INVESTIGATING THE EFFECT OF TURKEY'S HIGH-TECH EXPORTS ON THE ECONOMIC GROWTH USING THE STRUCTURAL BREAK ARDL BOUNDS TESTING

TÜRKİYE'DE YÜKSEK TEKNOLOJİ İHRACATININ İKTİSADİ BÜYÜMEYE ETKİSİNİN YAPISAL KIRILMALI ARDL SINIR TESTİ İLE İNCELENMESİ

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Abstract

While the technological capacity and efforts of developed and some developing countries as a result of R&D activities position these countries among the high-technology product exporting countries, it is seen that developing countries that don't have adequate technological infrastructure and don't attach importance to R&D activities are among the countries that import technology and high technology products at higher costs. The technological knowledge and skills discovered as a result of the increase in the intensity of R&D activities affect economic growth positively by leading to new high-tech products purchased in international markets.

This study aims to investigate the relationship between Turkey's high-tech exports economic growth. For this purpose, ARDL bounds testing was carried out to predict the relationships between the variables using the data on high-tech exports and GDP variables of Turkey for the 1989-2016 period. As a result of the analysis, it was found that a 1% increase in high technology exports increased the economic growth by approximately 0.44% in the long term.

Keyword: Economic Growth, High-tech Exports, Research and Development (R&D), Innovation, ARDL Bounds Testing

JEL Classification: F14, F43, N70, O30, O10

Öz

Gelişmiş ve bazı gelişmekte olan ülkelerin Ar-Ge faaliyetleri neticesinde elde ettikleri teknolojik kapasite ve çabalar, bu ülkeleri yüksek teknolojili ürün ihracatçısı ülkeler arasına sokarken, yeterli teknolojik alt yapıya sahip olamayan ve Ar-Ge faaliyetlerine yeterli önemi vermeyen/veremeyen çoğu gelişmekte olan ülkede ise yüksek maliyetlerle teknoloji ve yüksek teknolojili ürün ithal eden ülkeler içerisinde oldukları görülmektedir. Ar-Ge faaliyetlerinin yoğunluğunun artması neticesinde keşfedilen teknolojik bilgi ve yetenek ekonominin tümüne yayılması, yeni yüksek teknolojili ürünleri ortaya çıkartması ve bu ürünlerin uluslararası pazarlarda alıcı bulması suretiyle iktisadi büyümeyi olumlu yönde etkilemektedir.

Bu çalışmada Türkiye'nin yüksek teknoloji ihracatı ile iktisadi büyüme arasındaki ilişkilerin incelenmesi amaçlanmıştır. Bu amaç doğrultusunda Türkiye'nin 1989-2016 dönemi için yüksek teknolojili ürün ihracatı ile GSYİH değişkenlerine ait veriler kullanılarak ARDL sınır testi yapılmış ve değişkenler arasındaki ilişkiler tahmin edilmeye çalışılmıştır. Yapılan analiz sonucunda uzun dönemde yüksek teknoloji ihracatında görülen %1'lik artışın iktisadi büyümeyi yaklaşık %0.44 oranında artırdığı tespit edilmiştir.

Anahtar Kelimeler: İktisadi Büyüme, Yüksek Teknoloji İhracatı, Araştırma ve Geliştirme, İnovasyon, ARDL Sınır Testi

JEL Sınıflandırması: F14, F43, N70, O30, O10

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1. INTRODUCTION

The economic growth of a country depends on many factors. Especially in the early 1980s, many of the developing countries have made regulations to implement export-oriented growth strategies, one of these factors. Since then, the relationship between exports and economic growth has become a significant issue for all countries and has been one of the most studied economic topics in the literature.

To be able to escape the middle-income trap and to provide a competitive advantage in international trade, a country needs to be able to produce the products with the advanced and latest technology beyond its natural resources. Classical and Neoclassical economists have assumed that technological progress is exogenous to economic growth. Solow, who contributed significantly to the theory of economic growth with his model, was also considering technological progress as an exogenous factor to economic growth (Solow, 1956:66). As a result of his study conducted with US data, Solow (1957:312) argued that technology has increased economic growth. Romer, one of the founders of Research and Development (R&D) based Endogenous Growth Models, has also argued that the R&D-based technological development increased the economic growth and productivity (Romer, 1990:71; 1986:1002). Lucas, however, claimed that industries producing high-tech goods accelerated human capital accumulation (Lucas, 1988:27-28). All these results show that the countries producing technologically advanced products become superior to their competing countries, and increase the production level and quality (Sylwester, 2001:72).

In today's world, the competitiveness among countries has become connected to the high technology content of the goods and services they produce. For this reason, the struggle in the advanced technology-based industries has turned into a struggle for existence (Baumol, 2002:23). In the world that is in the process of constant change and development with the advances in technology, however, ensuring competitiveness against other countries and maintaining the struggle for existence is only possible by countries' resilience to this change. Furthermore, the primary source for this change necessary for the struggle for existence is the R&D activities. The significance of R&D activities lies in the resulting innovation and new technologies that penetrate the whole economy. There is strong evidence that the innovation and technology that emerge as a result of R&D activities lead to the increase in exports, capital accumulation and economic growth of the country by bringing high value-added products, especially high-tech products. Most of the researchers investigating the differences in economic growth rates between countries state that the level of R&D activities of countries and the levels of technological knowledge directly affect their economic growth performance. While the technological capacity and efforts of developed and some developing countries as a result of R&D activities position these countries among the high-technology product exporting countries, it is seen that developing countries that do not have adequate technological infrastructure and doesn't attach importance to R&D activities are among the countries that import technology and high technology products at higher costs. The technological knowledge and skills discovered as a result of the increase in the intensity of R&D activities affect economic growth positively by leading to new high-tech products purchased in international markets.

In this study, it was aimed to investigate the effect of Turkey's exports of high-tech products on economic growth. For this purpose, firstly, a literature review was made on the subject. Then the relationship between high technology product exports and economic growth in the 1989-2016 period, was examined using time series analysis.

2. LITERATURE REVIEW

The failure of import-substitution strategies started to boost economic growth in the 1970s has led to discussions about the possible contribution of exports to economic growth. Moreover, all these discussions have resulted in numerous empirical studies to test the export-based growth hypothesis. While some of these studies support the export-led growth hypothesis, others put forth the findings that do not support this hypothesis.

Some of the studies supporting the export-led growth hypothesis conducted by Tyler (1981), Kavoussi (1984), Rivera-Batiz and Romer (1991), Grossman (1991), Serletis (1992), Bahmani-Oskooee and Alse (1993), Sengupta and Espana (1994), Kwan and Kwok (1995), Doraisami (1996), Ghatak et al. (1997), Ekanayake (1999), Al-Yousif (1999), Bahmani-Oskooee and Niroomand (1999), Anwer and Sampath (2000), Ramos (2001), Vohra (2001), Medina-Smith (2001), Keong and Live (2003), Awokuse (2003), Yusop and Liew (2003), Abual-Foul (2004), Abou-Stait (2005), Shirazi and Abdul Manap (2005), Mamun and Nath (2005), Pandey (2006), Eusuf and Ahmed (2007), Ullah et al. (2009), Elbeydi et al. (2010), Jarra (2013), Yardımcıoğlu and Gülmez (2013), Istaiteyeh and Ismail (2015), Saleem and Sial (2015). Some of the studies in Turkey supporting the export-led growth hypothesis have been conducted by Kızılgöl (2006), Taban and Aktar (2008), Halıcıoğlu (2007), Bilgin and Şahbaz (2009), ıspir et al. (2009), Saraç (2013), Göçer and Hepkarşı (2013), Özcan and Özçelebi (2013), Korkmaz (2014), Küçükaksoy et al. (2015) and Dura et al. (2017).

Dutt and Ghosh (1994), Shan and Sun (1998), Akbar and Naqvi (2000), Ahmed et al. (2000), Panas and Vamvoukas (2002), Sharma and Panagiotidis (2004), Dritsakis (2006), Chimobi (2010), Dreger and Herzer (2011), Teodora and Marinela (2011), Azharuddin and Paramanik (2014), Kumar (2015)'s research on the export-led growth hypothesis is not valid. Yiğidim and Köse (1997), Özmen and Furtun (1998), Karagöl and Serel (2005), Demirhan (2005), Taban and Aktar (2008), Takım (2010) and Agayev (2011), however, have concluded that export-led growth hypothesis is not valid in Turkey.

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In the late 1980s, Paul M. Romer (1986) and Robert E. Lucas (1988) have established "Endogenous Growth Models" based on RandD and technology. These theories focus on the fact that economic growth can be positively affected by new technologies and new products that will emerge as a result of R&D activities. At this point, there are arguments that the return of export of especially new high-technology products to be obtained as a result of R&D activities can contribute to economic growth. In this study, which investigates the effect of exports of the high-tech product on economic growth, we observed that there are a limited number of studies in the literature that support this relationship. The reason for this can be attributed to the fact that high-tech goods are often considered a product of R&D activities. The fact that R&D expenditures are addressed as a whole in the literature, and the vast number of studies investigating the effects of R&D on economic growth seems to support this finding. The studies on the effect of high-technology product exports on economic growth are as follows:

In their study conducted by using the data from 45 developed and developing countries in the 1981-1997 period, Cuerasma and Wörz (2005) found that high technology product exports had a positive effect on economic growth.

Yoo (2008) has analysed the effects of high-technology product exports on economic production in his analysis conducted with 91 countries over the period of 1988-2000. The results show that high-technology product exports have a positive and significant contribution to economic growth.

In his panel data analysis conducted with the 5-year averages data of the 1980-2004 period for 22 OECD countries, Falk (2009) investigated the effect of the change in the share of high technology product export on economic growth. In the results of the study, it has been found that high technology product exports had a significant effect on economic growth.

In their study carried out with the help of China data for the period 2002-2007, Sun & Heshmati (2010) have found that high technology product export rates had a positive effect on total productivity.

Kılavuz and Topçu (2012) have used the method of panel data analysis with the 1998-2006 data for 22 developing countries, including Turkey, and investigated the relationship between high-tech product exports and economic growth. As a result of their study, it has been found that high-technology product exports had a positive and significant effect on economic growth.

Ustabaş and Ersin (2016) have conducted a study to determine the relationship between high-tech product exports and economic growth, using 1989-2014 data of Turkey and South Korea. As a result of the study, it has been concluded for South Korea that high-tech exports of products had a short and long-term positive effect on economic growth. However, it has been found that this relationship is not valid for Turkey and only had a limited effect in the short term.

Yıldız (2017) has investigated the effects of high-tech product exports on economic growth using the 2005-2014 data from BRICS countries and Turkey. The results of the study have indicated that the increase in high-tech products export in BRICS countries and Turkey had a boosting effect on economic growth.

In their study investigating the relationship between high-technology product exports and economic growth using data from 14 OECD countries between 1989 and 2015, Kabaklarlı et al. (2018) have found a long-term relationship between the two variables.

Considering the literature studies, it can be said that high technology product exports have positive effects on economic growth.

3. MODEL AND DATA

In this study that we investigated the relationship between Turkey's GDP and high-tech product exports to Turkey, the data from the 1989-2016 period was used. The data of the variables were obtained from the World Bank's official website, and high-tech products include products of industries such as aerospace, computer, medicine, as well as scientific instruments and electrical machinery. The natural logarithm of the variables was taken to ensure the linearity of the series and flexible interpretation of the coefficients.

When performing a time series analysis, one should first determine whether the variables have time series characteristics. In this context, time-series graphs of the variables should be plotted, and time series components such as seasonality, trends, breaks, etc. should be examined. Graphs of variables are shown in Figure 1.
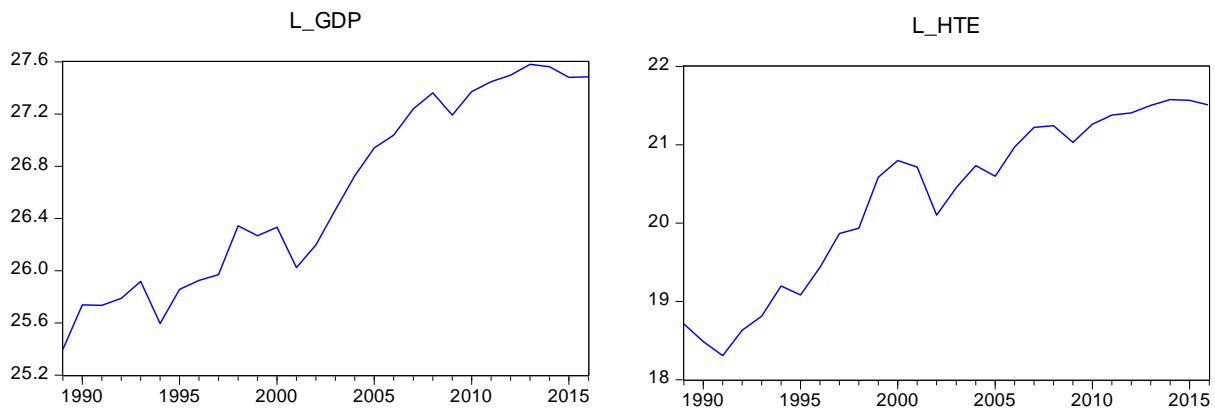
Figure 1. Graphs of Variables

When we look at Figure 1, it is noteworthy that there is an upward trend in both variables for the period addressed. It is considered that the current breaks are due to the effects of the economic and political developments of the period. This fact should not be ignored, and it is necessary to determine the periods in which the existing breaks were effective on the variables.

In the study, the relationships between variables were modelled as follows:

$$L\_GDP_t = \beta_0 + \beta_1 L\_HTE_t + \alpha_i Breaks + u_t \tag{1}$$

The dependent variable L_GDP in model 1 refers to the logarithmic GDP, and the independent variable L_HTE refers to the high technology product exports. The breaks variable refers to the dummy variables for the break dates obtained from the tests by Bai and Perron (2003), and α_i refers to the coefficient of the dummy variables. The t index at the end of the variables indicates that the variables are a time series. β_0 refers to the constant term coefficient, and β_1 refers to the model's slope coefficient. β_1 refers to the change in L_{GDP} induced by a 1% change in L_HTE. And, u_t is the error term of the model.

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4. METHODOLOGY AND RESULTS

In this study, which investigates the effect of high-tech product exports on economic growth, empirical correlations between variables were investigated in three stages. In the first stage, the significance of the breaks in Figure 1 in L_GDP, which is the dependent variable of the study, is statistically tested by using Bai and Perron (2003)[2] test. In the second stage, the steady-state levels of the variables were examined by the single-fracture ADF unit root test as carried out by Kırca and Topal (2017); and, in the third stage, the existence of long-term relationships between the variables were examined with the help of Bounds Testing based on Autoregressive Distributed Lag (ARDL) model.

When we look at Figure 1, we see that there are breaks in both variables for the studied period, and it is necessary to determine the periods, in which the existing breaks were effective on the variables. Since the dependent variable was L_GDP, only the break dates for this variable were investigated, and these dates were added to the ARDL model. Here, to determine the structural breaks, Bai and Perron (2003) structural breaks test was performed, and the test results were presented in Table1.

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2 Detailed information on the test can be found in the study by Bai and Perron (2003).

Table 1. Bai & Perron (2003) Test Results **

L_GDP		
Break test	**Calculated statistics**	**5% Critical values ** **
0 vs. 1 *	21.95	11.47
1 vs. 2	12.02	12.95
2 vs. 3 *	15.84	14.03
3 vs. 4	4.32	14.85
4 vs. 5	3.65	15.29

* Indicates the number of significant breaks.
** Calculated based on constant and trend model.
L_GDP variable significant dates of breaks: 1994, 2001, 2007

As shown in Table 1, there are significant structural breaks in L_GDP variable in 1994, 2001 and 2007. It is known that Turkey faced a severe economic crisis at these dates. Especially in 1994, the budget and current account deficit reached dramatic levels and the government's privatisation plans, which did not function as desired, caused the markets to narrow. With this process, the acceleration of capital outflows from the country led to a 14-fold increase in the dollar exchange rate and exacerbated the crisis. The 2001 crisis, which has started with political tension in Turkey's National Security Council (NSC) in 2001, has been narrowed similarly with the 1994 crisis and exacerbated with capital outflows. The crisis started mainly in the banking sector, had an impact on the whole of the real sector. 2007, however, is the beginning of a global crisis of foreign origin. In particular, the impact of this economic crisis was being felt on a global scale in 2008, which affected Turkey slightly and indirectly.

In time series analysis, it is crucial to test the stationarity of the variables. This is because non-stationary variables cause the false regression problem in the regression analysis to be performed with these variables. False regression is, in a sense, false correlations. For this reason, many unit root tests have been developed to test the stationarity. In this study, it was aimed to determine the degree of integration of the variables using single-break unit root test. Table 2 shows the results of the single-break ADF unit root test for the variables used in the study.

Table 2. Single-Break ADF Unit Root Test *

Variable	Calculated t-statistics value	Probability value	Date of break
L_GDP	-2545	0.935	2007
ΔL_GDP	**-5.804****	**0.001**	**2007**
L_HTE	-0.356	0.998	2001
ΔL_HTE	**-9.680****	**0.001**	**2001**

* The unit root test was performed in constant and trend models by taking into account the breaks.

** Expresses stationarity according to 1% level of significance.

According to the results of the single-break ADF unit root test in Table 2, both variables become stationary at the 1% level of statistical significance if the first differences I(1) are taken. Also, it was found that there were breaks for the L_GDP variable in 2007, and

the L_HTE in 2001. Existing breaks corresponded to the global crisis starting in 2007 and felt in 2008, and the 2001 crisis, which has started with political tension in Turkey's National Security Council (NSC) and reflected on the entire economy, which already has narrow.

ARDL Bounds Testing, developed by Pesaran et al. (2001), is a method developed to examine the long periods between variables. The most important advantage of this test compared to the other cointegration tests is that it allows the analysis of long-term relationships between the variables that are stationary at different levels. In other words, some of the variables can be I(1), and others can be I(0). However, one of the most important conditions that should be known here is that the dependent variable should be I(1); and the second one is that any of the variables should not be stationary higher-order than I(1).

ARDL models allow the inclusion of both the dependent variables and the delays of the independent variables in the same model. In model 2, an equation for the ARDL model we created by using our variables is shown. θs in the model show the coefficient matrix of the independent variables. The terms *m*, *n* and *l* refer to the different delay values that the variables can take. *i* refers to the delay number. And, e_t is the error term of the model. The delay numbers in model 2 are determined with the help of various information criteria. In this study, it was determined by Akaike Information Criterion (AIC). Besides, the breaks determined in the L_GDP variable were added to the ARDL model as an exogenous variable for analysis.

$$L\_GDP_t = \Theta_0 + \sum_{i=1}^{m} \Theta_{1i} L\_GDP_{t-i} + \sum_{i=0}^{n} \Theta_{2i} L\_HTE_{t-i} + \alpha_i Breaks + e_t \qquad (2)$$

As a result of the analysis, it was determined that the ARDL(1,0) model was a suitable model. It is essential in the test that this model is suitable. For this, descriptive tests were performed to test whether there were any problems in the model. As seen in Table 3, it is seen that there is no autocorrelation and heteroscedasticity problems in the ARDL (1.0) model, the error terms have a normal distribution and that there is no distress in the functional form of the model.

Table 3. ARDL(1,0) Model Prediction

Variable	Coefficient	Standard error	t-statistics	Probability
L_GDP(-1)	0.782*	0.084	9305	**0.001**
L_HTE	0.095	0.058	1638	0.116
D2001	-0.494*	0.124	-3961	**0.001**
D2007	0.103	0.088	1172	0.254
D1994	-0.450*	0.122	-3693	**0.001**
C	3.925*	1229	3192	**0.004**
Descriptive statistics				
Test		Calculated statistics		Probability
Breusch-Godfrey Autocorrelation		0.762		0.683
Breusch-Pagan-Godfrey Test		6408		0.268
Jargue-Bera Test of Normality		0.585		0.746
Ramsey RESET Test		0.716		0.407

* Expresses significance according to the 5% level of significance.

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The analysis of whether the coefficients obtained by the ARDL(1,0) model are stable during the examined period was performed with the help of CUSUM and CUSUMQ analysis. When we look at Figure 2, it is seen that the coefficients obtained in the period analysed for the ARDL(1,0) model are stable. This is because CUSUM and CUSUMQs obtained are within 5% confidence interval.
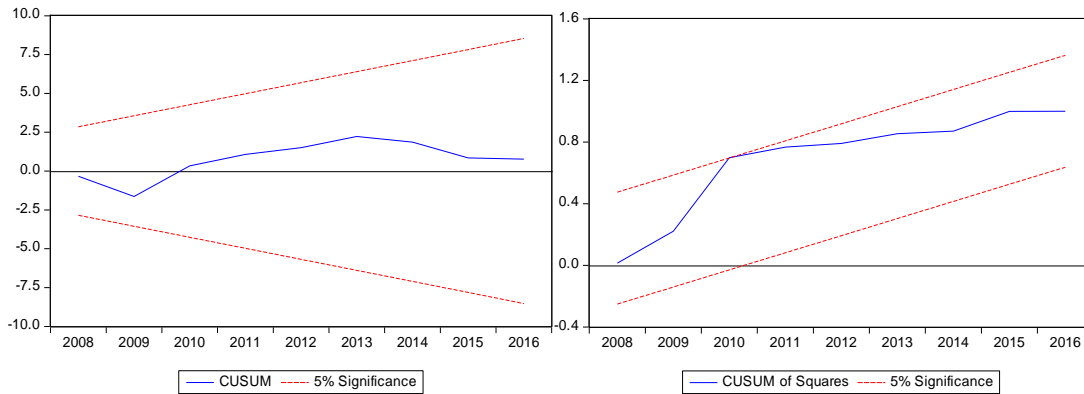

Figure 2. CUSUM ve CUSUMQ Results

After determining the ARDL model, the equation to be used in the bounds testing was formed. Equation 3 shows the equation used in the bounds testing. Using this equation, long-term relationships between variables were tested.

$$\Delta L\_GDP_t = \theta_0$$
$$+ \sum_{i=1}^{m} \theta_{1i}\Delta L\_GDP_{t-i}$$
$$+ \sum_{i=0}^{n} \theta_{2i}\Delta L\_HTE_{t-i} + \theta_3 L\_GDP_{t-i} + \theta_4 L\_HTE_{t-i} + \alpha_i Breaks + e_{1t} \quad (3)$$

In order to test the long-term relationships between variables, the following hypotheses were established for the ARDL bounds testing:

$H_0 : \theta_3 = \theta_4 = 0$ *(no cointegration),*

$H_1: \theta_3 \neq 0$ *or* $\theta_4 \neq 0$ *(cointegration).*

The hypotheses were tested using Wald F statistics. In other words, a Wald F test was used to test whether $\theta_3 = \theta_4 = 0$ coefficients are equal to zero in the model to obtain statistics on the bounds testing. This statistical value obtained in order to decide on hypotheses was compared with the lower limit I(0) and upper limit I(1) values, obtained from the study by Pesaran et al. (2001:300). If the calculated statistical value is higher than the critical value I(1), then H0 is not rejected, leading to conclusion that there is a long-term relationship between the variables.

Table 4. ARDL Bounds Testing Results

K	F-statistic	1% Critical values	
		I(0)	I(1)
1	**10.905***	4.94	5.58

Table 4 shows the ARDL bounds testing results. According to these results, *H₀* hypothesis is rejected because the F statistic value (4.94) obtained is higher than the critical

value I(1) (5.58). This means that the L_HTE variable affects the L_GDP variable in the long term. Taking this finding into consideration, it can be said that high technology product exports have an effect on GDP in the long term. After this stage, it should be determined whether the error correction mechanism works, as well as determining the extent and direction of effect of independent variables on the dependent variables in the long and short term. Also, it should be tested whether the independent variables have a statistically significant effect on the dependent variable. The error correction mechanism is tested employing the model no. 4.

$$\Delta L\_GDP_t = \theta_0 + \sum_{i=1}^{m} \theta_{1i} \Delta L\_GDP_{t-i} + \sum_{i=0}^{n} \theta_{2i} \Delta L\_HTE_{t-i} + \theta_3 ECM_{t-1} + e_{2t} \qquad (4)$$

A statistically significant ECM(-1) coefficient in model 4 in the range of 0 to -1 indicates that the imbalances between the variables are improved in the short term. Table 5 shows error correction model results. Besides, short-term and long-term coefficients can also be found in this table. According to these results, ECM(-1) coefficient is between 0 and -1, and it is statistically significant. This shows that the short-term deviations in the model have reached an equilibrium in the long term.

Table 5. Short-Term and Long-Term Coefficients

Short-term coefficients and error correction model				
Variable	**Coefficient**	**Standard error**	**t-statistics**	**Probability**
ΔL_HTE	-0.047	0.088	-0.535	0.597
ΔD2001	**-0.473***	0.084	-5600	**0.001**
ΔD2007	**0.229***	0.077	2978	**0.007**
ΔD1994	**-0.471***	0.08	-5842	**0.001**
ECM(-1)	**-0.243***	0.047	-5178	**0.001**
Long-term coefficients				
Variable	**Coefficient**	**Standard error**	**t-statistics**	**Probability**
L_HTE	**0.440***	0.13	3377	**0.002**
D2001	**-2.274***	0.895	-2539	**0.019**
D2007	0.475	0.44	1080	0.292
D1994	**-2.073***	1013	-2045	**0.053**
C	**18.056***	2769	6519	**0.001**

* Expresses significance according to the 5% level of significance.

If we look at Table 5, there is no statistically significant relationship between L_HTE and L_GDP in the short term, but it has a statistically significant effect on the L_GDP variable in the long term. A 1% increase in the L_HTE variable in the long term increases the L_GDP variable by approximately 0.44%. This means that changes in high-technology product exports have a significant impact on economic growth in the long run. As mentioned above, a 1% increase in high technology product exports increases economic growth by approximately 0.44% in the long term.

5. CONCLUSION

In this study, which investigates the effect of exports of the high-tech product on economic growth, long-term relationships were found between the variables according to the results of the ARDL bounds testing. This means that high-tech product exports affect economic growth in the long term. In addition, a 1% increase in high-tech product exports increases economic growth by approximately 0.44% in the long term. Similar to other studies in the literature, it has been concluded that exports of high-tech products affect economic growth positively in Turkey.

In countries such as South Korea and Singapore, which are growing fast in recent years by overcoming the middle-income trap, the driving force behind economic growth is higher value-added knowledge and the ability to produce technologically advanced products (Tsunekawa and Todo, 2019:5). According to 2016 data published in the World Bank official website, the ratio of high-tech export products were 26.6% in South Korea, 48.9% in Singapore, 2% in Turkey. As is seen, Turkey's share of such products is very small when the types of exported products of these example countries were compared with that of Turkey. As can be understood from all these, developing countries such as Turkey need to increase the rate of high-tech products in goods subject to export, to achieve stable economic growth and to maintain their competitive advantages in the international market. To achieve these gains, R&D activities should be encouraged, especially in such countries, and public sector, private sector and universities should work in cooperation in this regard.

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