expenditure, and ICT home market size follow the list of the next most important determinants.

The estimated regression model for the integrated circuits and electronic components product group produces coefficient signs that conform to our hypotheses. However, only four explanatory variables are found to be statistically significant: international market access, human capital, R&D expenditure, and cost competitiveness (in order of significance). On the other hand, the coefficients of ICT market size, agglomeration economies, multinational firm activity, and infrastructure are not statistically different from zero. Thus, the estimated model suggests that the above variables do not constitute deterministic factors of export specialization across countries in the given ICT product group.

In both fixed-effects tests the value and statistical significance of the test statistic is particularly high. This finding, coupled with the fact of many insignificant regressors, is an indication that unobserved country-specific factors are particularly important and that other factors account to a large extent for the observed export specialization patterns. In terms of relative importance, international market access is found to exert the strongest influence on the level of export specialization, with a beta coefficient of about 0.63. The estimated elasticity indicates that a 1% increase in the extent of a country's international market access leads to a 1.04% increase in the export specialization in the integrated circuits and electronic components product group. The next most important determinant is R&D expenditure, with a rather weak impact on the dependent variable, however, as the beta coefficient indicates.

In our third and final model of export specialization, all the parameter estimates have the expected signs. However, two independent variables are found to be statistically insignificant. Hence, according to the estimated regression model, cross-country export specialization within the world economy in telecommunications equipment is a positive function of a country's international market access, ICT home market size, telecommunications-related public infrastructure, agglomeration economies, and R&D; and a negative function of cost competitiveness (in order of statistical significance).

On the other hand, the importance of multinational firm activity within a country and human capital are found to have no effect on the dependent variable. The fixed-effects tests produce high test statistics and significance levels, indicating that unobserved country-specific characteristics and other determinants (not included in the model) explain significantly the cross-country variation in export specialization.

Regarding the relative importance of the determinants, it is evident that no large differences exist in this respect for most regressors. More specifically, four explanatory

variables appear to be about equally important in explaining the variation in the dependent variable (agglomeration economies, R&D expenditure, infrastructure, and international market access; in order of importance). Finally, cost competitiveness is found to have the weakest effect on export specialization in telecommunications equipment.

Since to our best knowledge there are no other empirical cross-country studies on ICT export specialization within the world economy³, no direct comparisons can be made with respect to our estimated determinants and their relative importance and elasticities. However, some loosely related cross-country studies on the determinants of export performance in high-tech products in general seem to agree with some of our findings, such as the importance of R&D (e.g. Braunerhjelm and Thulin, 2008).

The study by Srholec (2007), which comes closest to ours in the sense that it considers only electronics high-tech exports, finds that a country's technological capability (a composite variable that reflects R&D and human capital) is a statistically significant determinant of export specialization. However, other factors are found to be relatively more important, which is in line with our findings.⁴ Additionally, the significance of international market access is particularly stressed as a determinant of export performance in Redding and Venables (2003); though total exports instead of high-tech exports and are used in their analysis.

5. Conclusions

Our empirical analysis on the global export specialization in ICT products for 29 countries over the 2000-2006 period has provided descriptive as well as explanatory information and evidence on the observed specialization patterns. More specifically, it has been revealed that there have been some significant developments with respect to the dynamics and patterns (changes in the ICT export specialization levels and in the ordering of countries). This is especially pronounced for the case of China and Hong-Kong, economies which witnessed an impressive increase in their specialization index.

³ Several searches in the EconLit database did not return any relevant and directly comparable papers with regard to our empirical study.

⁴ Because of the special focus of Srholec's (2007) study on the relevance and importance of intermediate inputs and imports on export performance, the other variables considered by this study are not the same or even comparable to ours. An exception to this could be our international market access variable which also reflects international integration and trade openness. Since international trade can also include trade in intermediate inputs, the significance found for this variable in our analysis may also reflect to some extent the importance of intermediate inputs trade on export specialization, as found in Srholec (2007).

On the other hand, several countries regarded as “high-tech” economies witnessed to some extent a declining ICT export specialization. Overall, however, there is no evidence of a general reorganization of export specialization patterns in ICT products across countries.

Furthermore, the panel-econometric analysis employed to investigate the country-level determinants has revealed insightful and interesting findings; some of which are expected while others are less so. Specifically, although the results across the three ICT product groups are not identical, it has, in general, been found that R&D and human capital have a statistically significant effect on ICT export specialization. These deterministic factors are characterized by the theoretical literature as particularly important and driving forces of specialization in ICT and high-tech products. However, according to our findings other determinants are relatively more important than the above two factors for explaining the ICT export specialization across countries. This is especially true for human capital which has been found to have a rather small impact. R&D exerts a much stronger effect compared to human capital and lists among the most important determinants.

The factor that consistently exerts a strong impact on export specialization in all of the three ICT product groups has been found to be international market access; and in two of them this deterministic factor is found to be the most important. Agglomeration economies have also been found to have strong causal effects and be relatively more important than human capital (in all ICT product groups) and R&D expenditure (in two product groups).

Overall, the findings indicate that the determinants associated with the new economic geography are relatively more important than those associated with the traditional comparative advantage framework. Though our econometric analysis does not constitute a formal analysis for testing trade theories, the empirical results seem to suggest that the NEG theory explains to a large extent the observed export specialization patterns and is more relevant compared to the comparative advantage theory in the ICT case.

Hence, some policy implications with regard to a country’s extent of ICT export specialization seem to be hinted by our empirical analysis. In particular, besides efforts for increasing the national human capital stock and the R&D activities, policies that promote international market linkages, increase the openness of the domestic economy (where involvement in the global ICT production sharing may be particularly important),

and promote industrial clustering and agglomeration are expected to have, ceteris paribus, a significant positive effect on ICT export specialization.

Appendix 1: Variable Descriptions and Data Sources

Variable	Description	Data Source
<i>XS</i> : Export specialization	Balassa index, Equation (1)	Own calculations based on trade statistics from the World Trade Organization's international trade database
<i>RD</i> : R&D	Research & development expenditure as a % of GDP	World Development Indicators (WDI), World Bank
<i>HC</i> : Human capital stock	Researchers in R&D per million people	WDI
<i>CC</i> : Cost competitiveness	Real effective exchange rate index	WDI
<i>ICT</i> : ICT home market size	Total ICT expenditure within a country in current US dollars	WDI
<i>AE</i> : Agglomeration economies	Manufacturing value added in current US dollars	WDI
<i>IMA</i> : International market access	International openness index, Equation (2)	WDI
<i>INF</i> : Infrastructure	Telephone mainlines per 100 people	WDI
<i>MF</i> : Multinational firm activity	Inward FDI stock as a % of GDP	Own calculations based on data from the United Nations FDI database and WDI

Appendix 2: Figures and Tables

Figure 1: Trends in world ICT exports by main ICT product group, 2000-2007

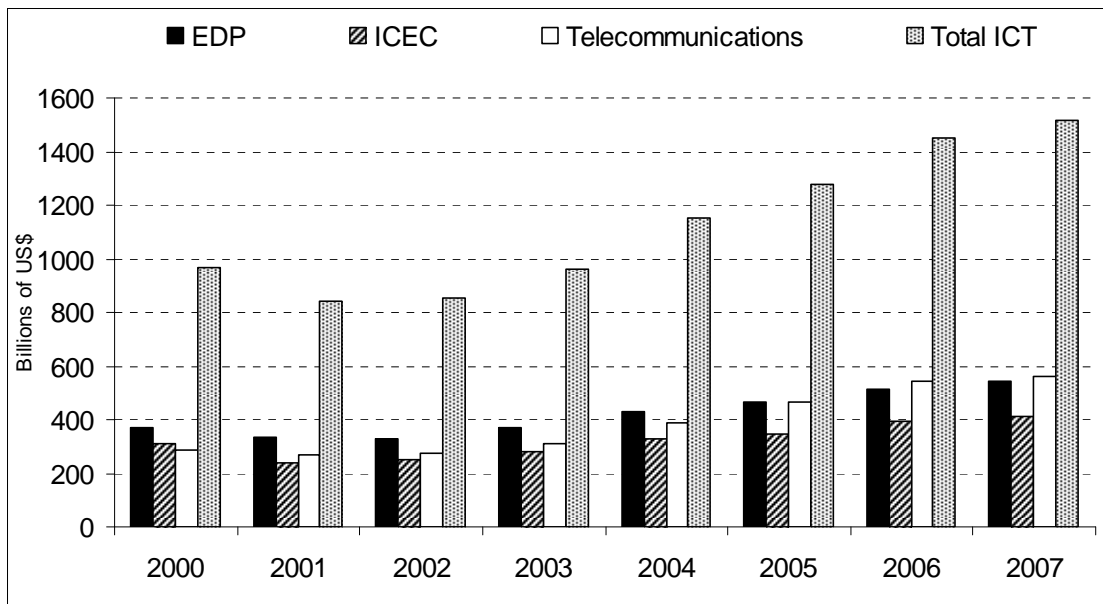


Figure 2: Shares of main ICT product groups in total ICT world exports, 2000-2007

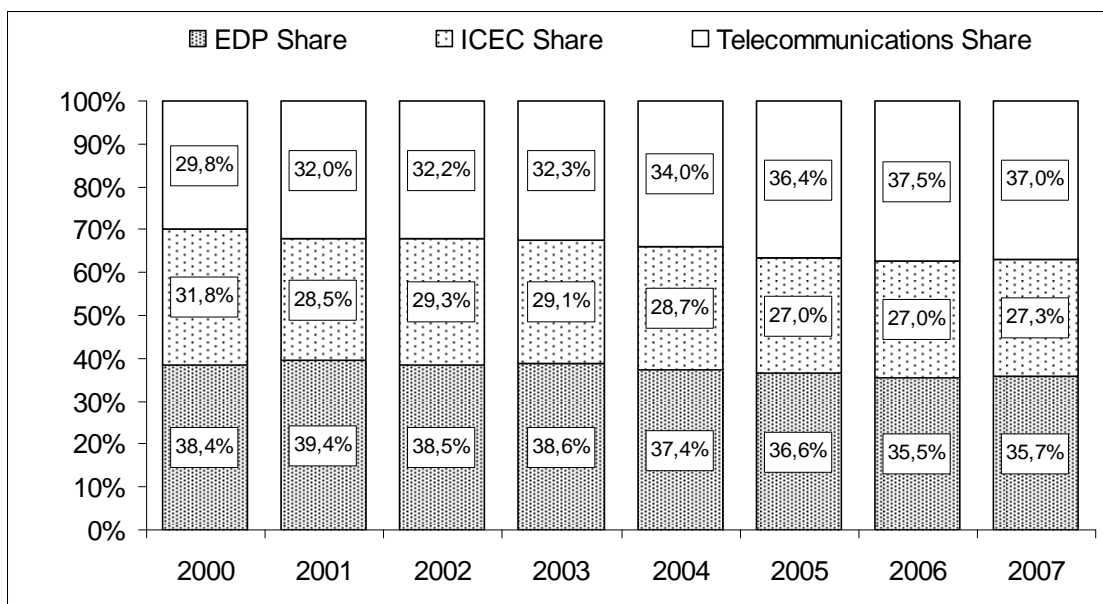


Figure 3: Shares of ICT exports in total manufacturing world exports, 2000 & 2007

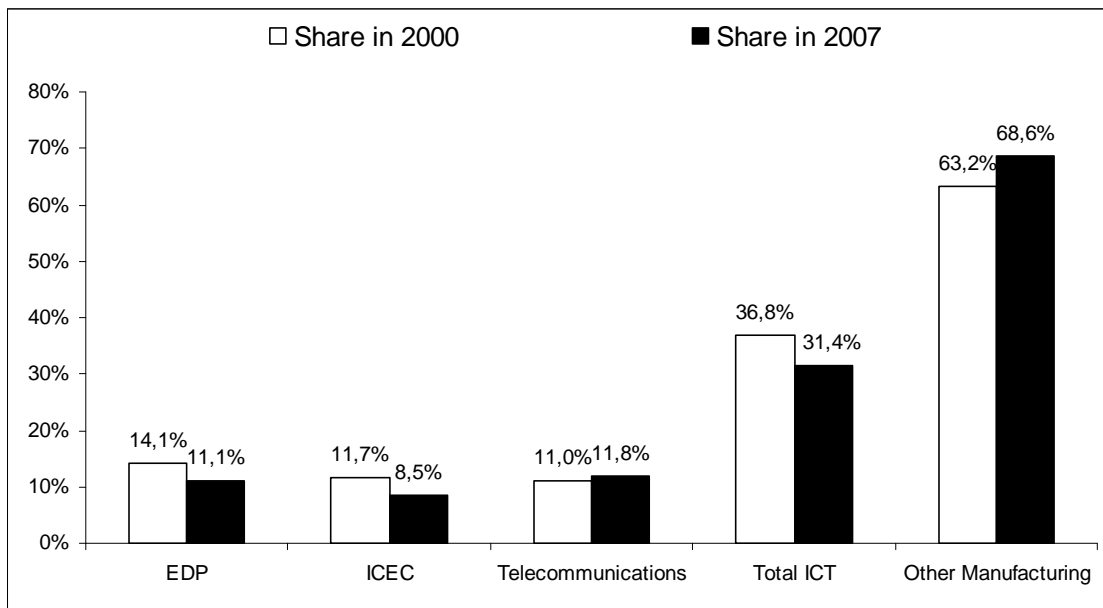


Table 1: Global export specialization in three broad ICT product groups across 29 countries, 2000-2006 (Balassa indices)

	Electronic Data Processing Machines				Integrated Circuits & Electronic Components				Telecommunications Equipment			
	2000	2003	2006	%Δ	2000	2003	2006	%Δ	2000	2003	2006	%Δ
Australia	0.17	0.21	0.14	-22.2	0.03	0.05	0.05	41.9	0.23	0.15	0.10	-57.8
Austria	0.45	0.49	0.38	-16.0	0.50	0.52	0.60	19.1	1.20	1.35	0.56	-53.1
Brazil	0.14	0.06	0.07	-48.6	0.08	0.07	0.03	-62.5	0.62	0.47	0.46	-25.3
Canada	0.32	0.22	0.22	-31.9	0.24	0.17	0.16	-34.6	0.88	0.41	0.46	-47.4
China	1.42	3.01	3.45	142.1	0.49	0.67	0.98	99.1	1.92	2.60	3.00	56.1
Denmark	0.39	0.43	0.38	-4.5	0.09	0.07	0.17	86.3	1.11	1.07	0.86	-23.0
Finland	0.20	0.17	0.28	39.0	0.26	0.21	0.11	-57.7	5.80	5.41	3.95	-31.8
France	0.58	0.43	0.42	-28.9	0.58	0.48	0.58	0.4	1.06	0.74	0.69	-35.3
Germany	0.63	0.67	0.76	21.3	0.58	0.59	0.56	-3.5	0.80	0.82	0.71	-11.7
Greece	0.12	0.09	0.10	-11.0	0.03	0.04	0.04	32.8	0.52	0.39	0.39	-25.8
Hong Kong	1.63	2.36	3.12	92.0	1.68	2.56	3.82	127.6	2.51	3.28	3.36	34.2
India	0.10	0.14	0.11	7.6	0.04	0.07	0.05	27.6	0.06	0.09	0.10	66.8
Ireland	3.17	2.94	2.99	-5.9	0.97	0.81	1.01	2.6	0.81	0.33	0.27	-66.5
Italy	0.33	0.26	0.17	-48.8	0.38	0.39	0.35	-7.5	0.53	0.42	0.42	-20.0
Japan	1.44	1.15	1.02	-29.5	2.10	2.23	2.31	10.0	1.61	1.74	1.34	-16.7
Korea	1.67	1.65	1.23	-26.3	2.54	2.32	2.58	1.5	1.58	2.91	2.43	54.2
Malaysia	2.85	2.60	3.43	20.4	3.12	4.60	4.11	31.8	2.30	1.92	1.67	-27.5
Mexico	1.16	1.56	1.10	-5.2	0.37	0.34	0.25	-30.6	2.44	2.21	2.72	11.4
Netherlands	1.81	1.90	2.30	26.8	0.88	0.80	0.56	-36.4	0.66	0.63	0.72	9.2
Norway	0.10	0.08	0.06	-41.8	0.01	0.03	0.04	390.2	0.18	0.18	0.12	-30.6
Portugal	0.06	0.38	0.44	590.2	0.35	0.76	1.15	226.7	0.98	0.84	0.77	-20.9
Singapore	3.20	2.91	2.44	-23.8	4.27	5.38	6.74	57.8	1.09	1.39	1.29	17.6
Spain	0.26	0.18	0.14	-47.9	0.10	0.17	0.12	19.5	0.49	0.53	0.48	-2.0
Sweden	0.17	0.28	0.35	110.5	0.20	0.14	0.18	-13.8	3.91	2.33	1.99	-49.1
Switzerland	0.41	0.19	0.15	-63.4	0.25	0.19	0.22	-10.7	0.34	0.23	0.23	-32.1
Taiwan	3.33	2.94	1.60	-52.0	2.99	3.78	5.97	99.6	0.99	1.45	1.26	27.2
Thailand	2.03	1.98	2.52	23.9	1.65	2.00	1.87	13.8	1.20	1.39	1.04	-13.3
UK	1.37	1.09	1.11	-19.3	0.71	0.50	0.49	-30.9	1.51	1.25	2.73	80.5
US	1.47	1.30	1.33	-9.0	1.93	2.01	1.89	-2.1	1.08	0.90	0.89	-17.9

Note: %Δ denotes percentage change in the Balassa index between 2000 and 2006. Source: Own calculations based on WTO trade data.

**Table 2: World export specialization dynamics across countries between 2000 and 2006
(Spearman's Rank Correlation Coefficients)**

ICT product group	SRC Coefficient	Significance (p-value)	N
Electronic Data Processing Machines	0.873	0.000	29
Integrated Circuits and Electronic Components	0.942	0.000	29
Telecommunications Equipment	0.920	0.000	29

Table 3: Determinants of Export Specialization in three broad ICT product groups (fixed-effects panel estimates)

Independent Variables/ <i>Statistics</i>	Electronic Data Processing Machines			Integrated Circuits & Electronic Components			Telecommunications Equipment		
	Regression coefficients	Standardized coefficients	Elasticity	Regression coefficients	Standardized coefficients	Elasticity	Regression coefficients	Standardized coefficients	Elasticity
RD	0.32351 (0.0000)	0.28534	0.65385	0.16857 (0.0245)	0.11190	0.33806	0.30112 (0.0644)	0.24209	0.50563
HC	2.3E-05 (0.0706)	0.03825	0.08064	2.1E-05 (0.0018)	0.02596	0.07215	4.2E-05 (0.4416)	0.06274	0.12054
CC	-0.00387 (0.0432)	-0.02858	-0.41586	-0.00263 (0.0982)	-0.01460	-0.28015	-0.00170 (0.0994)	-0.01143	-0.15163
ICT	1.3E-12 (0.0401)	0.26035	0.12750	3.9E-13 (0.4733)	0.05774	0.03728	9.8E-13 (0.0367)	0.17601	0.07856
AE	9.6E-13 (0.0103)	0.33683	0.22022	2.4E-13 (0.4497)	0.06383	0.05502	8.6E-13 (0.0601)	0.27636	0.16468
IMA	0.00559 (0.0001)	0.43997	0.54640	0.01073 (0.0000)	0.63552	1.04050	0.00324 (0.0007)	0.23224	0.26288
INF	0.01053 (0.0007)	0.13745	0.55604	0.00546 (0.2769)	0.05361	0.28591	0.01968 (0.0408)	0.23406	0.86298
MF	-0.00499 (0.0711)	-0.17321	-0.20084	0.00299 (0.3281)	0.07809	0.11936	2.2E-05 (0.9706)	0.00069	0.00073
AR(1)	0.73275 (0.0000)			0.22874 (0.0109)			0.19505 (0.0184)		
<i>Adj. R²</i>	0.9788			0.9839			0.9785		
<i>F-statistic</i>	318.84			585.38			309.59		
<i>DW</i>	2.1810			2.0693			1.9621		
<i>F(20, 75)</i>	3.8646 (0.0000)			7.3812 (0.0000)			7.1323 (0.0000)		
$\chi^2(20)$	74.373 (0.0000)			114.24 (0.0000)			111.86 (0.0000)		

Notes: Results for the constant are not shown. $F(20, 75)$ and $\chi^2(20)$ are fixed-effects tests. Panel observations (NT)=168, balanced NT=126, final NT with AR(1) term is 1

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