Determinants of Export Sophistication: An Investigation for Selected Developed and Developing Countries Using Second-Generation Panel Data Analyses[1]

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Abstract

The aim of this paper is to determine potential factors that may influence export sophistication index for both developed and developing countries. The present study calculated export sophistication values for selected developed and developing countries using a specific index (EXPY) proposed by Hausmann, Hwang and Rodrik (2007). Second-generation panel data analyses were subsequently performed to examine determinants of export sophistication index and whether selected developing countries are able to converge to developed countries. Empirical findings reveal that there exists a positive relationship between export sophistication index and foreign direct investments, total domestic savings, educational and research and development (R&D) expenditures. Particularly, the estimation results of the present study also indicate that two developing countries, namely, Malaysia and Romania are able to converge to developed countries in terms exporting performance, whereas Turkey and Bulgaria cannot achieve to converge to developed countries. As a result, developing countries should concentrate on improving their export sophistication index to converge to developed countries.

Keywords: *export sophistication, second-generation panel data analysis, economic growth, convergence, developing country*

JEL Classification: F14, O47, O57

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Introduction

The opinion that foreign trade has an impact on the economic performance of the countries dates back to Adam Smith. Smith stated that the expanding markets will enable countries to increase their production and raise their welfare levels with the held of foreign trade (Smith, 2006). The wave of globalization that has been continuing since the 1980s has allowed the global trade to increase rapidly, making the integration of world economies possible (Zhu et al., 2010). The total exports of the world, which was 2.3 trillion dollars in 1980, increased by 10 times and reached to 22.9 trillion dollars in 2017 (World Bank, 2018). This situation further enhanced the importance of foreign trade for national economies. Technological developments that have helped to reduce the costs of foreign trade, transport and coordination have led to an increase in Global Value Chains (OECD, WTO and WB, 2014). Hence, the production processes are segmented into different components, and each component is now being produced in the countries where the lowest costs are available. The growth of Global Value Chains enhanced the dependence of economies on each other and brought about specialization in a component or stage of Value Chains instead of a complete sector. Developing countries have been involved in GVCs at an increasing pace, which offer them the opportunity to integrate into the global economy with low costs. The companies, which became involved in GVCs with access to new technologies and information distribution, have specialized in both export and import and increased their productivity. This specialization and productivity have made great contributions to the economic growth of countries. However, the earnings of the countries from GVCs are not absolute. The earnings of the countries from GVCs vary depending on their specialization in the low or high value-added components of the Global Value Chain. The countries specializing in high-value-added components of a GVCs gain higher profits compared to countries specializing in low-value-added components (OECD, WTO and WB, 2014).

In another study focusing on this issue, Hausmann et al. stated that the products were not the same in terms of their contribution to economic growth. The authors reported that specialization in some product or product groups contributed more to economic growth than others. In the study, it was stated that the countries that are producing and specializing on the products produced and exported by the developed countries will develop more rapidly in economic terms; whereas the countries that continue to produce the products produced by the poor countries will remain poor. The authors, who created an index representing the rate of similarity to the exports of the developed countries in order to test this situation, determined that this index was effective on economic growth (Hausmann, Hwang and Rodrik, 2007).

At this point, specializing in products that are sophisticated in value and generally produced and exported by the developed countries is an important element for countries to exhibit a good performance in terms of economic growth. However, in addition to the unchanging elements, such as the size and geographical location of the country, some changeable factors are also effective to produce and export sophisticated products. Some of these changeable elements can be stated as the country's technology level, human capital, transportation and communication infrastructure, policies about foreign direct investments providing transfer of information and innovation, labor market policies, competition policies, investment policies, education policies and strategic investment policies, etc. (Vernon, 1992; Krugman, 1979; Posner, 1961; OECD, WTO and WB, 2014; Spatafora, Anand and Mishra, 2012).

This study tried to determine the factors affecting the sophisticated value of exports in some developed and developing countries. For this purpose, the EXPY index, whic was created by Hausmann et al. and represents the sophisticated value of the exports of the countries, was determined as the dependent variable. The effects of foreign direct investments, domestic savings, education expenditures, R&D expenditures, patent numbers of countries and legal rules index on the dependent variable were examined. In addition, it also tried to determine how these variables changed according to the development status of the country. As a result of the study, it was determined that foreign direct investments were a more effective variable in developing countries, and R&D expenditures and patent numbers were more effective in developed countries.

1. Literature Review

The relationship between export and economic growth has been the primary subject of interest for economists for many years. Researches have been conducted for different periods on many countries or country groups. Although sometimes different results are obtained in these studies, they generally conclude that exports have an impact on economic growth (Balassa, 1988; Michaely, 1977; Ekanayake, 1999; Kaya and Hüseyni, 2015). The fact that export is an effective parameter on economic growth also highlights the factors affecting exports. Generally in studies focusing on factors affecting exports, variables such as exchange rate, foreign direct investments and GDP of counterparty countries have been found to be influential on the export figures of countries (Sharma, 2000; Özer, 2014; Majeed, Ahmad and Khawaja, 2006; Balcilar et al., 2014; Kapkara and Koc, 2016). Especially after 2000s, studies that indicated the importance of exports not only in terms of quantity but also in terms of value were conducted (Amti and Freund, 2010; Finger and Kreinin, 1979). In these studies, it was tried to establish indexes to measure the sophisticated value of exports and whether these indexes were effective on the economic growth performance of countries (Lall, Weiss and Zhang, 2006; Lee, 2011; McCann, 2007). In these studies focusing on the sophisticated value of export, it was determined that the sophisticated value of exports had an effect on the economic growth of countries.

One of these studies which focued on the sophisticated value of export and drew plenty of attention was carried out by (Hausmann, Hwang and Rodrik, 2007). The authors, who created an index to measure the sophisticated value of exports called EXPY, determined that the value of EXPY was effective on GDP per capita in different country groups such as OECD countries, High Middle--Income Countries and Low-Income Countries. After the study of Hausmann, Hwang and Rodrik (2007), the impact of the EXPY index on the economic growth performance of the countries was examined by different researchers for different country groups. In these studies, it was determined that the EXPY index was effective on the economic growth performance of the countries in general (Vitola and Davidsons, 2008; Lin, Weldemicael and Wang 2017; McCann, 2007).

In addition to the studies examining the impact of the sophisticated value of exports on the economic growth performance of the countries, studies examining the impact of the sophisticated value of exports on the economic growth performance among different regions of a country were also conducted. These studies examined whether the regions that export more sophisticated products show better economic growth performance than other regions (Gillesa, 2013). Especially in the studies conducted on China's regions, it was determined that the regions that export sophisticated products show a better economic growth performance compared to other regions (Jarreau and Poncet, 2012).

The fact that the sophisticated value of exports has an impact on the economic growth performance of the countries ensures that the factors affecting the sophisticated value of exports are also at the forefront. One of the studies in this area was made by Hausmann et al. In this study, the rule of law index calculated by the World Bank, representing the GDP per capita, population, human capital and institutional structure, was used as an independent variable. As a result of the study, the GDP per capita and population variables were positive and statistically significant as expected. However, the variable used for human capital and the legal rules index used to represent the institutional structure did not show statistical significance. At this point, the author stated that not finding the institutional structure significant was an unexpected situation (Hausmann, Hwang and Rodrik, 2007).

One of the studies examining the factors affecting the quality of exports was conducted by (Zhu et al., 2010). In the study, for the innovative products and processes, the schooling rate of the country,[2] and for the transfer of technology, foreign direct investments and imports were chosen as independent variables. Instead of GDP per capita, the area per capita in the country was as a variable.[3] Capital labor ratio was determined to represent the traditional factor endowment. As a result of the study; population, labor capital ratio, schooling rate, foreign direct investment and import variable were found to be positive and statistically significant. The area per capita in the country was found to be negative and statistically significant. The authors based this situation on the theory of paradox of plenty.[4] The legal rules index representing the institutional structure was not statistically significant. One of the studies focusing on the factors that affect the sophisticated value of exports was conducted by Weldemicael, in 2012. In this study, the distance from the major trade centers variable was used different from the Hausmann et al. and Zhu et al. Four different variables were determined in order to represent institutional quality.[5] As a result of the study, the distance variable was found negative and statistically significant as expected while the variables used for the institutional structure were negative and did not have the expected sign (Weldemicael, 2012).

In the study conducted by Fang, Guoda and Hongyi in 2014, data of 31 regions of China between 2002 – 2008 were used instead of country data. In this study, especially the relationship between financial development and export quality was investigated. Three different variables were used for financial openness such as „financial ranking of the region“, „credit structure of the region“ and „financial efficiency of the region“. As a result of the study, the financial structure of the region and the credit structure variables of the region were found to be positive and statistically significant (Fang, Guoda and Hongyi, 2014). Another study using China's data was conducted by Yu and Hu in 2015. In this study, the effect of capital-labor ratio, financial development rate, foreign direct

[2] With reference to the study of Romer (1990), it was used instead of R&D and education expenditures.

[3] With reference to (Benhabib and Spiegel, 1994; Acemoglu, Simon and Robinson, 2001; Rodrik, Subramanian and Trebbi, 2004; Ulubasoglu and Doucouliagos, 2004), it was stated that the institutional structure and human capital were determinants of the GDP per capita variable and that the use of these three variables as independent variables in the same model would cause multiple linear associations. Therefore, the area per capita area variable was chosen.

[4] According to the paradox of plenty theory: In countries rich in natural resources, it is argued that this richness prevents the countries to increase their production skills and to develop their industries (Auty, 2002).

[5] Economic Freedom Index, Security of Property Rights Index, Political Control Index and Administrative Restrictions Index.

investment, human capital and R&D expenditures on the sophisticated value of China's exports was investigated. It was determined that China's R&D spending, financial development and capital-labor ratio had a positive and statistically significant effect on the sophisticated value of China's exports. However, it was determined that foreign direct investments had a negative effect as an unexpected situation (Yu and Hu, 2015).

In this study, two different models were used with the data of both developed and developing countries different from the literature. Hence, it was tried to determine variables whose effect differs on developed and developing countries. Moreover, the variables of domestic savings and the number of patents of countries, which were not encountered in any study beforehand, were used in the model.

2. Data Sampling, Methodology and Results

This study considers selected countries under two development levels, namely developed and developing countries by taking account that export sophistication is a process and determinants of export sophistication may change from earlier to the later stages of this process. When determining the developed country group, the following has been observed: Countries, which were underdeveloped in the 1960s, but increased their sophisticated value between 1960s and 1990s and entered in today's developed countries or converged to them, were taken. These countries were determined as Finland, Hong Kong, South Korea, Japan and Singapore. While determining the developing countries, in the 1960s, the countries that were again underdeveloped in the 1960s and whose structure of exports did not change between 1960 and 1990, but whose sophisticated value of exports gradually developed after the 1990s were selected. These countries were chosen as Brazil, Bulgaria, Malaysia, Romania and Turkey.

In this study, the EXPY index representing the sophisticated value of the exports of the countries was calculated and this index was determined as the dependent variable.

2.1. The Calculation of PRODY and EXPY Values

The concept of export sophistication has to be statistically defined as an index to be utilized in further empirical research. As stated earlier, Hausmann et al. (2007) introduced a specific index that represents the export sophistication of countries. However, the determination of the sophistication levels of each product groups of exports for a country should be accomplished before seeking how much each country is sophisticated in terms of exports. Particularly, an index called PRODY should be benefited through the weights of product groups to be exported on total export basket as the following (Hausmann, Hwang and Rodrik, 2007).

$$PRODY_k = \sum_{n=1}^{i} \frac{(x_{ik} / X_i)}{\sum_{n=1}^{i} (x_{ik} / X_i)} Y_i \tag{1}$$

where

x_{ik} – the amount of exports for product *k* by country *i*,
X_i – the total amount of exports by country *i*,
Y_i – the amount of per capita income for country *i*.

In order to obtain PRODY values for each product group in a specific year, the same calculation is repeated for all selected countries using the amount of exports and per capita income data during the same year. Practically, higher values of the PRODY index imply that the relevant group is labelled as more sophisticated. Otherwise, lower values of the index mean that product group of exports for a country is moderate. After the necessary calculations are made for all product groups, an EXPY index can be defined as the following.

$$EXPY_i = \sum_{n=1}^{k} (x_{ik} / X_i) PRODY_k \tag{2}$$

where

x_{ik} – the amount of exports for product *k* by country *i*,
X_i – the total amount of exports by country *i*,
$PRODY_k$ – the PRODY value for product *k*.

As shown in Equation (2), an EXPY value of a country can be calculated in a certain year. It can be noticed that once the PRODY values for all product groups are calculated, EXPY values for a country can be easily drawn for the sample period. As well as the interpretation of a PRODY value, higher values of the EXPY index imply that exports performance of the country is more sophisticated and otherwise, lower values of the index mean that product group of exports for a country is moderate. From Equation (2), it can also be concluded that countries which tend to export products with higher PRODY values will also have higher EXPY values confirming that their exports are more sophisticated.

In this paper, PRODY values of 717 product groups from 1033 product groups were calculated by utilizing the data from Standard International Trade Classification (SITC) Revision 3 (Rev3) Level 4 after mining, agriculture and farming groups were excluded due to very specific product groups that may produce biased results. After PRODY values for 2005, 2006 and 2007 were calculated for each product group following a three-year calculation by Hausmann, Hwang and Rodrik (2007). Thus specific EXPY values were obtained by taking the mean of PRODY values for all three years. Table 1 summarizes some PRODY values drawn from all product groups being utilized. As seen Table 1, technology intensive products, of which developed countries usually export, have generally higher values of PRODY, whereas labour intensive products, of which developing countries usually export, have lower values of PRODY. This circumstance designates that PRODY index succeeds to reflect whether the specific product is sophisticated or not.

Table 1

Summary of PRODY Values for Some Product Groups from the Sample

Rank	Product group	PRODY value
1	Parts of firearms, pieces	53.395
2	Compounds with carboxamide groups	49.809
3	Substances suitable for weaving, hoses, conveying columns, etc.	48.807
4	Hormones, derivatives; hormone replacement steroids	44.403
5	Parts of machinery, mechanical devices, other	41.002
713	Flying oils, resinoids, terpene by-products	2.054
714	Untreated tin	1.963
715	Weaving and yarns from jute-plant inner shell	1.123
716	Prepared skin of sheep and lambs (without wool)	1.098
717	Prepared skin of goats and kids (without wool)	778

Source: United Nations (2018).

After the calculation of PRODY indexes for each product group, EXPY values of selected countries were subsequently calculated for the year 2013. Table 2 presents EXPY values for some countries drawn from all 135 countries. As shown in Table 2, high-income countries are more likely to have higher values of EXPY, whereas most developing countries that have labour intensive production and export structure are more likely have lower values of EXPY. This evidence addresses that EXPY value is capable of reflecting export sophistication of countries.

In order to illustrate the efficiency and to guarantee whether or not EXPY value is associated with the levels of development for selected countries, Figure 1 depicts the distribution of both EXPY and GDP per capita values of selected countries in 2013 by taking their natural logarithms. As illustrated in Figure 1, there exists a relatively high relationship between GDP per capita and export sophistication values in 2013. In fact, it can be initially concluded that EXPY value of countries is associated with their economic growth performance.

Table 2

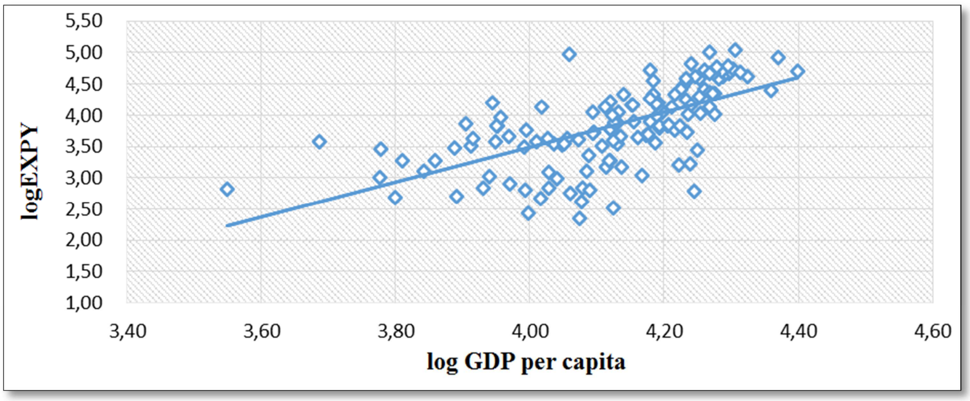
Summary of EXPY Values for Some Countries from the Sample

Rank	Country	EXPY value	Rank	Country	EXPY value
1	Qatar	39.192	116	Pakistan	8.788
2	Switzerland	34.350	117	Tanzania	8.753
3	Luxembourg	33.262	118	Cambodia	8.441
4	Rep. of Ireland	32.965	119	Madagascar	8.201
6	Finland	27.505	120	Cape Verde	8.187
7	Singapore	26.308	121	Guana	7.607
8	Sweden	25.575	122	Kiribati	6.395
10	Japan	25.291	123	Mauritania	6.296
11	Belgium	25.116	124	Zimbabwe	6.202
12	Germany	25.109	127	Ethiopia	5.691
13	Denmark	24.880	128	Burkina Faso	5.280
14	England	24.588	129	Burundi	4.843
15	Austria	24.539	130	Sao Tome and Pr.	4.616
16	Australia	24.401	133	Central Afr. Rep.	3.760
17	France	24.305	134	Malawi	3.727
18	United States	23.939	135	Afghanistan	1.034

Source: United Nations (2018).

Figure 1

The Distribution of EXPY and GDP per capita in 2013



Source: Hüseyni (2015).

As explained in detail earlier, the PRODY index for each product group has to be principally calculated before a transition to EXPY index of developed and developing countries. In order to avoid a potential appraisal on PRODY values due to an increase based on national income of selected countries instead of actual increases on the quality, PRODY values were calculated for 717 product groups and three consecutive years (2005, 2006, and 2007) using manufacturing industry exports data of 142 countries following SITC Rev.3 classification. Later, products that one country makes more than 50% contribution were excluded from the final estimated model to avoid potential deviation and PRODY values were re-calculated by taking the mean of three consecutive years. Using these PRODY values, the EXPY values were calculated between the sample period 1996 – 2013. The dependent variable of this study was the EXPY values of selected countries. Besides, the explanatory variables involve the amount of total domestic savings (SAV), the ratio of total educational expenditures to the amount of GDP (EDU), the amount of foreign direct investments (FDI), the ratio of R&D expenditures to the amount of GDP (RRD), the ratio of the number of patents to the amount of GDP (PAT), and the rules of law index (LAW). The ratio of R&D expenditures to the amount of GDP and the ratio of the number of patents to the amount of GDP have been included in the final estimated model as a proxy of innovation and innovative processes. Similarly, rules of law index has been included in the model as a proxy of institutional structure. As far as is known, no empirical studies has been used total domestic savings and the number of patents in the existing literature which adds originality to the present study.

2.2. Methodology

After all necessary calculations, panel data models were performed to determine factors affecting EXPY values of selected developed and developing countries. In panel data models, series should be tested whether or not there exists a cross-section dependency to determine which tests should be used for the stationary level of variables. For first-generation unit root tests give reliable results if there is no cross-section dependency among series. First-generation unit root tests can be classified by the behaviour of cross-sections of the panel. Some panel unit root tests (Hadri, 2000; Levin, Lin and Chu, 2002; Breitung, 2005) assume that cross-sections are homogeneous, whereas other unit root tests (Maddala and Wu, 1999; Im, Pesaran and Shin, 2003) assume that cross-sectional units are heterogeneous. However, when there exists a cross-section dependency among series, first-generation unit root tests do not provide reliable evidence. In such a circumstance, second-generation panel unit root tests (Taylor and Sarno, 1998; Breuer, Mc Nown and Wallace, 2002; Pesaran, 2007; Hadri and Kurozomi, 2012) that allow cross-dependency among series can be used. In this study, CD LM1 test was performed to explore cross-dependency among variables. CD LM1 test gives reliable evidence for the condition of $T > N$. Similarly, cross-section dependency among fitted models were tested using adjusted LM test proposed by Pesaran (2007) and their results will be presented along with the estimated model output for brevity (Breusch and Pagan, 1980; Pesaran, 2004; Pesaran, Ullah and Yamagata, 2008; Göçer, 2013). As a result of CDLM1 test, it was found that some variables contained CSD while others did not.

Variables that doesnt contains cross-section dependency were examined using one of first-generation test Levin, Lin and Chu (2002) panel unit root test. A second-generation unit root test Cross-Sectional Augmented Dickey Fuller (CADF) was performed to examine stationary level of variables that include cross-section dependency. Pesaran (2007) CADF unit root test gives significant evidence for both conditions of $N > T$ and $N < T$. In Pesaran (2007) CADF unit root test, a CADF test statistic is initially calculated. Later, Cross-Sectionally Augmented IPS (CIPS) test statistic is calculated that provides information the stationary condition of the whole panel by taking means of CADF test statistics. CIPS test statistics are compared to critical table values calculated in Pesaran (2007) by Monte Carlo simulations. When CIPS test statistic is more than critical table value, the variable is assumed to be stationary among the whole panel. The stationary conditions of stationary series obtained by CADF unit root test were tested utilizing Hadri-Kuruzomi (HK) unit root tests. The HK test produces two test statistics with respect to calculation of long-term variances labelled as ZA^{SPC} and ZA^{LA}. When both time and unit dimensions of the data being utilized were considered, ZA^{LA} was found as the appropriate test statistic to the present data. Therefore, only the results of ZA^{LA} test statistic was presented for brevity.

When a panel data model involving series, which are stationary at their first--differences is considered, the operation of calculating first-differences not only provides to eliminate the impact of temporary shocks being exposed in earlier periods but also avoids possible long-term relationship among series. Therefore, a regression model with stationary variables at first-or higher-differences lacks to reflect long-term relationships among series. In such a circumstance, it is proposed that a stationary combination of series may be existed even if series are not stationary. In that sense, a cointegration analysis is performed to determine the relevant combination (Tarı, 2011). Whilst cointegration tests that do not take cross-section dependency (Johansen, 1988; Kao, 1999; Pedroni, 1999) are widely performed for panel data analysis, if there exists a cross-section dependency among series, these cointegration tests do not provide a reliable evidence. In such a circumstance, the use of second-generation panel cointegration tests that allow cross-section dependency among series (Westerlund and Edgerton, 2007; Westerlund, 2008) is alternatively considered. In this study, the cross-section dependency situation of estimated model was tested by using adjusted LM test and the results of the test confirmed that there is no cross-section dependency in models. Thus, one of first-generation tests including Johansen (1988), Kao (1999), and Pedroni (1999) can be easily applied to determine variables used in model are co-integrete or not. Since Johansen (1988) cointegration test allows endogeneity among variables among other cointegration tests, Johansen-Fisher cointegration test was performed to seek cointegrated relationships.

As all three estimated models were found as cointegrated, the long-term parameters were estimated using Fully Modified Ordinary Least Squares (FMOLS) estimators. FMOLS estimators provides to eliminate potential deviations on parameters since they adjust autocorrelation and heteroscedasticity issues for normal fixed effects.

After long-term parameters were estimated, error correction model was established in order to test whether the effect of a short-term shock disappeared in the long-term. In the error correction model, errors of long-term parameters estimated with FMOLS are included in the model as a new variable with a delay. If the parameter of this variable is negative, statistically significant and smaller than one, this means that the error correction mechanism is working. Such a situation means that the effects of short-term shocks are recorded in the long-term, that is, the variables used are effective on the long-term dependent variable.

2.3. Results

In the study, firstly the series were examined with the help of CDLM1 test whether they included Cross Sectional Dependency, and the results were given in Table 3.

Table 3

CD LM1 Cross-dependency Test Results

Variable	**CD LM1 (Developed countries)**		**CD LM1 (Developing countries)**	
	Test Statistic	*Probability*	*Test Statistic*	*Probability*
lnEXPY	106.035	$(0.001)^{y}$	13.768	(0.1840)
lnSAV	39.263	$(0.001)^{y}$	13.072	(0.2200)
lnFDI	29.704	$(0.013)^{y}$	25.732	$(0.0040)^{y}$
lnEDU	12.635	(0.631)	21.178	$(0.0200)^{y}$
lnPAT	15.213	(0.436)	11.098	(0.3500)
lnRRD	20.841	(0.142)	25.383	$(0.0050)^{y}$

Note: ^{y} denotes that there exists a cross-section dependency. Natural logarithms of variables are used.

Source: Authors' own calculations.

As shown in Table 3, some variables contain cross-section dependency while others don't. Variables that doesnt contains cross-section dependency were examined using one of first-generation test Levin, Lin and Chu (2002) panel unit root test. The resul of Levin, Lin and Chu panel unit root test is shown in the Table 4.

Table 4 presents Levin, Lin and Chu (2002) unit root test results and it indicates that none of variables was stationary at their levels, but stationary at first--difference. Variables contain cross section dependency were examined with the help of CADF unit root test, and the results were given in Table 5.

Table 4

Levin, Lin and Chu (2002) Unit Root Test Results

Country Group	Variables	Level		First-difference	
		Statistic value	*Statistic value*	*Statistic value*	*Probability*
Developed	lnEXPY lnSAV lnPAT	–0.14356 0.82573 0.71357	0.4429 0.7955 0.7623	–3.72973 –4.89728 –10.4650	0.0001 0.0000 0.7623
Developing	lnEDU lnRRD lnPAT	–0.41115 –1.25378 0.75043	0.3405 0.1050 0.7735	–6.41031 –5.49909 –4.64874	0.0000 0.0000 0.0000

Source: Authors' own calculations.

Table 5

CADF Unit Root Test Results

Country Group	Variables	CIPS test statistics				CIPS Critical Table value (0.05)
		Level	*First-difference*	*L*	*T*	
Developed Country	lnEXPY lnSAV lnFDI	–2.67 –1.91 –1.86	–4.47* –2.75* –3.67*	3 3 2	1 1 1	–2.74 –2.74 –2.74
Developing Country	lnEDU lnFDI lnRRD	–2.19 –0.59 –2.35	–3.07* 3.06* –3.80*	1 1 4	0 1 1	–2.21 –2.74 –2.74

Note: Natural logarithms of variables are used. * denotes the variable is stationary; L denotes the level of lags; if T = 1, then it means there exists a trend, if T = 0, it means there is no trend.

Source: Authors' own calculations.

Table 5 gives the output of CADF unit root tests. As seen in Table 5, none of variables that include cross-section dependency was stationary at their levels, but stationary at first-difference. The stationary conditions of stationary series obtained by CADF unit root test were tested utilizing Hadri-Kuruzomi (HK) unit root tests, as presented in Table 6.

Table 6

Hadri-Kurozumi Unit Root Test Results

County group	Variables	HK test statistic	
		ZA^{LA}	
		Level	*First-difference*
Developed countries	lnEXPY lnSAV lnFDI	3.52 13.14 10.10	1.59* –0.95* 0.13*
Developing countries	lnEDU lnFDI lnRRD	74.128 89.544 48.895	0.336* –1.630* 0.624*

Note: * denotes the variable is stationary.

Source: Authors' own calculations.

Table 6 reveals that none of the variables were found as stationary at their levels, but they were stationary at first-differences. Consequently, both unit root tests for cross-dependent variables designated that variables were stationary at their first differences that implies they were I(I) variables. After determining that all the variables used in the study were stationary in the first differences, the co-integration of the models used was examined with the help of Johansen-Fisher co-integration test, and the results were given in Table 7 and Table 8. Table 7 introduces the results of Johansen-Fisher cointegration test for selected developed countries.

Table 7

Cointegration Test Results for Selected Developed Countries

Model 1: LNEXPY, LNEDU, LNFDI, LNSAV, LNPAT				
	Fisher test statistic		**Fisher test statistic**	
	(Trace test)	*Probability*	*(Max-Eigenvalue)*	*Probability*
No root	280.0	0.0000	216.0	0.0000
At most 1	177.6	0.0000	130.3	0.0000
At most 2	71.52	0.0000	44.66	0.0000
At most 3	42.18	0.0000	23.68	0.0224
Model 2: LNEXPY, LNEDU, LNFDI, LNSAV, LNRRD				
	Fisher test statistic		**Fisher test statistic**	
	(Trace test)	*Probability*	*(Max-Eigenvalue)*	*Probability*
No root	271.6	0.0000	203.1	0.0000
At most 1	155.0	0.0000	112.3	0.0000
At most 2	60.89	0.0000	35.62	0.0004
At most 3	38.94	0.0001	22.46	0.0327
Model 3: LNEXPY, LNDYY, LNTAS, LNLAW				
	Fisher test statistic		**Fisher test statistic**	
	(Trace test)	*Probability*	*(Max-Eigenvalue)*	*Probability*
No root	110.90	0.0000	85.65	0.0000
At most 1	44.73	0.0000	23.97	0.0205
At most 2	32.97	0.0010	22.14	0.0360
At most 3	30.96	0.0020	30.96	0.0020

Source: Authors' own calculations.

As shown in Table 7, the null hypothesis that states „there is no cointegration on estimated models", was rejected for both Johansen-Fisher tests for selected developed countries since all probability values were less than 0.05 significance level. This implies that there exists a cointegration relationship among variables for the fitted models. The same procedure can be applied to variables for selected developing countries. Table 8 presents Johansen-Fisher cointegration test results for developing countries. As seen in Table 8, the outcome has confirmed that there exists a cointegration relation among series for selected developing country-group since the null hypothesis was rejected since all probability values were less than 0.05 significance level. Table 9 presents the outcome of fitted models using FMOLS estimators and adjusted LM tests.

T a b l e 8

Cointegration Test Results for Selected Developing Countries

Model 4: LNEXPY, LNEDU, LNFDI, LNSAV, LNPAT				
	Fisher test statistic		**Fisher test statistic**	
	(Trace test)	*Probability*	*(Max-Eigenvalue)*	*Probability*
No root	237.2	0.0000	180.9	0.0000
At most 1	142.2	0.0000	89.88	0.0000
At most 2	71.70	0.0000	46.55	0.0000
At most 3	37.23	0.0001	24.45	0.0065
Model 5: LNEXP, LNEDU, LNFDI, LNSAV, LNRRD				
	Fisher test statistic		**Fisher test statistic**	
	(Trace test)	*Probability*	*(Max-Eigenvalue)*	*Probability*
No root	226.5	0.0000	146.7	0.0000
At most 1	125.2	0.0000	65.00	0.0000
At most 2	75.68	0.0000	41.10	0.0000
At most 3	48.92	0.0000	36.81	0.0001
Model 6: LNEXPY, LNFDI, LNSAV, LNLAW				
	Fisher test statistic		**Fisher test statistic**	
	(Trace test)	*Probability*	*(Max-Eigenvalue)*	*Probability*
No root	93.43	0.0000	50.32	0.0000
At most 1	53.70	0.0000	30.28	0.0008
At most 2	34.08	0.0002	22.12	0.0145
At most 3	33.26	0.0002	33.26	0.0002

Source: Authors' own calculations.

T a b l e 9

Full Modified Ordinary Least Square Test Results for Selected Developed and Developing Countries

	Developed countries			**Developing countries**		
	I	**II**	**III**	**IV**	**V**	**VI**
LNFDI	0.081* (0.023)	0.212* (0.003)	0.027* (0.007)	0.133* (0.008)	0.032* (0.007)	0.008* (0.004)
LNSAV	0.982* (0.109)	1.446* (0.003)	0.082* (0.047)	1.516* (0.008)	0.091* (0.038)	–0.24* (0.003)
LNEDU	0.642* (0.173)	1.573* (0.001)	–0.14* (0.05)	0.052* (0.005)	0.161* (0.047)	0.61* (0.004)
LNPAT	0.451* (0.053)			0.385* (0.012)		
LNRRD		0.088* (0.005)			0.026 (0.669)	
LNLAW			0.11* (0.04)			1.04* (0.002)
ADJ_LM	1.08 0.14^{y}	1.31 0.10^{y}	0.56 0.71^{y}	–0.3 0.62^{y}	1.76 0.04^{y}	2.00 0.02^{y}

Note: * denotes that parameters are statistically significant at 0.05 significance level; ^{y} denotes that there is no cross-section dependency on the model at 0.01 significance level. Values in parentheses are standard errors.

Source: Authors' own calculations.

As Table 9 indicates, no cross-dependency was observed among none of fitted models for both developed and developing countries with respect to adjusted LM results. Additionally, since series were found as cointegrated, FMOLS estimators were utilized for model estimation. As shown in Table 9 where long-term parameters are given, foreign direct investments, domestic savings and education expenditures are positive and statistically significant in both developed and developing countries. Patant variable was also positive and statistically significant in both groups. However, while the R&D expenditure variable was found to be positive and statistically significant in developed countries, it was not found statistically significant in developing countries. The rule of law index which had no expected sign in many previous studies was found to be positive and statistically significant with the use of an appropriate estimator as FMOLS.

Earlier research in the existing literature assumes that the impact of independent variables on export sophistication does not change during development process. On the contrary, the present study considers the development as a changing process, more precisely, the impact of the amount of foreign direct investments may be relatively respectable in the earlier stages of development. Besides, the parameter of the amount of foreign direct investments may decrease in numbers when the level of development increases. Thus, the proxy variables of innovation and innovative processes might have been considered to have a more dramatic impact on making a more sophisticated exporting for a country in the higher levels of development. For that purpose, selected countries were classified as developed and developing countries, the impact of the amount of foreign direct investments were expected to be relatively higher for developing countries that developed counterparts. However, the impact of the proxy variables of innovation and innovative processes was expected to be comparatively higher for developed countries than developing countries. When the results of both Model I and IV were simultaneously examined in Table 9, one can argue that the impact of foreign direct investments on export sophistication is relatively higher for selected developing countries than selected developed countries. Table 9 also gives valuable information that R&D expenditures and the number of patents have higher parameters in numbers for selected developed countries than developing countries.

After long-term parameters were estimated in the study, error correction model was established. In the error correction model, the error series obtained from the model installed with FMOLS is included in the model as a new variable (ECM (–1)) with a delay. That the parameter of this variable is negative and statistically significant means that the effect of the shocks created in the short-term will disappear in the long-term. This situation also indicates that the independent variables used in the model are effective on the dependent variable in the long-term. Whether the variables are effective in the short-term is decided according to the parameters of the variables. In this study, the relations among variables both in the short- and long-term were examined using Error-Correction Model and the results were presented in Table 10.

T a b l e 10

Results of Error-Correction Model

	Developed countries			Developing countries		
	I	**II**	**III**	**IV**	**V**	**VI**
LNFDI	0.021 [–] (0.012)*	0.024 [–] (0.012)*	0.011 [1] (0.013)	0.027 [1] (0.013)*	0.021 [1] (0.011)*	0.034 [1] (0.013)*
LNSAV	0.044 [2] (0.041)	0.026 [2] (0.043)	0.044 [4] (0.047)	0.019 [1] (0.031)	0.005 [1] (0.028)*	0.038 [2] (0.046)
LNEDU	0.080 [3] (0.044)*	0.094 [3] (0.045)*		0.034 [2] (0.034)		
LNPAT	0.037 [–] (0.018)*			0.004 [1] (0.015)		
LNRRD		0.004 [1] (0.039)			0.084 [–] (0.037)*	
LNLAW			0.019 [2] (0.029)			0.15 [6] (0.03)*
ECM(–1)	–0.259 (0.077)*	–0.241 (0.079)*	–0.200 (0.084)*	–0.291 (0.080)*	–0.278 (0.071)*	–0.21 (0.08)*
R^2	0.17	0.12	0.06	0.18	0.18	0.38

Note: * denotes that the parameter is statistically significant; values in parentheses are standard errors of the relevant parameters; values in square brackets denote the length of lag.

Source: Authors' own calculations.

As shown in Table 10, the ECM (–1) parameter was negative and statistically significant in all models. In this case it means that, for example in the first model, the FDI, SAV, EDU and PAT variables all together have a significant effect on the EXPY variable in the long-term. That the ECM (–1) parameter used in the first model is –0.259, means that the effect of a shock generated in this model will disappear by 25% each period. This indicates that the effect of the shock will be lost in an average of four periods. Other models can be interpreted in the same way.

In the table, it is seen that FDI variable is statistically significant in almost all models but the saving and education variables are not significant in general. This is an expected result since these parameters represent the short-term effect. Since foreign direct investments export after they make investments in the country they come to, the high-value-added products they export affect the sophisticated value of this country's exports. Therefore, it is expected that the parameters of FDIs will be statistically significant. However, the increase in domestic savings and education expenditures does not affect the sophisticated value of the country's exports in the short-term. Increasing education expenditures of a country improves human capital after 10 years in the best-case scenario. The improvement of the human capital affects the production and export to be more sophisticated 5 – 10 years after this date. Therefore, this variable is not expected to be effective in the short-term and to be statistically significant. The same can be said for domestic savings. The increase in domestic savings does not lead to an immediate recovery of the country's financial situation. However, the increase in savings helps decreasing interest rates, increasing investments and allow more sophisticated exports by strengthening the country's financial structure in the long-term. These parameters, which did not appear to be effective in the short-term, were determined to be effective in the long-term with the FMOLS estimator given in Table 9. That the ECM (–1) parameter given in Table 10 is negative and statistically significant supports FMOLS results.

This study also investigates whether or not selected developing countries can converge to developed countries in regard to their current export sophistication numerically during the sample period 1996 – 2013. Dummy variables were included in the estimated models to examine the convergence potential of developing countries. The models were estimated using GLS estimators and Table 11 presents estimation results.

Table 11

The Convergence Potential for Developing Countries

	I	II	III	IV	V
LNSAV	0.288* (0.000)	0.290* (0.000)	0.105* (0.015)	0.276* (0.000)	0.260* (0.000)
LNEDU	–0.052 (0.379)	0.158* (0.000)	0.139* (0.000)	0.159* (0.001)	0.192* (0.000)
LNFDI	0.042* (0.000)	0.027* (0.000)	0.035* (0.000)	0.028* (0.000)	0.0224* (0.004)
LNRRD	0.086* (0.001)	0.093* (0.002)	0.059* (0.025)	0.060* (0.063)	0.060* (0.036)
Turkey	–0.060* (0.000)				
Romania		0.0246* (0.01)			
Malaysia			0.083* (0.000)		
Brazil				0.004 (0.781)	
Bulgaria					–0.019* (0.067)

Source: Authors' own calculations.

As shown in Table 11, dummy variables for Turkey and Bulgaria were statistically significant with a negative sign implying that both countries are not able to converge to developed countries within their current exporting performance during the sample period. On the contrary, dummy variables for Romania and Malaysia were also statistically significant with a positive sign which means that both countries converge to developed countries in terms of their export sophistication success. Finally, though the dummy variable for Brazil has a positive sign, it was not found as statistically significant to confirm their convergence.

Conclusions

In recent years, many studies have been conducted that suggest the sophisticated value of production and exports to be a very important element for the economic growth of countries. In these studies, it was stated that the contribution of exports of each product to economic growth was not the same. It is suggested that countries producing and exporting more sophisticated products will exhibit better growth performance than others. However, the studies focusing on the factors affecting the sophisticated value of exports remained limited. In order to contribute to this deficiency in the literature, this study tries to determine the factors affecting the countries' sophisticated value of exports for both developed and developing countries separately.

As a result of the study, it was determined that foreign direct investment was one of the important determinants of the sophisticated value of exports as in the studies of Hausmann, Hwang and Rodrik (2007), Zhu et al. (2010) and Weldemicael (2012). Since foreign direct investments export their products produced in the countries of investment to other countries, they contribute to the sophisticated value of the exports of these countries in the short-term. In addition, FDIs provide transfer of technology and information from developed countries to developing countries in the long-term and contribute to the sophisticated value of their production and exports. At this point, especially developing countries should implement policies that encourage foreign direct investments to increase the sophisticated value of their exports and to converge to developed countries. Another result of the study is that foreign direct investments in developing countries and R&D expenditures are more effective in developed countries. This result suggests that developing countries should give more importance to R&D expenditures in the later stages of development in order to ensure the continuity of the sophisticated value of their exports which improved thanks to foreign direct investments.

In the study, it was determined that educational expenditures were positive and statistically significant on the sophisticated value of exports. The same variable was not found statistically significant in the study of Weldemicael (2012). This different result is thought to result from the estimator used. While the OLS estimator was used in the study of Weldemicael (2012), in this study FMOLS estimator was used because the model was determined to be co-integrated. The education expenditure contributes to the increase of the country's human capital and allows the development of production processes and rise of the added value of the products produced. This situation contributes to the structural transformation of the country's production and, accordingly, the sophisticated value of its exports.

However, the effects of education expenditures on the country's production and exports will appear in the long-term. This indicates that countries should give great importance to education expenditures with patience in order to increase the sophisticated value of their production and exports.

No studies have been encountered that have previously used the domestic savings variable which was used in this study and found positive and statistically significant on the sophisticated value of exports. The increase in the savings of countries allows the country to increase its financial depth and to decrease interest rates. The increase in the country's investments due to the falling interest rates contributes to the development of the country's production structure and the sophisticated value of its exports. At this point, that the decision-makers encourage elements such as individual pensions to drive some of their income into savings will contribute to the development of the country.

Many of earlier research has generally considered that institutional structure may have a positive impact on export sophistication and moreover many proxy variables of institutional structure were utilized in estimated models.

However, earlier empirical evidence suggests that the corresponding proxy variable unexpectedly has a negative sign or it was not found as statistically significant. In this study, the proxy variable that may explain institutional structure was considered as the rules of law index and its impact on export sophistication of selected developed and developing countries was examined. The empirical evidence gathered from estimated models using FMOLS estimators indicates that there exists a statistically significant positive association between the rules of law and export sophistication of both selected developed and developing countries. It can easily be said that the development and spread of property rights, legal rules and contractual practices in a country have an impact on economic growth. The development of the institutional structure is another advantage expected to facilitate technology transfer through foreign direct investments. It would not be wrong to expect foreign investors to be willing to invest in the countries where the institutional structure is developed, and on the contrary to act more abstained in terms of taking risk in countries where the institutional structure is not developed.

It is also examined whether the sophisticated values of the exports of the developing countries examined in this study will converge to those of developed countries if they continue in this way. At the end of the study, it was determined that Malaysia and Romania converged to developed countries. And, it is determined that Turkey and Bulgaria need to further develop the sophisticated value of their exports in order to converge to the developed countries. Although the dummy variable created for Brazil is positive, no comments can be made since it is not found statistically significant.

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