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Economic Complexity – High Technological Product Nexus for Selected EU Countries: Panel Data Analysis

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Abstract: Making high-tech goods is the main requirement for scoring highly on the economic complexity index (ECI). Importing high-tech goods can help nations that lack access to these entire resources boost their production capacity. The purpose of this study is to determine whether five European Union (EU) countries can rise to the top of the ECI by importing high-tech products as determined by the EU statistical office (Eurostat). This will be done by using the autoregressive distributed lag (ARDL)/Pooled Average Group (PMG) method and accounting for the 2007–2021 period. The chosen nations have the lowest ECI value, and all are full members of the EU. Recurring data indicates that no high-tech product alters the position of nations in the ECI. To rise to the top of the ECI, countries should import high-tech goods based on their own production systems.

Keywords: international economics; economic complexity; import; European Union; high technological product.

JEL classification: F14; 014; B17.

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1. INTRODUCTION

The production of high-tech products is now thought to have begun with the industrial revolution of the Eightieth century. The concept of high-tech items was made possible by advancements that have occurred since the industrial revolution. Regarding whether products qualify as high-tech and which products ought to be in this category, many viewpoints have been expressed. Products like aerospace, Electronic-Communications, and pharmaceuticals have been classified as high-tech products by internationally renowned economic and scientific organizations like OECD (The Organization for Economic Co-operation and Development), TUBITAK (The Scientific and Technological Research Council of Türkiye), and Eurostat (The Statistical Office of The European Union). It has also been acknowledged that the nations that make these goods can produce high-tech goods. A high-tech product is a product that is used extensively in all stages of the production process of the goods and services that are subject to production, from start to finish. It is also referred to as a sophisticated product concept. Research and development (RD) activities are heavily integrated into all stages of process management and organization, marketing, sales, and post-sales. Hidalgo and Hausmann (2009) proposed the concept of economic complexity, while the notion of sophisticated product has actively found its place in study in recent years (Grupp, 1995; Bustos, 2007; Córcoles *et al.*, 2014; Baliamoune-Lutz, 2019). The economic complexity index (ECI), which measures the technological development of countries and ranks them in the context of a technological country, is directly affected by the production of sophisticated products. The primary goal of the study is to determine how beneficial it would be for the five fully-member EU nations (Bulgaria, Greece, Lithuania, Portugal, and Romania) to import the necessary goods in order to move up ECI in the event that they were unable to manufacture the high-tech goods that were chosen for the analysis.

Although quite a few empirical research (Katırcıoğlu *et al.*, 2010; Lapatinas, 2016; Lee and Lee, 2020; Ikram *et al.*, 2021; Mealy and Teytelboym, 2022; Özekenci, 2023) have been conducted on the potential causal relationship between economic complexity, unemployment rate, green economy, international trade, low income, research and development (RD), and foreign direct investment (FDI); comparatively less focus has been placed on effect of various variables on ECI for countries those are low and mid economic developed. In several research conducted in high technology that is related with economic complexity and innovations. Santos-Paulino (2010) examines the export composition of China, India, Brazil, and South Africa using the productivity level associated to a country's exports (EXPY) variable. The study's conclusion is that productivity rises when high-tech products are exported. Moagar-Poladian *et al.* (2017) examine the research and innovation competitiveness of member states of the EU from the standpoint of obtaining research money from the EU, as well as from the perspective of important science and innovation performance indicators for the years 2007-2015. By writers, RD spending lays the groundwork for the introduction of new goods and manufacturing techniques as well as the use of improved and more sophisticated technology, as several writers have demonstrated. Popovici (2018) made an explanation in the export capacity in the EU countries. The author used the FDI and domestic investment to find export performance in manufacturing and services and used GMM approach with the period from 1999-2012. By the result, based on the type of economic activity and the group of nations involved, the empirical data indicates that FDI has varying effects on exports. Akın and Güneş (2018) investigated that economic complexity, and foreign trade has positive and significant relationship. The authors have been used the Johansen cointegration test and Zivot-Andres one structural unit root test to prove the correlation. Mewes and Broekel (2022) found that complicated technologies provide significant economic advantages. They applied the dynamic panel regression for 2000-2014 periods to reach the result by assessing the complexity of technological activities in 159 European NUTS 2 regions. Goryushkin and Khalimova (2023) make a paper that is about high technological businesses and their roles on economic growth. This paper is research paper and not used the econometric models. By the paper, having the technological advantages for the countries bring the growth of regional advantages, market expansion, and interregional collaboration. Thus, countries could get higher stand on technology league. Aalami *et al.* (2022) state that national IQ, innovation, educational attainment, nutrition explains the nations in terms of the production of high-tech. They focus on twenty-three countries with panel analyses.

Upon examination of the literature review, this study closes the gap to the body of knowledge in a number of ways, including the following: (1) The researcher uses an Autoregressive distributed lag (ARDL) estimating technique based on a PMG panel. This approach is being investigated in published works on economic complexity, aeronautics, electronic communications, pharmaceuticals, research and development, and foreign direct investment. With these characteristics, the research deviates significantly from the other publications. (2) Importantly, selection of lower developed EU countries if compared with the other countries those are full membered of EU also separates this paper from similar ones. (3) Although there is quiet research that examines the effect of various variables on ECI, this study examines with several regression models to find the reactions on ECI. (4) Lastly, the effect of higher technological products on ECI distinguishes this study from others sharply. Thus, this study has been filled the gap in literature.

The study is organized as follows: Section 2 outlines the theoretical model specifications and research technique employed in the empirical experiments. The econometric method is covered in the same section. Empirical results with further pertinent investigations are included in Section 3. The analysis is concluded with policy suggestions in Section 4.

2. RESEARCH METHODOLOGY

2.1 Theoretical model specification

With the aim of examining the causal relationship amid variables, this study adopts ARDL/ PMG method. Levin *et al.* (2002) Panel Unit Root Test (LLC thereafter) prefer to reach the significant results that provides a unit root of model before ARDL. By literature review of economic complexity (Bhaumik and Co, 2011; Kannen, 2020; Khan *et al.*, 2020; Nguyen and Su, 2021; Yeung and Huber, 2024), the estimation model and the variables used for this study is ECI: f (AERO, EE, PHAR, RD, FDI). As on the mentioned on the previous section and avoid repetition, variables are not explained once again. There are three different but similar models used for this study.

ECI_{it} is a dependent variable for all regressions and stands for economics complexity index for five different countries.

$$ECI_{it} = \beta_{it} + AERO_{1t} + RD_{2t} + FD_{3t} + u_{it} \; i = 1, \dots, N, t = 1, \dots, T \quad (1)$$

Regression A (1) is finding the effect of importing of Aerospace goods to five different countries. $AERO_{it}$ is representing with the percentage of total import, RD_{it} is representing the research and development and FD_{it} is the foreign direct investment. i stands for countries in t time. u_{it} is error term in regression.

$$ECI_{it} = \beta_{it} + EE_{1t} + RD_{2t} + FD_{3t} + u_{it} \;\; i = 1, \dots, N \, , t = 1, \dots, T \quad (2)$$

Regression B (2) is finding the effect of importing of Electronic-Communications goods to five different countries. EE_{it} is representing with the percentage of total import as well. RD_{it} is representing the research and development and FD_{it} is the foreign direct investment as regression A. i stands for countries in t time. u_{it} is error term in regression.

$$ECI_{it} = \beta_{it} + PHAR_{1t} + RD_{2t} + FD_{3t} + u_{it} \; i = 1, \dots, N, \; t = 1, \dots, T \quad (3)$$

Regression C (3) is finding the effect of importing of Pharmaceuticals goods to five different countries. $PHAR_{it}$ is representing with the percentage of total import as on regression A and B, RD_{it} is representing the research and development and FD_{it} is the foreign direct investment. i stands for countries in t time. u_{it} is error term in regression as well.

The variables (RD_{it} and FD_{it}) are representing the percent of RD_{it} respectively FD_{it} in gross domestic product (GDP) of each country. On the other hand, the control variables such as $AERO_{it}$, EE_{it} and $PHAR_{it}$ are representing the percent of total import of each country.

The next section would be the econometric approach that is about what methods used for the research.

2.2 Econometric Approach

Homogeneity and cross-sectional dependency among the variables are significant for choosing additional econometric tests (such unit roots) that are employed in the analysis. Thus, the Pesaran and Yamagata (2008) modified delta tilde test was used to assess homogeneity, and the Pesaran CD test of Pesaran (2004) was utilized to test cross-sectional independency among the series. Subsequently, Levin *et al.* (2002) unit roots used to analyze the variable integration levels regarding cross-sectional dependence. The long-term and short-term coefficients as well as the causalities between the variables were also estimated using the Pesaran *et al.* (1999) intermediate econometric estimator (PMG estimator), which uses the ARDL model to allow the short-term coefficients to vary between country groups while enforcing the similarity of long-term parameters. As previously mentioned, this estimator maintains consistent long-term parameters across several nation groups but allows for variations in the short-term estimates, error variance, and intercepts. Because the ARDL model may be used to create both short-term and long-term estimates concurrently, regardless of whether the series is I(0) or I(1), it has been increasingly popular in recent years.

2.2.1 Levin, Lin, and Chu (2002) Panel Unit Root Test

Unit root tests of the first-generation panel divide into two groups: first group tests and second group testing, based on whether ρ remains constant or varies from unit to unit. The LLC test in the first group takes into account individual constants and time trends. Higher ordinary serial correlation and inter-unit error variance are permitted to fluctuate freely in this test.

This test was developed by Levin *et al.* (2002) using three distinct models:

$$\Delta y_{it} = \delta y_{it-1} + u_{it} \tag{4}$$

$$\Delta y_{it} = \alpha_{0i} + \delta y_{it-1} + u_{it} \tag{5}$$

$$\Delta y_{it} = \alpha_{0i} + \alpha_{1i} t + \delta y_{it-1} + u_{it} \tag{6}$$

The models without constant, with constant, and with constant trend are referred to by these three terms, respectively. The error process, represented by u_{it} in this instance, is correlated across units and adheres to the stationary reversible ARMA process.

$$u_{it} = \sum_{j=1}^{\infty} \theta_{ij} u_{it-j} + \varepsilon_{it}, \quad i = 1, \dots, N \quad , \quad t = 1, \dots, T \tag{7}$$

If the main hypothesis in LLC panel unit root test generalized by considering model 2 (5):

$$\Delta y_{it} = \delta y_{it-1} + \sum_{L=1}^{P_i} \theta_{iL} \Delta y_{it-L} + \alpha_{mi} d_{mt} + \varepsilon_{it} \quad m = 1,2,3 \tag{8}$$

In Equation (8), d_m indicates the vector of deterministic variables, while their parameters are shown (Levin *et al.*, 2002). The best lag length (L) in the equation can be found by applying any information criterion.

The standard deviation in the LLC panel unit root test is computed by dividing the cross-sectional data's long-term standard deviation by the short-term standard deviation. Corrected t statistics are computed using computed standard deviations. Equation (6) expresses the revised t statistic formulation.

$$t_{\delta}^{*} = \frac{t_{\delta} - N\tilde{T}\widehat{S_N}\sigma_{\tilde{\varepsilon}}^{-2}\widehat{STD(\hat{\delta})}\mu_{m\tilde{T}}^{*}}{\sigma_{m\tilde{T}}^{*}} \tag{9}$$

The study's mean $\mu_{m\tilde{T}}^{*}$ and standard deviation $\sigma_{m\tilde{T}}^{*}$ corrections table includes the mean correction and standard deviation values (Levin *et al.*, 2002, pp. 7-8).

2.2.2 Panel ARDL/PMG

Examining the data set's characteristics reveals that the variables' relationships are comparable to those found in Pesaran *et al.* (1999) and Pesaran and Smith (1995). It appears that the Panel ARDL approach established by Pesaran and Smith (1995) is the best appropriate method to examine it. Due to the better qualities of the Panel ARDL approach over other dynamic panel data regression techniques, as demonstrated by the research of Arellano (1989), Anderson and Hsiao (1981) and Arellano and Bover (1995), fixed effects, and instrumental factors are among the techniques. Alternative approaches are likely to yield inaccurate results unless the predicted coefficients are consistent across national boundaries. Panel ARDL found to be the most successful approach in situations where the data set exhibited comparable features in the study by Karadam (2015). Based on the research and applications found in the literature, Panel ARDL was determined to be the most appropriate approach.

The ARDL (p,q,q,..,q) model can be defined as follows:

$$Y_{it} = \sum_{j=1}^{p} a_{ij} Y_{i,t-j} + \sum_{j=1}^{q} \delta'_{ij} X_{i,t} + \mu_i + \varepsilon_{it} \tag{10}$$

The dependent variable in the equation above is Y, and the explanatory variables are X. The model assumes the following structure when it is parameterized once again.

$$\Delta Y_{it} = \emptyset_i \big(Y_{i,t-1)} - \beta'_i X_{it}\big) + \sum_{j=1}^{p-1} \alpha^*_{ij}\, \Delta Y_{i,t-j} + \sum_{j=1}^{q-1} \delta^{*\prime}_{ij} X_{i,t-j} + \mu_i + \varepsilon_{it} \tag{11}$$

The coefficients in the model above, denoted as β_i, are intended to be obtained and provide insight into the long-term impact on economic complexity of the explanatory variables included in the model. Furthermore, the coefficient known as Error Correction Mechanism Impact is represented by $\emptyset_i$. The model's other variables display the nations' short-term coefficients. The error term, ε_{it}, has a mean of zero and a variance of constant, and it is independent of time and units. Upon closer inspection, the model allows us to investigate the short- and long-term effects of the variables independently. Being able to see the short- and long-term correlations between variables independently is an advantage. By reviewing the literature, Pesaran *et al.* (1999) and Pesaran and Smith (1995) demonstrated that the MG (Mean Group) approach can reliably estimate the model found in Equation (10). This method involves calculating and averaging coefficients for each cross-sectional data set. On the other hand, a more successful approach known as PMG is advised if the long-term coefficients included in the equation demonstrate homogeneity for each nation, as in this study, Pesaran *et al.* (1999), Pesaran and Smith (1995). According to PMG, short-term coefficients differ between nations even while the long-term structure of the relationship between the variables is the same. Considering this circumstance, the PMG method was used and established as the foundational approach for the investigation. The fourth next section will be about empirical findings which gives the estimations for the research.

3. EMPIRICAL FINDING

The following data set summary and descriptive statistics for the variables used in the study are shown in Table no. 1 for a selected number of years:

Table no. 1 – Summary of data set

Variables	Explanations	Sources
ECI	Economic Complexity Index	M.I.T. - The Observatory of Economic Complexity Index
AEOR	Aerospace (% of Total Import)	World Bank Development Indicators
EE	Electronic-Communications (% of Total Import)	World Bank Development Indicators
PHAR	Pharmaceuticals (% of Total Import)	World Bank Development Indicators
FDI	Foreign Direct Investment (% of GDP)	World Bank Development Indicators
RD	Research & Development (% of GDP)	World Bank Development Indicators

In summary, Table no. 2 shows the descriptive statistics for the factors described above for a sample of five EU nations between 2007 and 2021. Statistics in Table no. 2. descriptively reveals for the sample of EU countries, economic complexity on average (M) is 0.5177 which is nearly with standard deviation (SD) of 0.2286 compared to Aerospace (M. 0.7609, SD. 0.5944), research and development (M. 0.8834, SD. 0.3596). Conversely, the three variables with the greatest mean values – pharmaceuticals (M. 4.2554, SD. 1.1456), foreign direct investment (M. 3.5997, SD. 4.1838), and electronic communications (M. 9.1169, SD. 2.9796) - were the others. Generally speaking, if the normal values for skewness and kurtosis are "zero" and "three," respectively, then the observed series is said to be normally distributed or symmetric. The skewness and kurtosis results in Table no. 2 suggest that none of the observed series have a normal distribution. Specifically, skewness-based figures show that all variables skewed favorably and positively to the right. This suggests that for the first four distributions, the bulk of the study's observations distributed on the positive side. The values in Table no. 3 the Spearman coefficient analysis is computed and showed in Table no. 3.

Table no. 2 – Summary statistic of variables

Statistics	ECI	AEOR	EE	PHAR	FDI	RD
Mean	0.517733	0.760933	9.169867	4.255467	3.599791	0.883465
Median	0.450000	0.620000	8.430000	3.970000	2.856728	0.830840
Max.	1.070000	3.970000	16.00000	7.310000	31.22753	1.680720
Min.	0.210000	0.150000	5.310000	2.230000	-0.963401	0.382080
Std. Dev.	0.228672	0.594404	2.979642	1.145617	4.183871	0.359680
Num. of Count.	5	5	5	5	5	5
Obs.	75	75	75	75	75	75

Note: Data from 2007 to 2021 taken into consideration for normal distribution or not, apply the Jarque-Bera test. It examines the proposition that a particular series has a normal distribution.

Table no. 3 – Correlation analysis

Variables	ECI	EE	PHAR	AEOR	FDI	RD
ECI	1					
EE	6.468489	1				
PHAR	-2.447877	-1.251326	1			
AEOR	-3.300299	-0.285757	0.130572	1		
FDI	1.706935	2.735676	-5.566842	-0.417200	1	
RD	-2.450421	-4.742849	-0.145382	4.305667	0.651865	1

Unlike Levin and Lin (1992), Levin *et al.* (2002) known to allow for homogeneity and autocorrelation. Therefore, it is not necessary to display the tables for the two outcomes in this work. According to Table no. 4, the level value of the dependent variable ECI seen to be statistically insignificant in the model with constant and constant and trend, therefore the null hypothesis "H_0: There is no unit root" rejected. The first difference value of the variable found to be statistically significant in the model with constant and constant and trend, so the null hypothesis "H_0: There is no unit root" accepted and it determined as I (1). Additionally, It seen that the level values of the independent variables PHAR and RD statistically insignificant in the constant and constant and trend model, therefore the null hypothesis "H_0: There is no unit root" rejected. For this reason, the first difference value of the variable found to be statistically significant in the model with constant and constant and trend, and therefore the null hypothesis "H_0: There is no unit root" accepted. In this case, the variables determined as I (1). It seen that the level value of the FDI and AERO independent variables statistically significant in the model with constant and constant and trend, therefore the null hypothesis"H_0: There is no unit root" accepted. The variables are designated as I (0).

Table no. 4 – Levin-Lin-Chu (2002) panel unit root test

Variables	Constant		Constant &Trend	
	t-Statistic	P-Value	t- Statistic	P-Value
ECI	-1.5318	0.0628	-1.3402	0.0901
ΔECI	-3.1247	0.0009***	-2.1279	0.0167**
AERO	-2.4419	0.0073***	-4.3588	0.0000***
EE	-4.3774	0.0000***	-4.4310	0.0000***
PHAR	0.6706	0.7488	-1.3144	0.0944
ΔPHAR	-4.4055	0.0000***	-6.5255	0.0000***
RD	0.7244	0.7656	-1.3253	0.0925
ΔRD	-3.6859	0.0001***	-1.7939	0.0364**
FDI	-5.7764	0.0000***	-6.6325	0.0000***

Note: ** and *** denote statistical significance at the 1% and 5% levels, respectively, while Δ denotes the initial differences.

The findings of regressions A, B, and C are displayed in Tables no. 5, no. 6, and no. 7. When the ARDL limit test results are analyzed for every model, several assessments can be made. First, a closer look at Table no. 5 reveals that the relevant nations have the potential to move up the ECI rankings by gradually increasing their imports of aeronautical goods. In another way, it is anticipated that the relevant nations would advance technologically and be able to rank better in the ECI as a result of rising import statistics in the aerospace industry.

Table no. 5 – ARDL result of variable aero

Variables		Coeff.	Prob.
Long Run (LR)	**AERO**	0.0986	0.0000***
	RD	-0.0166	0.0000***
	FDI	0.5448	0.0000***
Short Run (SR)	**Ec__**	0.4011	0.3571
	D(AERO)	0.0527	0.0628
	D(RD)	0.1034	0.5019
	D(FDI)	0.0156	0.3440

Note: At the 1% and 5% levels, respectively, *** and ** denote statistical significance.

A similar situation can be said in the results obtained in Table no. 6 and Table no. 7 Importing electronic-communications and pharmaceutical products from abroad helps the relevant countries advance technologically and climb to the top of the ECI. The fact that the effects of technological developments generally seen in the long term also supports the results obtained. An important detail is that importing Pharmaceuticals products from abroad will enable the relevant countries to rank higher in the ECI in the long run, faster than other products. When Tables no. 5, no. 6, and no. 7 examine, Pharmaceuticals products have the biggest impact on ECI with 0.1362 (0.0031***). In addition, the fact that the developments achieved in the long-term don not observed in the short term is compatible with the idea that the returns on investments made in technology receives in the long term.

Table no. 6 – ARDL result of variable ee

Variables		Coeff.	Prob.
Long Run (LR)	**EE**	0.0346	0.0473**
	RD	-3.6475	0.1015
	FDI	1.2644	0.0998
Short Run (SR)	**Ec__**	-0.0197	0.0862
	D(EE)	-0.0016	0.9472
	D(RD)	0.0761	0.4895
	D(FDI)	-0.0135	0.3115

Note: At the 1% and 5% levels, respectively, *** and ** denote statistical significance

Table no. 7 – ARDL result of variable phar

Variables		Coeff.	Prob.
Long Run (LR)	**PHAR**	0.1362	0.0031***
	RD	-0.0782	0.6066
	FDI	0.0129	0.4030
Short Run (SR)	**Ec_____**	0.0129	0.5715
	D(PHAR)	0.0064	0.6833
	D(RD)	0.0711	0.3598
	D(FDI)	0.0013	0.8148

Note: At the 1% and 5% levels, respectively, *** and ** denote statistical significance.

Following the evaluation of the findings with all countries, each country's results looked at separately. The numbers in Tables no. 8, no. 9, and no. 10 obtained when the impacts of the pertinent variables studied independently for the study's focal countries, Bulgaria, Greece, Lithuania, Portugal, and Romania.

Upon closer inspection of the data shown in Tables no. 8, all nations except Lithuania have considerable error correction parameters. Although it is not negative, Bulgaria and Romania's error-correction parameter is considerable. Thus, aside from these three nations, Greece and Portugal may be considered to have a long-standing partnership between ECI and AERO. From this point on, almost 19% of the imbalances in the ECI that would arise in the next period as a result of AERO imports into Greece will be fixed. In a similar vein in Portugal, the next period will make up for about 1% of any imbalances in the ECI that may arise from AERO imports during a given period. As a result, Greece values AERO imports more than Portugal does, is able to address import imbalances more quickly, and can react to a spike in ECI more quickly. It is clear from these findings that Greece needs to prioritize AERO imports.

Table no. 8 – PMG result of variable aero

	AERO		RD		FDI		EC__	
Countries	**Coeff.**	**Prob.**	**Coeff.**	**Prob.**	**Coeff.**	**Prob.**	**Coeff.**	**Prob.**
Bulgaria	0.1325	0.0000***	0.4688	0.0026***	-0.0010	0.0000***	2.1127	0.0001***
Greece	0.0165	0.0000***	-0.2770	0.0001***	0.0803	0.0000***	-0.1528	0.0000***
Lithuania	0.0114	0.0071***	-0.0716	0.2716	-0.0008	0.0001***	-0.0038	0.6711
Portugal	-0.0012	0.0000***	0.4605	0.0000***	0.0071	0.0000***	-0.0162	0.0000***
Romania	0.1044	0.0004***	-0.0631	0.2790	-0.0072	0.0000***	0.0659	0.0000***

Note: At the 1% and 5% levels, respectively, *** and ** denote statistical significance

Following examination, the statistics shown in Table no. 9 show that each country's error correction parameter is considerable. Although it is not negative, Lithuania's error correction parameter is considerable. Thus, for all nations with the exception of Lithuania, a long-term link between ECI and EE may be noted. Examining the data reveals that imbalances in the ECI that can arise from EE imports into Greece in one period can be addressed in the subsequent month with a value less than 1%. Likewise, in Portugal, the correction of ECI imbalances resulting from EE imports in a given period will only account for around 2% of the imbalances in the subsequent period. Merely 5% of the potential imbalances in the ECI resulting from EE imports into Romania during a given period will be rectified in the subsequent quarter. Ultimately, the next period will only rectify around 2% of the imbalances in the ECI that could arise from Bulgaria's EE imports during that particular time. This indicates that Romania values EE imports more than Portugal does, that Portugal can address import imbalances more rapidly than Bulgaria, allowing it to react to the rise in ECI more swiftly, and that the other three nations are able to address their imbalances in comparison to Greece. It is acknowledged that a quicker correction is possible. This condition leads one to believe that Romania need to prioritize EE imports.

Table no. 9 – PMG result of variable ee

	EE		RD		FDI		EC__	
Countries	**Coeff.**	**Prob.**	**Coeff.**	**Prob.**	**Coeff.**	**Prob.**	**Coeff.**	**Prob.**
Bulgaria	-0.0414	0.0000***	0.2464	0.0483**	-0.0149	0.0000***	-0.0226	0.0000***
Greece	-0.0348	0.0000***	0.1930	0.1043	-0.0127	0.0080***	-0.0096	0.0001***
Lithuania	-0.0235	0.0000***	-0.0901	0.0008***	0.0152	0.0000***	0.0145	0.0000***
Portugal	0.0922	0.0000***	-0.2667	0.0000***	-0.0179	0.0000***	-0.0273	0.0000***
Romania	-0.0005	0.0004***	0.2980	0.0001***	0.0087	0.0000***	-0.0533	0.0000***

Note: At the 1% and 5% levels, respectively, *** and ** denote statistical significance.

Lastly, a closer look at Table no. 10 reveals that every country's error correction parameter is considerable. Although it is not negative, the error correction parameter for Romania and Lithuania is noteworthy. As a result, not all nations can have a long-term association between ECI and PHAR. Upon analysis of the data, it is possible to rectify imbalances in the ECI that may arise in a certain period as a result of PHAR imports into Greece by less than 1% in the subsequent month. Comparably, in Portugal, the next period will make up for around 20% of any imbalances in the ECI that may arise from PHAR imports during a given period. Ultimately, in Bulgaria, the subsequent period will rectify around 24% of the imbalances that can arise in the ECI as a result of PHAR imports during one period. This suggests that Portugal can adjust import imbalances more quickly than Romania, which allows Portugal to react to a rise in ECI more quickly than Bulgaria, which places a higher value on PHAR imports. This condition leads one to believe that PHAR imports should be Bulgaria's top priority.

Table no. 10 – PMG result of variable phar

	PHAR		RD		FDI		EC__	
Countries	**Coeff.**	**Prob.**	**Coeff.**	**Prob.**	**Coeff.**	**Prob.**	**Coeff.**	**Prob.**
Bulgaria	-0.2402	0.0159**	-0.1124	0.0022***	-0.0002	0.0002***	-0.2402	0.0159**
Greece	0.0136	0.0000***	-0.0437	0.0520	0.0222	0.0000***	-0.0070	0.0007***
Lithuania	-0.0208	0.0000***	0.0510	0.0303**	-0.0091	0.0000***	0.1324	0.0000***
Portugal	-0.0151	0.0003***	0.1290	0.0012***	8.3805	0.0169**	-0.2028	0.0263**
Romania	0.0649	0.0000***	0.3318	0.1238	-0.0064	0.0000***	0.0999	0.0002***

Note: At the 1% and 5% levels, respectively, *** and ** denote statistical significance.

4. CONCLUSION AND RECOMMENDATION

This study looked at the casual link between high technology products (aero, ee, phar) and eci for five EU full member countries (Bulgaria, Greece, Lithuania, Portugal and Romania) for the period 2007-2021. The following is a summary of the study's findings-based policy suggestion and conclusion: First, looked at the summary statistic of variables. Second, applied the LLC panel unit root test by the result of cross-sectional correlation. Third, used the ARDL to show for long and short-run relationship with ECI for each control variables. Last, result from the PMG for each country through the panel ARDL model.

According to the results obtained from the analysis, imports of relevant high-tech products generally take the countries selected in the study higher in the ECI. As expected, the effects of high-tech product imports are consistent with the idea that the results of high-tech products obtained as a result of RD can be seen in the long term, not in the short term. When the relevant high-tech products examined for each selected countries, previously unobtainable and interesting results can be obtained. When examined for the aerospace, Greece is better than Portugal at valuing AERO imports, addressing import imbalances faster, and responding swiftly to an increase in ECI. These results demonstrate that Greece must give AERO imports first priority. If examined for electronic-communications, Romania places a higher value on EE imports than does Portugal, that Portugal is able to react to the growth in ECI more quickly than Bulgaria due to its ability to fix import imbalances more quickly, and that the other three countries are able to address their imbalances more quickly than Greece. It is accepted that a speedier fix is achievable. This criterion suggests that Romania should give EE imports priority. On the other hand, when looking at pharmaceuticals, Portugal can respond to an increase in ECI faster than Bulgaria, which places a greater value on PHAR imports, since Portugal can correct import imbalances more rapidly than Romania. One would seem that Bulgaria's main priority should be PHAR imports based on this circumstance.

All these findings have especially important policy implications. The results give an idea that being a member of the EU paves the way for technological development for member countries. The funds available from the EU enable development. However, it is an important detail in how these funds should be used to climb to the top of the ECI, which is an indicator of technological development. In this sense, this study provides information to the countries selected in the study about which areas they should invest in to develop their technologies, and if they do not have the opportunity and conditions to invest, which areas they should import and develop their technologies. When looked at, it seems essential for Greece to import in the field of aerospace. On the other hand, Romania should give importance to the import of electronic-communications products. Finally, one-step of Bulgaria's rise to the upper leagues technologically is through the import of pharmaceutical products.

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