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Impact of the Technological Developments to the Computer and Communication Service Exports: Panel Data Analysis

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Abstract

The study has potential limitations. A random effects model has been estimated considering log-transformed data seeking to obtain reliable measurements that allow a statistical analysis. The estimate model has conducted a panel data analysis considering the computer, communications and other services as a percentage of commercial service exports taken as a dependent variable (Y) and three explanatory variables related to the share of high-technology exports in manufactured exports (X_1), researchers (per million) (X_2) in research and development (R&D), share of computer, communications and other services in commercial service imports (X_3). A panel of eight developed countries has been chosen that are United States, Japan, China, France, Germany, United Kingdom, Singapore and Korea Republic covering the period of 1996-2017 (22 years). With three panel unit root tests, such that λ_B, IPS and CADF, all variables require a first difference to become stationary. The null hypothesis of no co-integration can not be rejected according to the seven tests proposed by Pedroni. The findings reveal a positive impact for both variables (X_2) and (X_3) but a negative impact for (X_1) on the variable (Y). The findings reveal that if (X_2) (respectively (X_3)) increases 1% then Y increases 0.115% (respectively 0.271%). While if the variable (X_1) increases 1% then Y decreases 0.119%.

Keywords: Technology; Technician; Researchers; Computer; Communications; Fixed effects model; Random effects model

Introduction

It is known that the importance of high-technology exports in manufactured exports ((X_{1t}) variable) and hence in merchandise exports became one of the indicators of scientific progress in developed countries. Moreover, the numbers of researchers per million people, (X_{2t}) variable, working in research and development (R&D) are characteristic of these countries and illustrate the importance of investment in human resources and by consequence the positive impact on the knowledge economy that leads to the economic growth. The exchange of computer services, of communications ((X_{3t}) variable) between countries has positively impact on both exporting and importing countries. And as a result the variable associated with computer, communications and other services (% of commercial service exports), (Y_t) variable, will be influenced by the above three variables. To complete this small introduction, we add that today the computer plays a crucial role in all banking sectors, in the business world, in everyday life revealed by the speed of communication (mail, face book, a portable machine, etc.). With the internet, we can easily get all the information that we need, and everyone knows that there is an impact of this technology on the growth of productivity and industrial competitiveness as well as on economic and social development.

Methodology

In our paper, we will study the impact of the explanatory variables X_{1t}, X_{2t} and X_{3t} on the computer, communications and other service exports (Y_t) as a dependent variable. We have a panel of eight countries that have a remarkable role in the world in the transfer of computer technology. These countries are United States, Japan, China, France, Germany, United Kingdom, Singapore and Korea, Rep. For each country, four-time series have been constructed covering the period of 1996-2017 (22 years). The choice of these countries is justified by their technological importance on the international scene and by their policy to increase the number of researchers in research and development offering them all kinds of concern allowing them to give the best to serve their country.

Our paper will use an econometric approach by choosing between three types of models known in Econometric for Panel Data: Pooled regression model, fixed effects model and random effects model. Each model uses an appropriate estimation method [1]. Before turning to these three models, panel unit root tests will be executed using λ_B, IPS and CIPS tests proposed respectively by Breitung [2], Im et al. [3] and Pesaran [4].

Economically, we believe that there are impacts of the three explanatory variables X_{1t}, X_{2t} and X_{3t} on the dependent variable (Y_t). A long-run equilibrium relationship (co-integration) will be tested among these variables both for each country in the panel and for the entire panel. If the null hypothesis of panel unit root is accepted, then the seven tests of no co-integration of Pedroni will be used. If the null hypothesis of no co-integration cannot be rejected, then we return to choosing between a fixed individual effects model and a random individual effects model.

The paper is divided into 5 sections: The first is devoted to the introduction. The second is for a descriptive statistical analysis of the variables for each country, while the third is for a review of the literature. The fourth section will be addressed to the implementation of the specified economic panel model and finally in the fifth section we finish with a discussion and conclusion.

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Results and Discussion

Descriptive statistics

In Appendix 2, we have grouped the basic statistics for each of the four variables and for the eight countries involved by this research. For the high technology export variable, we will see a peculiarity of Singapore compared to other countries. Indeed, the standard deviation recorded the highest value (11.42) showing a great variability in the evolution of this variable. This explains the great difference between the maximum of 90.02% in 2003 and the minimum of 34.38% in 2006. For France, there was equality between the median and the mean. The lowest standard deviation is 1.54 and it is found in Germany. To make better the use of the CAGR statistics, for China, in the period of 1996-2005, the CAGR is 10.64% while in the period of 2005-2017, the CAGR is 2.13%. In fact, the China Real GDP Growth has increased from 9.9% in 1996 to reach a rate of 14.2% in 2007 and then a decreasing trend starts reaching the rate of 6.8% in 2017 [5].

For the countries USA, Japan, Germany, United Kingdom, Singapore and Korea, Rep., the negative values of CAGR reflect a decrease in the importance of the high technology exports in manufactured exports. For China and France, the CAGR positive values were 3.15% and 1.05%, respectively.

China is now a major player in the global economy. China's high-technology revolution extends to the factory floor. About 80% of China's exports consist of manufactured goods, most of which are textiles and electronic equipment, with agricultural products and chemicals constituting the remainder. The graph associated to the United States reveals that the high-technology exports dropped from 30.76% to 13.8% of the manufactured exports between 1996 and 2017. US and China brawl over high technology. But China's role as a high-tech exporter is growing on the International scene. In other words, China has been gaining traction. According to the Stephen Ezell, Director of Global Innovation Policy, Information Technology and Innovation Foundation, China has raised its share of global output in 18 high-tech manufacturing industries from 8% in 2003 to 27% in 2018. Moreover, University-level education is improving. In 2011, China has 11 Universities in the top-ranked 200 universities of the world [6]. China is now the world's largest export of high-tech products. Singapore ranked in the top 10 in the world in terms of technology using indicators such as quality of school science and technology education, licensing of foreign technologies [7].

The Singapore's high-technology exports among the manufactured exports experienced a large increase of 60.63% in 2002 to 90.02% in 2003 and according to Srholec [8], this increase in the high-tech exports has been dominated by electronics. Then Singapore's exports decline unexpectedly over the period 2003-2006 to reach 34.38 noting according to the World Health Organization (WHO) that between November 2002 and July 2003, an outbreak of Severe Acute Respiratory Syndrome (SARS) appeared in Southern China causing 774 deaths reported in 37 countries [9]. Based on data as of the 31 December 2003, the cumulative number of cases was observed in the top five countries which are: China (5327), China-Hong Kong (1755), China-Taiwan (346), Canada (251) and Singapore (238).

The share of high technology exports in UK manufactured exports decline from 34.02% in 2001 to 24.27% in 2004, then a pick of 33.85% is observed in 2006 and a decline to 18.66% in 2007. In fact the 2007-2010 financial crises and the late 2000s global recession are responsible for this decline maintaining an almost stable evolution until 2017. According to the Figures in Appendix 1, over the period 2007-2017, the share of high technology exports in UK goods exports is above Germany but just below France. For more information about UK trade performance over the past years refer to Curran and Zignago [10]. By inspecting the Figure 1, China ranked first in R&D researchers, followed by USA and Japan. Yet the annual growth rates between 1996 and 2017 were 6.83% in Singapore, 6.35% in Korea, 5.36% in China, 3.31% in UK, 2.86% in France, 2.45% in Germany, 2.41% in USA and 0.38% in Japan. The figures associated with this variable show a small decline in the number per millions of researchers in R&D due to the 2008 financial crisis.

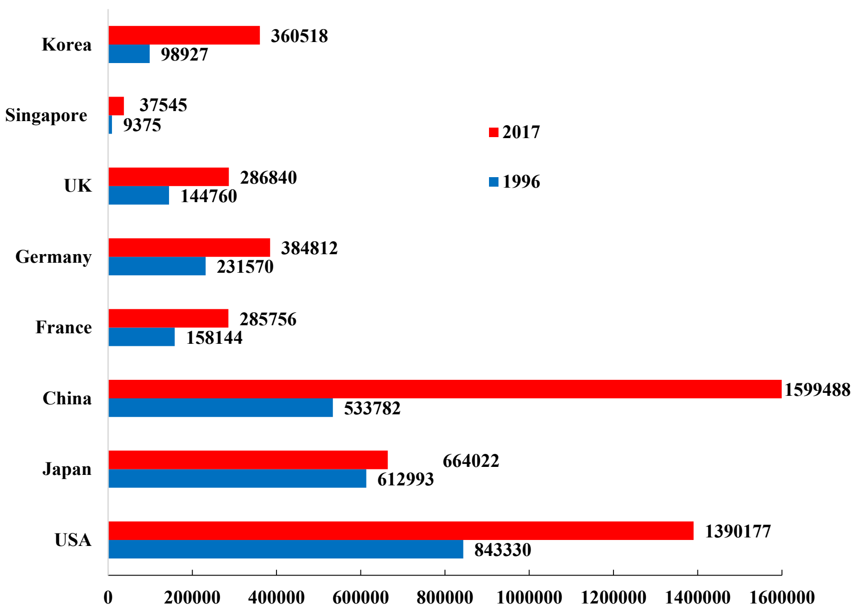

Figure 1: The researchers in R&D.

According to the Yearbook of Statistics Singapore, Research and Development, a significant increase in the number of patents awarded in Singapore, passing from 58 in 1994 to 599 in 2004. Using high technology, Singapore becomes now a smart Nation. Singapore animates technology upgrades across seven ways [11]:

1. Pay via QR codes (Quick Response Code) at the coffee shop.
2. Cars can now drive by themselves.
3. The EZ-Link payment system being accepted at over 30,000 retail stores across Singapore.
4. The police are using drones to catch bad guys.
5. Intelligent HDB home systems (Housing and Development Board).
6. Lamp posts that gather data.
7. Robots are being integrated into society.

Let us return to the variables "*Computer, communications and other services as percentage of commercial service imports*". Some peaks and troughs deserve to investigate the cause of behind them. The 2008 financial crisis has led to a decline in the share of computer, communications and other services imports in China commercial service imports passing from 35.81% in 2008 to 3.22 in 2010. Then a peak is observed reaching 29.69% in 2011 and maintaining a weak decaying trend until 2017. Neglecting the important trough achieved in 2010, China has a negative CAGR of -1.84%. For the three European countries, the chart shows that the share of computer, communications and other services imports in France commercial service imports is above both Germany and United Kingdom. For all three countries, there was a slight fluctuation over the period 1996-2017. Singapore reports on the highest CAGR of the order of 3.63% followed by Japan (1.8%), USA (1.79%), Germany (1.72%), United Kingdom (1.36%), France (1.31%) and Korea, Rep. (1.14%).

The Computer, communications and other services as a percentage of commercial service exports reveal a significant fluctuation in China. A peak of 73.51% achieved in 1997, then an evolution almost stables until 2002 with 74.10% doing a fall until 2006 with 40.46% then an important trough observed in 2010 with 28.73% then an increase to 56.11% in 2011 with stability over the rest of the period.

How can we explain this two consecutive falls?-the first took place on the period 2002-2006 and the second was punctual in 2010? We believe that the first has been resulted of negative impact of the outbreak of SARS appeared in Southern China while the second due to the global financial crisis. For Japan and USA, we observe CAGR of -0.1% and 0.99%, respectively. It would be more informative to consider two periods for Japan: between year 1996 and 2005 with a CAGR of -2.36% and between year 2005 and 2017 with a CAGR of 1.63%. For the other countries, we have CAGR of 2.64% for Singapore, 2.04% for Germany, 1.17% for France, 1.06% for Korea, Rep., and 1.03% for United Kingdom.

Literature review

Since the 1960s, export growth has played a central role in many countries' economic growth strategies. Analyses of export growth and its general economic effects have been an important topic in the economic literature in the last decade. In the same way, the technological innovation has been considered one of the most important drives of the worldwide economy in the last few decades and Research and Development (R&D) investment is one of the key strategies to secure technological potential. Reaching a certain level of R&D expenditures has been the main target of many innovative policies in the recent years.

We begin with a book that just carried out of Mourad [1] dealing with panel data analysis, theory and practice, based on a great bibliography by examining all the sides that make this topic easily affordable by researchers. Mourad et al. [12] performed a study Modelling the relationship between the computer, communications and other services as a percentage of commercial service exports with three explanatory variables related to the high-technology exports, researchers (per million) in research and development (R&D), communications and other services in commercial service imports. Also with Mourad [13], a panel co-integration analysis is carried out by considering the impact of trade on GDP in the World's top ten economies. Mourad [14] uses Pedroni's approach to estimate the long-run equilibrium relationships between vital economic determinants and real GDP in GCC countries. The two FMOLS and DOLS estimators were used to estimate individual targets and a target for the entire group. Kabaklarli et al. [15] used a panel co-integration model to analyze the long-term relationship between high-technology exports and economic growth in selected OECD countries. The empirical results showed that an improvement in patent applications and foreign direct investment play a decisive role in upgrading selected OECD countries' high-tech exports, while growth rate and investment play a negative role in enhancing these countries' high-tech exports. Pradhan et al. [16] used a macroeconomic growth framework to investigate the long run relationship between broadband infrastructure (both broadband and internet users), and economic growth, consumer price index, labor force participation rate, and gross domestic fixed capital formation. The results of the study highlighted, in particular, a positive relationship between broadband infrastructure and economic growth. Mehrara et al. [17] studied the determinants of export for 24 developing countries based on Bayesian Model Averaging (BMA) and Weighted-Average Least Square (WALS) technique. The results showed that rule of law as a proxy for Institutional quality, human capital, import (as a measure of openness) and GDP with posterior inclusion probability 100% are the most important variables influencing the high-technology export in developing countries. Hawash and Lang [18] tested in their study whether higher IT adoption results in higher total factor productivity (TFP) growth of developing countries or not, by conducting a panel data regression for 33 developing countries. They also examined the relative importance of IT adoption in comparison to other technological aspects such as: Technology creation, technology transfer, and enhancing individuals' technological absorptive capacities through higher educational levels. The study concluded that IT adoption and higher educational attainment tend to relatively be the most significant factors affecting TFP growth in developing countries. Meo and Usmani [19] compares the impact of R&D expenditures on research publications, patents and high-tech exports among European countries. They found a positive correlation between patent application and high-tech exports. However, there was no association between GDP per capita and research outcomes. Sandua and Ciocane [20] intend to assess, at the European level, the relationship between medium and high-tech exports, on one hand, and some of the main determinants of innovation, on the other hand. The volume of research-development expenditure, both public and private, the human resources employed in knowledge intensive activities or the propensity for international commercial relation have been assumed as important causal factors for increasing high tech export in EU countries. The results of the econometric analysis conducted in this paper confirm a causal relationship between the independent variables mentioned above and the EU high-tech exports level. The specific variations at country level are also displayed. Research results also confirmed a positive correlation between total R&D expenditure volume and the level of high-tech exports, with variability between countries. The influence of private R&D expenditure on high-tech exports is stronger than public R&D expenditure. Gökmen and Turen [21] examined the associations among inward Foreign Direct Investments (FDI), Economic Freedom Level (EFL) and Human Development Level (HDL) variables using a panel data of EU-15 countries and found that EFL, HDL and FDI aggregately have a statistically significant positive impact on High technology exports (HTX) by conducting panel co-integration method. Additionally, they employed panel causality test and saw that there is long-run Granger causality running from FDI, HDL and EFL to HTX and similarly from HTX, FDI and EFL to HDL. Ahmed and Ridzuan [22] tested the impact of information and communications technology (ICT) on economic growth. The study concluded that ICT has played an important role as engine of growth for sustainable development in ASEAN5 and ASEAN5+3 countries. Gani [23] examined the relationship between high technology exports and per capita economic growth in countries with higher levels of technological achievement is examined. Three groups of countries classified as technological leaders, potential leaders and dynamic adopters are chosen for empirical analysis on the basis of the technological achievement index. The regression results reveal that high technology exports exert a statistically significant positive effect on growth of the technological leader category of countries and a positive but statistically insignificant effect on the potential leader category of countries. Kanamori and Motohashi [24] compared sources of economic growth in Japan and Korea. The result of the study showed that in both countries, the information technology industry is an important source of economic and productivity growth from the output side. In addition, active IT investments are supposed to lead to substantial IT capital service contribution to economic growth from the input side. Samimi and Alerasoul [25] estimated the impact of R&D on economic growth of developing countries. To do so he has used a sample of 30 developing countries. His findings based on panel data regression models indicate that in general no significance positive impact exists in the countries under consideration. Braunerhjelm and Thulin [26] analysed how increased R&D expenditures and market size influence the distribution of comparative advantage. The empirical analysis comprises 19 OECD countries. It is shown how an increase in R&D expenditures by one percentage point implies a three percentage point increase in high-technology exports, whereas market size fails to attain significance. Also institutional factors influence the dynamics of comparative advantage. Žáková [27] deal with the expenditures on research and development and the influence they have on economic growth of a country. A positive correlation between R&D expenditures and the stage of economic development of a country is confirmed but the impact depends on various socio-economic, institutional, and structural variables. Falk [28] estimated a dynamic growth model on panel data for 22 OECD (Organization for Economic Co-operation and Development) countries, in which the data is measured as 5 year averages. Using the system GMM panel estimator, which corrects for simultaneity, he found that both business R&D intensity and the share of high-tech exports are significantly positively related to the GDP per working age population. Sridhar and Sridhar [29] investigated empirically the relationship between telephone penetration and economic growth, using data for developing countries. The study found positive impacts of mobile and landline phones on national output, when he controls for the effects of capital and labor.

Panel data analysis: Fixed or random effects model

Using panel data, we perform with a much larger data set. This use leads to reduce the collinearity among the explanatory variables, and it will be more variability than the typical of time series data. In other words, with more informative data, we can obtain more credible estimates comparing several models. Another advantage of panel data is their ability to control and to distinguish between individual heterogeneity.

In the panel data, the research effort should focus on the distinction between three types of models: Pooled regression model, fixed effects model and random effects model. The strategy of choice begins by testing three types of null hypothesis as proposed by Hsiao [30]. However, this strategy was proposed before the appearance of the new statistical tests which permit to make a decision around the panel unit roots and which take into account both the independence and the dependence (cross-independence or cross dependence) among the panel sections of a variable. For this, if the data require a first difference to get stationary series , then a question will be imposed: the variables in question i.e. the dependent variable (Y_t) and the independent variables $X_{1,it}$, $X_{2,it}$, $X_{3,it}$, i=1,……,8, t=1996,……,2017, are they co-integrated? In other words, is there a long-run equilibrium relationship that governs the behaviour of the variables in level? If the null hypothesis of no co-integration cannot be rejected, we will have to choose between the models described above.

In the following, the cross sectional dependence (CSD) in panel data has been carried out using the tests the most used in the literature such that the Pesaran's CD_p and Breusch-Pagan's (CD_{BP}) tests for cross sectional dependence in panel models [31]. It is very useful to mention that asymptotically: $CD_P \underset{T\to\infty, N\to\infty}{\rightarrow} N(0,1)$ and by consequence, with the two-tailed of a standard normal, the critical values are 1.65, 1.96, and 2.58 for 10%, 5%, and 1%, respectively.

While, $CD_{BP} \underset{T\to\infty}{\rightarrow} \chi^2_{\frac{N(N-1)}{2};\ N=8} = \chi^2_{28}$

where with 10%, 5% and 1% levels, the critical values with 28 degrees of freedom of Chi-Squared distribution are 37.92, 41.34 and 48.28, respectively. The findings in Table 1 reveal a cross dependence for the variables Y_{it}, $X_{1,it}$ and $X_{3,it}$ especially adopting the Pesaran's test [4].

Now the panel unit root tests are carried out using two tests from the first generation [1], that are λ_B test suggested by Breitung [2] and IPS test (Z-tildebar) proposed by Im et al. [3], then from the second generation, the Cross-Sectionally Augmented Dickey-Fuller (CADF) performed by Pesaran [4] test will be used. The findings are in Table 2 considering Log-transformed data with Constant as an Individual Specific Components with an average *p* chosen from 2 by AIC.

Basing on the findings of Table 3, the panel co-integration tests can be now performed with Pedroni's approach using the famous seven

Variables	Tests			
	CD_{BP}		CD_P	
	X	ΔX	X	ΔX
Y	38.94[c]	31.3	4.51[a]	3.63[a]
X_1	95.48[a]	107.73[a]	7.96[a]	8.19[a]
X_2	27.22	23.77	-0.62	0.63
X_3	35.45	36.63	3.28[a]	3.04[a]

[a] and [c] indicate that the test is significant at 1% and 10% significant levels, respectively

Table 1: Testing for cross-section dependence in panel.

Variables	Tests							
	Breitung test			IPS test			CIPS test	
	λ_B			Z-tildebar			CIPS=$\overline{CADF}$	
	X	ΔX	$\overline{p}$	X	ΔX	$\overline{p}$	X	ΔX
Y	1.49	-5.62[a]	(0.25, 0.00)	0.78	-5.91[a]	(0.25,0.00)	-1.90	-3.23[a]
X_1	-0.22	-4.5[a]	(0.38, 0.00)	0.40	-3.29[a]	(0.38,0.50)	-1.82	-3.31[a]
X_2	3.48	-4.18[a]	(0.25,0.00)	-0.86	-3.91[a]	(0.25,0.50)	-1.74	-2.87[a]
X_3	2.20	-4.19[a]	(0.13,0.00)	0.42	-4.27[a]	(0.13,0.38)	-2.17	-2.68[a]

[a]indicates that the variable is stationary in the first difference at 1% significance level.
Note: For the CIPS test, the critical values of average of individual Cross-Sectionally Augmented Dickey-Fuller are around -2.60, -2.34 and -2.21 at 1%, 5% and 10% significant levels (constant only), respectively [4].

Table 2: Panel unit root tests.

Panel		Group	
panel v-stat	0.35	group rho-stat	1.29
panel rho-stat	0.22	group PP-stat	-0.53
panel PP-stat	-0.92	group ADF-stat	0.15
panel ADF-stat	-0.46		

The null hypothesis of no co-integration is accepted at 5% level of significance

Table 3: Pedroni's panel co-integration tests.

test statistics under a null of no co-integration in a heterogeneous panel (medium to large N, large T) with one or more non-stationary regressors. In fact, the seven test statistics of no co-integration proposed by Pedroni [32-34] have been used with an automatic lag length selection based on AIC (Kernel Width=3).

It seems that the variables are not co-integrated and therefore the long-run equilibrium relationship does not exist between the variables. We have to choose now between the fixed effects model estimated by Least Squares Dummy Variable (LSDV) and the random effects model also called Error Components Model (ECM) estimated by the Feasible Generalized Least squares (FGLS) method. The estimate of pooled regression model, fixed effects model and random effects model are in Tables 4-6, respectively.

***Choice between pooled OLS regression model and LSDV model*:** If there is an individual effect that characterizes each of eight countries, then the model will be:

$$Y_{it} = \sum_{d=1}^{N} \alpha_d \ \text{IDUMMIES}(d) + \beta_{1i}X_{1it} + \beta_{2i}X_{2it} + \beta_{3i}X_{3it} + \varepsilon_{it}$$

Testing now the null hypothesis vs the alternative:

H_0: $\alpha_1 = \ldots = \alpha_8 = \alpha_0$

H_a: $\exists$ (i,j); $\alpha_i \neq a_j$

Under H_0, $\sum_{d=1}^{N} \text{IDUMMIES}(d) = 1$ and we obtain the pooled model called the restricted model,

$Y_{it} = \alpha_0 + \beta_{1i}X_{1it} + \beta_{2i}X_{2it} + \beta_{3i}X_{3it} + \varepsilon_{it}$

We have the choice between the restricted model that is the pooled model and the unrestricted model that is the LSDV model. We estimate the two models and we retain the Restricted Residual Sum of squares RSS_R and the Unrestricted Residual Sum of squares RSS_U and then we calculate the statistic,

$$F = \frac{\left[RSS_R - RSS_U\right]/(N-1)}{RSS_U / \left(NT - (N+K)\right)}, \quad N = 8 \ \text{and} \ K = 3$$

$F(7,165) = 25.43 > F_{0.05,7,165} = 2.07$

Variable	Coefficient	Std. error	t-Statistic	Significance
Constant	4.898	0.203	24.074	0
X_1	-0.291	0.034	-8.567	0
X_2	-0.126	0.024	-5.163	0
X_3	0.232	0.051	4.552	0

F(3,172)=47.96; Standard error of estimate=0.160201

Table 4: Panel regression-estimation by pooled sample.

Variable	Coefficient	Std. error	t-statistic	Significance
X_1	-0.107	0.047	-2.292	0.023
X_2	0.132	0.035	3.800	0.000
X_3	0.276	0.043	6.357	0.000
IDUMMIES(1)	2.061	0.347	5.943	0.000
IDUMMIES(2)	2.119	0.356	5.948	0.000
IDUMMIES(3)	2.561	0.304	8.422	0.000
IDUMMIES(4)	2.059	0.349	5.901	0.000
IDUMMIES(5)	1.993	0.338	5.898	0.000
IDUMMIES(6)	2.006	0.346	5.795	0.000
IDUMMIES(7)	1.736	0.378	4.596	0.000
IDUMMIES(8)	1.911	0.356	5.365	0.000

F(10,165)=46.4930; Standard error of estimate=0.11344

Table 5: Panel regression-estimation by least squares dummy variable.

Variable	Coefficient	Std. error	t-statistic	Significance
Constant	2.246	0.346	6.487	0
X_1	-0.119	0.046	-2.592	0.009
X_2	0.115	0.034	3.402	0.001
X_3	0.271	0.043	6.263	0

RSS=2.12845; S_u=Standard error of estimate=0.11124; S_α=Individual-specific standard error=0.2328; S_ε=Purely random standard error=0.1134; Hausman test (3)=5.83; Significance Level=0.120.

Table 6: Panel regression-estimation by random effects.

The LSDV model is preferred compared to pooled model.

***Choice between fixed effects model and random effects model*:** According to Hausman [35], Hausman and Taylor [36], the null hypothesis H_0 versus the alternative will be considered. Based on the Hausman test and in Table 6, H_0 is accepted at 5% significance level.

H_0: Random effects (RE) are preferred

H_a: Fixed effects (FE) is preferred

The variance of the individual effects and the variance of the idiosyncratic error represent the component variances. The findings in Table 6, there are a positive impact of both variables X_2 and X_3 while the effect of X_1 is negative on the variable Y that is computer, communications and other services as a percentage of commercial service exports. If X_2 increases 1% then Y increases 0.115%. This result

Variable	Coefficient	Std. error	t-statistic	Significance
Constant	0.01	0.007	1.39	0.165
ΔX_1	-0.033	0.055	-0.596	0.551
ΔX_2	0.013	0.113	0.118	0.906
ΔX_3	0.247	0.027	9.268	0
RSS=1.179421; S_u=Standard error of estimate= 0.08480; S_α=Individual-specific standard error=0.0000; S_ε=Purely random standard error=0.0859; Hausman test (3)=2.27; Significance Level=0.519.				

Table 7: Panel regression-estimation by random effects data in first difference dependent variable: ΔY.

reflects the importance of the numbers of researchers working in R&D on the Computer, communications and other services as a percentage of commercial service exports. If the variable X_3 increases 1% then the variable Y increases 0.271%. Yet important information given by our proposed model is that an increase in computer, communications and other services as percentage of commercial service imports is positively impacting on the growth of Y. Finally, if the variable X_1 increases 1% then Y decreases 0.119%.

The Table 7 contains the estimate model in first difference. Only the variable ΔX_{3t} has a positive impact on the variable ΔY_t. In fact $\Delta X_{3t} = \ln\left(\frac{X_{3,t}}{X_{3,t-1}}\right)$ and $\Delta Y_t = \ln\left(\frac{Y_t}{Y_{t-1}}\right)$. If the ratio $\frac{X_{3,t}}{X_{3,t-1}}$ rises 1% then $\frac{Y_t}{Y_{t-1}}$ rises about 0.25%.

Conclusion

At the end of this research, certain points deserve to be emphasized in order to better appreciate the contribution of this article. As we have seen in the other sections, the panel contains eight countries that are ranked among the first in the world regarding the high technology products, the investment in research and development, and by consequence the ability to export its performance and innovations in computer and communications, will give them a competitive advantage to exploit the benefits of the commercial service imports from other countries. Each of these countries is characterized by its own peculiarity, that is to say, it has an individual effect which has appeared when describing graphs for each of the four variables considered in this research. The Compound Annual Growth Rate (CAGR) differs with the countries and the other basic statistics such as median, average, standard deviation, minimum, maximum change from one country to another. The co-integration test proposed by Pedroni did not favor the presence of a long-run equilibrium relationship either individually or aggregately. However, the country effect has been found very strong random and therefore its variance is an interesting component in the errors of the random effect model. In the log-transformed data, it appears that there are a positive effect on the dependent variable Y (computer, communications and other services as a percentage of commercial service exports), for both variables X_2 (researchers in R&D) and X_3 (computer, communications and other services as percentage of commercial service imports), while a negative effect of X_1 (high-tech as percentage of manufactured exports) has been emerged. The findings of panel unit root tests have made possible to consider the random effect model in first difference. But in this case, the data are transformed in increasing factor and the variable $\frac{X_{3,t}}{X_{3,t-1}}$ has only a positive impact on the increasing factor $\frac{Y_t}{Y_{t-1}}$.

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