HIGH-TECHNOLOGY EXPORTS AND ECONOMIC GROWTH: PANEL DATA ANALYSIS FOR SELECTED OECD COUNTRIES[1]

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ABSTRACT

This paper uses a panel cointegration model to analyse the long-term relationship between high-technology exports and economic growth in selected OECD countries in the period from 1989 to 2015. We used high-technology exports (current US$) as the dependent variable and the GDP growth rate, FDI (foreign direct investment), application of patents by residents, and gross capital formation % of GDP as explanatory variables. The export structure of countries is moving increasingly towards technology-intensive products such as ICT (information and communications technology), aerospace, computing and office equipment, electronics, chemical products, pharmaceuticals, and electrical machinery. The export structure has played an important role in the economic growth theories of many countries since the 1960s, as export growth has been associated with faster productivity and GDP growth. We aimed to find out the relationship between high-technology exports and the explanatory variables which we listed for 14 selected OECD countries (Canada, Denmark, Finland, France, Germany, Israel, Korea, the Netherlands, Norway, Switzerland, Sweden, Turkey, the UK, and the USA). According to our empirical results, there is a long-term relationship between high-technology exports and economic growth in selected OECD countries. The empirical results show 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.

KEY WORDS

High technology export, GDP growth, FDI, Panel cointegration

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Introduction

One of the reasons underlying differences in economic growth and income level between developed and developing countries is undoubtedly the technology

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infrastructures these countries have. While many factors such as the workforce, natural resources, economic and political stability, educational status, density of R&D activities, innovation and so on lead to differences in development and growth among countries, the most important factor is the technology on which production is based.

High technology (high-tech) is used in the sense of goods and services created by innovative and advanced technology companies and industries. Such firms are generally reliant on advanced scientific and technological expertise and are generally characterised by high R&D spending (employment) in their labour force (total labour force). High technology sectors are, for example, aerospace, computers, pharmaceuticals, scientific instruments and electric machines. Countries that have developed advanced technology infrastructures in these sectors can finally achieve better levels of economic growth.

The OECD has classified numerous categories of exports – high, medium-high, medium-low and low-technology. "*The classification is based on the importance of expenditures on research and development relative to the gross output and value added of different types of industries that produce goods for export. Examples of high-technology industries are aircraft, computers, and pharmaceuticals; medium-high-technology includes motor vehicles, electrical equipment and most chemicals; medium-low-technology includes rubber, plastics, basic metals and ship construction; low-technology industries include food processing, textiles, clothing and footwear*" (OECD 2011).

Many countries that wish to be in a better position in terms of the level of economic growth and development are now paying more attention to technology-based industrial development. New Silicon Valleys have begun to be established in several countries around the world. Especially considering the developments of the last two decades, we are aware that many Western European countries are starting to establish venture centres in newly established universities.

In recent years, the rapidly increasing use of high technology worldwide and the high-tech production base has made it possible to accelerate the export of high technology. The ability of emerging countries to rise to the level of developed countries depends on the scale of high technology exports that these countries can achieve. It is important for developing countries to rapidly focus on quality education and R&D activities, and to produce and export high-tech products.

When we look at Table 1, which shows high technology exports for selected countries, China has an absolute advantage among developed and developing countries. There are many reasons for this state of affairs, the most important of which are industrial production, level of education and investments in R&D projects.

Table 1. High technology exports for selected countries (billion $)

	2000	2010	2013	2014	2015
Developing countries					
Brazil	6.0	8.1	8.4	8.2	8.8
China	41.7	406.1	560.1	558.6	554.3
Turkey	1.1	1.7	2.2	2.3	2.3
Indonesia	5.8	5.7	4.8	5.0	4.4
South Korea	54.3	121.5	130.5	133.4	126.5
Mexico	31.2	37.7	45.4	49.4	45.8
Russia	3.9	5.1	8.7	9.8	9.7

Developed countries					
US	197.5	145.9	148.5	155.6	154.3
UK	71.7	60.2	69.2	70.7	69.4
Japan	128.9	122.1	105.1	101.0	91.5
Germany	85.5	158.5	193.8	199.7	185.6
World	1.158.1	1.780.1	2.106.3	2.150.9	-

Source: World Bank.

Low and medium-low technology sectors have the highest share of added value in developing countries. In this context, the place of South Korea as the only developing country for which high technology has the highest share of added value is worth emphasising. The food and beverage and textile sectors are the most developed sectors in developing countries.

Table 2. Sectors with the highest share of added value in developing countries (%) (2014)

Country	Sectors	Share (%)	Level of technology
Turkey	food and beverage	14	low technology
Indonesia	food and beverage	20	low technology
China	metal industry	14	medium-low technology
Brazil	food and beverage	21	low technology
India	chemistry	18	medium-high technology
Argentina	food and beverage	30	low technology
South Korea	ICT machines	25	high technology
Russia	oil and nuclear fuel, coal	22	low technology
South Africa	food and beverage	22	low technology
Mexico	food and beverage	22	low technology

Source and Note: OECD, Classification of Manufacturing Industries Based on Technology Intensity, UNIDO and Eşiyok Bayram Ali Calculations.

The aim of this paper is to analyse the relationship between high-tech exports and economic growth in selected OECD countries (Canada, Denmark, Finland, France, Germany, Israel, Korea, the Netherlands, Norway, Switzerland, Sweden, Turkey, the UK, and the USA), adding other explanatory variables (foreign direct investment, domestic patent applications, investment) by using a panel data approach. For this purpose, the study was formed as follows. In the introduction section, we provided a definition of high-tech products; in the second section, we examined literature related to the study; and in the third section, the theoretical framework of the study is presented. In the fourth part of the study, the dataset, model and method were introduced and evaluations pertaining to the results of the study were made. In conclusion, policy proposals were presented through empirical findings and determinations.

1. Literature review

Since the 1960s, export growth has played a central role in many countries' economic growth strategies. Export growth is associated with faster productivity and GDP growth (Bernard and Jensen 2004). Analyses of export growth and its general economic effects have been an important topic in the economic literature in the last decade. However, more recently, as researchers began to understand the relationship between innovation, high-technology-based international trade and

overall economic performance, they focused more on high-tech trade (Tebaldi 2011: 343). This growing interest in high-tech trade is largely due to the fact that an international commercial economy of high-tech products informs general competitiveness and its position in the global technology market. This interest also contributes to how innovation in a dynamic economic environment affects comparative advantage and the relative importance of high technology to international markets (Tebaldi 2011: 344).

The literature highlights the fact that high-tech industries are the fastest developing industries in international commerce. This contributes to boosting performance in other sectors through the dynamism and positive externalities that unfold. For example, Hatzichronoglou (1997), in the context of economic globalisation, stated that technology is an important factor in growing business and increasing competitive power. Technology-intensive manufacturing firms create more innovation, enter new markets and use existing resources more productively, resulting in higher pay for employees. Montobbio and Rampa (2005) are of a similar opinion, claiming that innovative activities tend to intensify in sectors that are stagnating at world level. They used a structural decomposition model to study nine developing countries. Although countries are in greater harmony with global demand, the share of global exports is also harmonious at the same time. Econometric analysis shows that if a country is growing towards technology-compatible industries, technological activity leads to export gains in high-tech sectors. In addition, both the high and low technology sectors are affected by levels of growth in technical capacity sectors, foreign direct investments, productivity, and technical skills.

R&D investments are a key factor in determining high-tech exports among OECD countries (Braunerhjelm and Thulin 2008). The technological capabilities of a country, gross enrolments in tertiary education, the number of patents as well as access to computers all have positive effects on high technology exports (Srholec 2007). In addition, the size of the economy plays an important role in high technology exports, and developing countries attract manufacturing-based fragments of global production networks in electronics, while developing countries must focus on specialisation in electronics.

A summary of the literature is presented in Table 3.

Table 3. A summary of the literature on high technology exports and R&D expenditure

Year	Author(s)	Result
2007	Frolov and Lebedev	The modernisation of capital assets will be a tool in shaping the technological development of the Russian economy.
2008	Seung-Hoo Yoo	High-technology exports and economic output: an empirical investigation
2009	Jafari et al.	R&D expenditures have no effect on growth.
2009	Ozer and Çiftci	For OECD countries there is a positive relationship between R&D expenditure and exports.
2010	Jong-Wha Lee and Kiseok Hong	In terms of countries which export traditional and low-tech products respectively, countries with high-tech product exports achieved faster economic growth.
2013	Gocer	It has been determined that R&D expenditure is a relationship between high-tech products and that exports of high-tech products increase economic growth.
2013	Moiseeva and Mazol	Confirms the relationship between the share of public and private R&D expenditure and the national R&D sector's effectiveness.
2013	Ismail et al.	Innovation activities positively affect high-tech product exports.

2014	Meo and Usmaný	While they found a positive relationship between patent applications and high-tech exports, they found no relationship between per capita GDP and research outcomes.
2014	Kýlýc et al.	R&D expenditures and real exchange rates have been found to have a positive effect on exports of high technology products.
2014	Sandu and Ciocanel	A positive correlation between R&D spending volume and level of high-tech exports is confirmed. The impact of private R&D spending on high tech exports is stronger than public R&D spending.
2015	Akhvlediani and Śledziewska	Although the effect of accumulation of physical and human capital on export growth for the EU-15 countries is similar, it has a positive effect on the V-4 countries.
2016	Ustabas and Omer Ersin	For South Korea, the positive effect on GDP of high-tech exports in the short and long term is irrefutable, and Turkey has seen limited short-term positive effects of high-tech exports.
2016	Alagoz et al.	It was determined that China's share in both R & D spending and high-tech exports is higher than in other countries.
2017	Mehrara et al.	Corporate quality, human capital, import (as a measure of openness), legal dominance and GDP are the most important variables affecting high-tech exports in developing countries.
2017	Ozkan and Yýlmaz	They came to the conclusion that R&D spending boosts high-tech exports.

Source: Own elaboration.

3. The theory of high technology exports

It is known that development strategies directed towards exports have a positive impact on economic growth, as they increase efficiency and productivity in resource distribution, increase market size and increase foreign direct investment. In this sense, it is important to increase exports in many developing countries that want to catch up to industrialised countries. If exports have an effect on the growth channel, undoubtedly the biggest effect is the production and marketing of high technology products. It is also crucial for such countries to export high technology and concentrate their investments in these fields.

"High Technology" is used to represent companies and industries which create innovative, cutting-edge technologies, products or services. These companies are commonly credited with advanced scientific and technological expertise and are generally characterised by high turnover (total work force) and high R&D expenditure (employment) (Seyoum 2004: 145).

Davis (1982) undertook the first systematic effort in the sense of measuring the high-tech combination. The products produced by high-tech producers have been identified as the products with the highest R&D expenditure according to the value of the senders. The second definition of High Technology was undertaken by Hatzichronoglou (1997). He prepared a list of high-tech products. This list is the result of calculations of R&D intensity (R&D spending / total sales) covering six countries (USA, Japan, Germany, Italy, Sweden, and the Netherlands). Finally, the OECD identified the best definition of products as advanced technology (Seyoum 2004: 146).

The empirical descriptions of high-tech products overlap at large. Although the literature has been developed differently, different definitions have been given; according to the OECD definition, high-tech products are listed as aerospace, computer and office equipment, electronics and telecommunication, scientific instruments, chemical products, drugs, weapons, electrical and non-electrical equipment.

With the rapid development of communications and transportation technologies along with the decline in costs over the 1960s, the global economy has entered a period of rapid globalisation. In such a period, developed economies opened their economies more quickly to international trade, while export increases in East Asian countries were influential in the opening of emerging economies to international trade (Balcilar et al. 2014: 451). Today, many Western countries have begun to develop their production with a focus on technology-based industrial growth as a result of such a growth and competitive environment brought about by globalisation. These countries, which can make good use of the advantages arising from technology-intensive production, have come to assume a better position in international trade.

On the other hand, in today's global economy where globalisation is growing and competition is intense, countries can only export if they can produce appropriately high-quality products (Özer and Çiftçi 2009: 42). Given that the greatest share in the composition of international trade in the last two decades is high-tech products, the production of these products has been vital to sustaining global competition.

Achievement in high-tech exports is often seen as a measure of the competitiveness of industries in a country. Markets for high-tech products are growing faster than for other products, the reason being that the income elasticity of demands, product innovation and increase in productivity are higher. If a competitive position can be achieved in high-tech products, it is easier for a country to sustain its export growth (Mani 2004: 26-27).

The competitive position of a country in high technology exports is linked to various factors. If we move from general literature, factoring in the conditions of an individual country, the amount of direct foreign investment, the domestic competition environment, demand conditions and exchange rates, patent applications, R&D expenditures, innovation and so on, many factors play an important role in the level of high technology exports of the country.

Factoring in the conditions, human and physical information and capital resources and the type, quality and usability of the infrastructure allow competition to be realised. The creation of advanced technology factors (highly skilled human resources, research centres and communication infrastructure) is considered to be of critical importance for creating and developing competitive advantage in technology-intensive sectors. Therefore, the greater the number of scientists and engineers involved in a country's R&D, the emphasis on mathematics and scientific training, the number of R&D business associations with other countries and the better the state of modern physical infrastructure, the higher the amount of high technology exports (Seyoum 2004: 150-151).

Foreign direct investment is considered one of the factors which contributes to the economic growth and development of developing countries. Foreign direct investment contributes to the growth rate of the countries to which it has been sent, and increases its competitiveness in production and the international arena. Multinational corporations are also making technology transfers that countries cannot achieve on their own, by investing in countries where labour is relatively cheaper. By using this transferred technology, the related country can increase high technology exports (Kýzýlkaya et al., 2017: 67). For this reason, it is also important that high-tech investments and direct exports to the country are directed towards high-tech areas.

The presence of strong local competitors is a strong stimulus for the creation and continuity of national competitive advantage. Intensive domestic competition will ultimately create pressure to replace domestic firms and, at the same time, to look at global markets. Such aggressive competition will force domestic companies to succeed in international markets.

As a result of the R&D expenditures realised by countries, technological advances and increases in the level of completed production processes are emerging. These technological developments arise as a result of R&D activities, capital accumulation, invention, innovation, the efficient use of resources, and so on, and are manifested in the form of utilities. These increased benefits and technological advances as a result of the R&D work carried out by countries are being used both to raise demand in domestic markets and to increase exports. Moreover, there is a positive relationship between R&D expenditures and patent applications, and studies have been carried out in which the patent applicants contribute to the increase in high-tech exports (Kýzýlkaya et al. 2017: 67).

On the other hand, the literature reveals that increasing innovation activities as a result of these R&D studies contributes to the diversification of exports. There is a positive relationship between R&D expenditures and patent numbers and innovation. An increase in product technology content with increased innovation, production of new products and production of new and added value products will have a positive effect in terms of the diversification of and increase in exports (Ferragina and Pastore 2007: 4-5).

4. Data and descriptive statistics

Our data set covers annual data from the period of 1989-2015 for 14 selected OECD countries (Canada, Denmark, Finland, France, Germany, Israel, Korea, the Netherlands, Norway, Switzerland, Sweden, Turkey, the UK, and the USA). We have chosen data from that period because high technology export and patent application data begins in 1989. Table 4 denotes the definition of the data set.

Table 4. Definition of the data set

Export	High-technology exports (% of manufactured exports)
Lngdp	GDP (current US$)
FDI	Foreign direct investment, net inflows (% of GDP)
Ýnvestment	Gross capital formation (% of GDP)
Inpatent	Patent applications, residents

Source: Own elaboration.

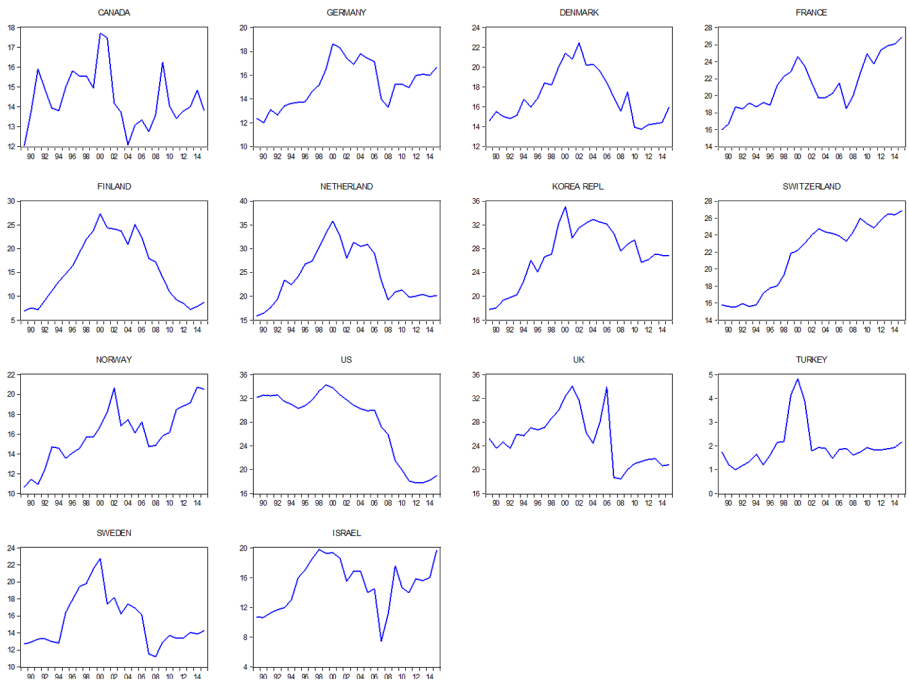
Our dependent variable is high-technology exports (% of manufactured exports) which incorporate aerospace, computers / office machines, electronics-telecommunications, pharmacy, electrical machinery, and non-electrical machinery. We also use foreign direct investments to GDP ratio, the natural logarithm of patent applications, and gross capital formation (% of GDP) as proxy for investment. All of our data was obtained from the World Bank databank. Our explanatory variable is the natural logarithm of GDP. We used ratio variables (high tech export % of manufactured and investment / GDP ratio, FDI/GDP ratio) without a natural logarithm form, although we used the rest of the variables (GDP and patent applications) in natural logarithm form. Table 5 denotes the descriptive statistics.

Table 5. Descriptive statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
lngdp	378	27.17361	1.267417	24.50	30.52
exports	378	18.47323	7.643881	0.99	35.80
fdi	378	3.451735	6.871879	-3.69	87.40
investment	378	23.12238	4.219917	14.70	41.30
lnpatent	378	8.588343	1.725721	4.92	12.57

Source: Own elaboration.

Figure 1. Individual countries' high-technology exports (% of manufactured exports)



Source: Own elaboration.

According to Figure 1, the US, Sweden, Finland, Denmark and the UK show a slowdown trend in terms of the share of high-tech exports after the 2008 global financial crisis, while Israel, Norway, Korea, Switzerland, and France have shown a positive trend in recent years.

We applied a panel data analysis to test the relationship between high-tech exports and economic growth. For estimating and evaluating the long-term parameters of the economic theories, using the panel cointegration model is the best approach (Yerdelen Tatoğlu, 2012).

4.1. Testing cross-section dependency and unit root

The first essential step in a panel data analysis is to find out whether or not there is cross-section dependence. OECD countries integrate in terms of international trade and financial transactions. Globalisation, custom unions, economic unions and contagious financial crises make

countries sensitive to economic shocks from other countries. Because of this integration in panel data analysis, we must consider possible cross-section dependence across countries (Zhong et al. 2015). The following panel equation is estimated to manage the CD test for cross-section dependency:

$$y_{it} = \alpha_i + \beta_i' x_{it} + u_{it} \text{ for } i = 1,2,\ldots,N; t = 1,2,\ldots,T \quad (1)$$

where i is the individual dimension, t is the time dimension, x_{it} is the k x 1vector of explanatory variables, and α_i and β_i are individual intercepts and slope coefficients, respectively, which are allowed to vary across states. The null hypothesis of no cross-sectional dependence for all t and $i \neq$ j is tested against the alternative hypothesis of cross-section dependence. To test the null hypothesis, the CD statistic is:

$$CD = \sqrt{\left(\frac{2T}{N(N-1)}\right)}\left(\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}_{ij}\right) \quad (2)$$

where $\hat{\rho}_{ij}$ is the sample estimate of the pair-wise correlation of the residuals from the pooled ordinary least squares (OLS) estimation of equation (1) for each i (Pesaran, 2004).

The data used in this paper is from 1989-2015. As part of our analysis, we checked each of these series for cross-section dependency so that the hypothesis of a cross-section dependency could not be rejected for all the variables. Table 6 and Table 7 denote the cross-section dependency and slope homogeneity test results respectively.

Table 6. Cross-section dependency CD test results

Variable	CD-test	p-value
exports	20.85	0
lngdp	46.97	0
fdi	22.88	0
investment	9.34	0
lnpatent	8.16	0

Source: Own elaboration.

Table 7. Slope Homogeneity tests in Pesaran and Yamagata (2008)

	Statistic	p-value
Homogeneity tests:		
$\Delta^{\%}$	13.35	0.000
$\Delta^{\%}_{adj}$	15.06	0.000

Source: Own elaboration.

The implications of unit roots in macroeconomic data are highly significant. If a structural variable, such as GDP, is not stationary and I(1), then shocks to GDP will have enduring effects (Greene 2008). Before analysing the determinants of high technological exports, we must check the stationarity of the variables. We use a cross-sectionally augmented ADF (CADF) unit root test which allows for cross-section dependence to confirm whether variables are stationary or not (Pesaran 2007).

Table 8. Cross-Sectionally Augmented (CADF) Unit Root Test

		CADF-stat			
		Level			First Difference
	lag	Constant		Constant and Trend	
export	3	-2.045		-3.222***	
lngdp		-1.864		-2.171	-3.995***
FDI	3	-3.711***		-3.954***	
Investment	3	-2.066		-2.893**	
lnpatent	3	-2.013		-2.547	-4.713***
		10%	5%	1%	
Critical values	at constant[1]	-2.14	-2.25	-2.44	
Critical values	at constant and trend	-2.66	-2.76	-2.96	

*** denotes the rejection of the null hypothesis at the 1% level
** the rejection of the null hypothesis at the 5% level
* the rejection of the null hypothesis at the 10% level
The optimal lag length is chosen on the basis of the Schwartz Information Criterion

Source: Own elaboration.

The panel unit root test statistics based on CADF regressions are summarised in Table 8. The *CIPS statistics of CADF* test do not reject the null hypothesis of the unit root for lngdp and ln patent variables at 5% levels. When both a constant and a linear trend are included in the model, we could not reject the null at 5% and 1% for FDI, export and investment. As a result of the unit root test, FDI, export and investment series are I (0).

4.2. Estimating cointegration between the variables

As presented in Table 9, the results of Westerlund's (2008) Durbin_h cointegration test indicates that the null hypothesis of no cointegration is rejected at 5% significance levels. After detecting cointegration between the variables, the long-run parameters (cointegrating vector) should be estimated (Özcan and Arý 2015).

Table 9. Westerlund (2008) Durbin_hCointegration Tests

Tests	Statistic	Critical values	
Westerlund Durbin_h Tests, (Ho: No cointegration)		1.28 1.645	10% 5%
dh_g	0.648		
dh_p	1.709 **	2.333	1%

Source: Own elaboration.

The Pooled Mean Group (PMG) estimator is an approach by Pesaran et al. (1999) that facilitates the estimation of the short- and long-run parameters which can be shown in Table 10 (Pesaran et al., 2007). The PMG estimator allows coefficients and error variances to differ freely across countries in the short run. However, PMG assumes long-run homogeneity among the panel group. The PMG estimator provides the advantage of calculating the error correction term which measures the speed of adjustment towards the long-run equilibrium.

[1] Critical values for CADF statistics are based on Peseran 2007: 281, Table II (b) and Table II (c).

Table 10. Results of PMG Panel and MG estimation

Long-run coefficient	PMGE	MGE	Hausman test
lngdp	-2,61*** (0.001)	-4.25* (0.080)	2.76
FDI	0,39*** (0.000)	-0,13 (0,653)	(0.59)
investment	-0,28** (0.030)	-0,004 (0.987)	
lnpatent	3,47*** (0.006)	14.96*** (0.018)	
Error correction	−0,20*** (0.000)	−0,51*** (0.000)	

Source: Own elaboration.

The null hypothesis of the Hausman test which asserts that MG and PMG are consistent, but MG is inefficient, is accepted according to prob value (0.59). After the Hausman test results, we considered the PMG analysis.

We used GDP and patent variables in logarithm form so the long-run coefficient gives us information on the elasticity of high-tech exports towards the GDP and patent across sample countries. Our findings show that a 1% increase in GDP will lead to a 2.61% decrease in high-tech exports. According to our results, GCF (investment) and high-tech exports have a negative and significant relationship in the long run. Patent applications affect high-tech exports positively. A 1% increase in patent applications will lead to a 3.47% increase in high-tech exports. FDI has a positive and significant impact on high-tech exports.

Conclusions

This study aimed to determine the relationship between high-tech exports and economic growth for selected OECD countries between 1989 and 2015. At the end of the analysis, a statistically significant relationship was observed between high-tech exports and economic growth in the long run. Having a great deal of knowledge in high technology sectors such as aerospace, computers, pharmaceuticals, scientific instruments and electric machines gives a comparative advantage to countries. High technological production contributes added value to exports to achieve better levels of economic growth for countries. Many countries that want to be in a better position in terms of economic growth and development level are now paying more attention to technology-based industrial development.

We applied a Pooled Mean Group Cointegration analysis for a selected group of OECD countries for the years between 1989 and 2015 to examine the relationship between high technology exports and economic growth. Our findings reveal that FDI and patent applications have a positive and significant impact on high-tech exports. Contrary to the economic literature, GDP growth has not been associated with high-tech export growth. As a conclusion, countries must focus on innovation such as patent applications and foreign direct investment to stimulate high-tech exports. Our findings run parallel to the findings of Kýzýlkaya et al. (2017) and Srholec (2007) who assert that new patent applications and FDI contribute to high-tech exports.

The error correction term which measures the speed of adjustment towards the long-run equilibrium is negative and significant. It indicates the existence of a relationship between long-term high-tech and other explanatory variables, and that the short run is driven by the extent of the gap between short- and long-run values.

The empirical results show that improvement of 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. FDI leads to knowledge and technology spillovers to local firms in the same industry or across industries. There are numerous studies which conclude that FDI has a positive effect on increasing a host country's high-tech exports.

Based on the above conclusions, we have the following policy recommendations. First, developing countries must focus on enhancement of the "innovation strategy" through designing well-structured patent policies. Second, they must make structural reforms to attract FDI to their countries.

References

Akhvlediani, T., Śledziewska, K. (2015), What determines export performances in high-tech industries? Working Paper Delab UW, No. 05.

Alagöz, M., Akar, G., Akar, T., (2016), Hýgh technology export and R&D expenditures: A study for E7 countries, International Journal of Economics, Commerce and Management, 4(1): 219-230.

Balcilar, M., Bal, H., Algan, N., Demiral, M. (2014), Turkey's export performance: examining the main determinants of export volume (1995-2012), Ege Akademik Bakis, 14(3): 451-462.

Bernard, A.B., Jensen, J.B. (2004), Exporting and productivity in the USA, Oxford Review of Economic Policy, 20(3): 343-357.

Braunerhjelm, P., Thulin, P. (2008), Can countries create comparative advantages? R&D expenditures, high-tech exports and country size in 19 OECD countries, 1981-1999, International Economic Journal, 22(1): 95-111.

Ferragina, A.M., Pastore, F. (2007), High tech export performance: Which role for diversification? Ninth Annual Conference ETSG 2007 Athens, 13-15 September 2007, Athens University of Economics and Business..

Frolov, I.E., Lebedev, K.K. (2007), Assessing the impact of high-technology exports on the growth rate and structure of the Russian economy, Studies on Russian Economic Development, 18(5): 490-500.

Göçer, İ. (2013), Ar-Ge Harcamalarının Yüksek Teknolojili Ürün İhracatı, Dış Ticaret Dengesi ve Ekonomik Büyüme Üzerindeki Etkileri, Maliye Dergisi, 165(2): 215-240.

Greene, William H. (2008), Econometric Analysis (7th edition), New York: Pearson Int.

Hatzichronoglou, T. (1997), Revision of the high-technology sector and product classification, OECD Science, Technology and Industry Working Papers, No. 1997/02, Paris: OECD Publishing.

Kılıç, C., Bayar, Y., Özekicioğlu, H. (2014), Araştırma Geliştirme Harcamalarının Yüksek Teknoloji Ürün İhracatı Üzerindeki Etkisi: G-8 Ülkeleri İçin Bir Panel Veri Analizi, Erciyes Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, 44: 115-130.

Kızılkaya, O., Sofuoğlu, E., Ay, A. (2017), Yüksek Teknolojili Ürün İhracatı Üzerinde Doğrudan Yabancı Sermaye Yatırımları ve Dışa Açıklığın Etkisi: Gelişmekte Olan Ülkelerde Panel Veri Analizi, Doğuş Üniversitesi Dergisi, 18(1): 63-78.

Lee, J.W., Hong, K. (2010), Economic growth in Asia: Determinants and prospects, ADB Economics Working Paper Series, No. 220.

Mani, S. (2004), Exports of high technology products from developing countries: Are the figures real or are they statistical artefacts? Innovation, Learning, and Technological Dynamism of Developing Countries, UNU-INTECH Discussion Paper Series 1, United Nations University - INTECH.

Mehrara, M., Seijani, S., Karsalari, A.R. (2017), Determinants of high-tech export

in developing countries based on Bayesian model averaging, Journal of Economics and Business, 35(1): 199-215,

Meo, S.A., Usmani, A.M. (2014), Impact of R&D expenditures on research publications, patents and high-tech exports among European countries, European Review for Medical and Pharmacological Sciences, 18(1): 1-9.

Moiseeva O., Mazol S. (2013), How to make high-tech industry highly developed? Effective model of national R&D investment policy, Proceedings of the 9th International Conference on ICT in Education, Research and Industrial Applications, Integration, Harmonization and Knowledge Transfer (pp. 366-373), Kherson, Ukraine, 19-22 June 2013.

Montobbio, F., Rampa, F. (2005), The impact of technology and structural change on export performance in nine developing countries, World Development, 33(4): 527-547.

OECD (1998), Technology, productivity and job creation. Best policy practices 1998 edition, Paris: OECD Publishing.

OECD (2011), Directorate for science, technology and industry, economic analysis and statistics division, available at: https://www.oecd.org/sti/ind/48350231.pdf...(accessed 5 September 2017).

Özcan, B. Ari, A. (2015), Does the Fisher hypothesis hold for the G7? Evidence from the panel cointegration test, Economic Research-Ekonomska Istraživanja, 2(1): 271-283.

Özer, M., Çiftçi, N. (2009), Ar-ge Harcamaları ve İhracat İlişkisi: OECD Ülkeleri Panel Veri Analizi, Dumlupınar Üniversitesi Sosyal Bilimler Dergisi.

Özkan, G., Yılmaz, D.H. (2017), Ar-Ge Harcamalarının Yüksek Teknoloji Ürün İhracatı Ve Kişi Başı Gelir Üzerindeki Etkileri: 12 AB Ülkesi Ve Türkiye İçin Uygulama (1996-2015), Bilgi Ekonomisi ve Yönetimi Dergisi, 12(1): 1-12.

Pesaran, M.H. (2007), A simple panel unit root test in the presence of cross-section dependence, Journal of Applied Economics, 22: 265-312.

Pesaran, M.H. (2004), General diagnostic tests for cross section dependence in panels, Cambridge Working Papers in Economic, No. 0435.

Pesaran, M.H., Shin, Y., Smith, R. (1999), Pooled mean group estimator of dynamic heterogeneous panels, Journal of the American Statistical Association, 94: 621-634.

Samimi, A.J., Alerasoul, S.M. (2009), R&D and economic growth: New evidence from some developing countries, Australian Journal of Basic and Applied Sciences, 3(4): 3464-3469.

Sandu, S., Ciocanel, B. (2014), Impact of R&D and innovation on high-tech export, Procedia Economics and Finance, 15: 80-90.

Seyoum, B. (2004), The role of factor conditions in high-technology exports: An empirical examination, The journal of High Technology Management Research, 15(1):145-162.

Srholec, M. (2007), High-tech exports from developing countries: A symptom of technology spurts or statistical illusion?, Review of World Economics/Weltwirtschaftliches Archiv, 143(2): 227-255.

Tebaldi, E. (2011), The determinants of high-technology exports: A panel data analysis, Atlantic Economic Journal, 39(4): 343-353.

Ustabaş, A., Ersin, Ö. (2016), The effects of R&D and high technology exports on economic growth: A comparative cointegration analysis for Turkey and South Korea, Proceedings from International Conference on Eurasian Economies 2016, session 2A: Growth (pp. 44-55), Kaposvar.

Wana Ismail, N. (2013), Innovation and high-tech trade in Asian countries, Proceedings from International Conference on Recent Developments in Asian Trade Policy and Integration (pp. 1-19), Kuala Lumpur, 20-21 February 2013, The University of Nottingham Malay.

Westerlund, J. (2008), Panel cointegration tests of the fisher effect, Journal of Applied Econometrics, 23: 193-223.

Yerdelen Tatoğlu, F. (2012), Panel Veri Ekonometrisi, Beta Yayýnlarý, Ýstanbul. (in Turkish).
Yoo, S. H. (2008), High-technology exports and economic output: an empirical investigation, Applied Economics Letters, 15(7): 523-525.
Zhong, M, Chang, Tang, D.P., Rufael, Y. (2015), The causal nexus between military spending and unemployment in the G7: A bootstrap panel causality test, Defence and Peace Economics, 26(6): 1-14.

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