Education and Economic Growth: A Panel Cointegration Approach in OECD Countries (1980-2008)

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Abstract

The purpose of this study is to investigate the long-run relationship between education and economic growth in the 25 OECD countries over the period from 1980 to 2008 by utilizing the Pedroni and Kao panel cointegration, Pedroni DOLS and FMOLS and Canning-Pedroni causality methods. According to DOLS results the elasticity coefficients of education and economic growth are %0.283 and %2,931 respectively. According to FMOLS results the elasticity coefficients of education and economic growth are %0.25 and %2.82 respectively. While the results of Lamda-Pearson statistics indicate the long-run bilateral causality between education and economic growth, Group statistics indicate the long-run uni-directional causality from economic growth to education. It is concluded that there is a strong cointegration relationship between education and economic growth.

Keywords: Education, Economic Growth, Education Expenditure

Introduction

Education transforms human beings who are raw into a more productive "human capital" by equipping them with the skills necessary for a modern sector as well as for the traditional sector of the economy. Education contributes to the productivity and efficiency by ensuring development of skills of population or labor (Tilak, 1989: 10). Educated labor supply is regarded as one of the basic elements of endogenous growth (Yardımcı, 2006: 77). The expansion of educational opportunities increases both the individual's labor productivity and the productivity of those with whom the individual's workforce interact and as the average education level increases so does the aggregate efficiency (Ranis *et al.*, 2000: 202).

Education affects productivity and growth through different channels. For example education increases the ability of individuals to do standard tasks and to learn new tasks to do and the ability to comprehend and apply new information / processing them, individuals' ability to evaluate changing situations and adapt to them as well. Education accelerating the individual's adaptation process to new technologies and improving the likelihood of its practice (Lau et al. 1991: 2) also increases productivity of individuals who are an important factor in a sustainable economic growth. Benefits arising from productivity can be both individual and social. Increased productivity means a higher standard of living and a higher salary and income for a worker and for all other employees. At the same time, rise in the income of employees means higher tax revenue for the state. Tax revenue increases public savings and these savings can be transferred to the projects which will be the source of the growth (Badibanga, 2010: 8). In addition to this, education is an important factor in the equal distribution of the economic welfare between individuals of a society (Tomul, 2011: 134). Undoubtedly, the relationship between education and growth is not a unidirectional relationship (Tilak, 1989: 8). Education affects not only economic growth but it is also affected by economic growth (Harbison and Myers 1964: 3).

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The purpose of this study is to investigate the relationship between public education expenditure and economic growth and the size and direction of this relationship. With this aim, firstly the relationship between public education expenditure and economic growth has been introduced by summarizing the earlier studies. And then the relationship between public education expenditures and economic growth in the OECD countries over the period from 1980 to 2008 has been investigated by utilizing the Pedroni and Kao panel cointegration tests. Later cointegration coefficients have been determined through DOLS and FMOLS cointegration tests developed by Pedroni (2000, 2001) while the causality relationship between public education expenditures and economic growth variables has been determined by causality method developed by Canning and Pedroni (2008).

Literature Review

There are numerous studies having investigated the relationship between education and economic growth. Findings of many of these studies point out the fact that there is a positive and significant relationship between education and economic growth, which also has a positive impact on education. Denison (1962), one of the economists trying to answer the question how education contributes to economic growth concluded in his work that education in the U.S. and EU countries has an impact on economic growth (Woodhall, 1987: 3). Similar to the results of Denison, Schultz (1963) has found out that increasing the level of education of the workforce explains a large part of the growth in both developing and developed countries. Hicks (1980) also states that there is a nexus between national income and literacy rate (Psacharopoulos and Woodhall, 1985: 16-19). Lucas (1988), one of the authors who contributed significantly to the endogenous growth theory, points out that human capital accumulation arises through schooling and education or learning by doing and the resulting externalities cause endogenous growth. Barro and Lee (1993, 1994, 2010) have also reached similar conclusions in their studies.

Lau et al., (1993) state that in Brazil an additional year of education of workforce increases the real output level by approximately 20% and 40% of the current growth is determined by human capital. On the other hand Tallman and Wang (1994) points out that education in Taiwan explains about 45% of real GDP per capita. O'Neill (1995) found out that contribution of education to GDP is 58% for developed countries and 64% for the developing countries (O'Neill, 1995: 1295). Chuang (1999: 138) stated the effect of education on productivity growth in the manufacturing industry of Taiwan was 39%. According to Ergen (1999) an annual increase in average years of formal education of the labor force in Turkey leads to an increase of 0.21 in the growth rate of GDP.

Benhabib and Spiegel (1994), Temple (1999), Abu-Qarn and Abu-Bader (2007), Savaşan and Çetinbaş (2008) support that education in the context of human capital has a positive and crucial impact on economic growth. Webber (2002: 1639) suggests that a primary school, high school and university level of education has a positive effect on economic growth. Similarly, Gylfason and Zoega (2003: 569) have reached the conclusion that raising the level of education and making quality improvements directly promote economic growth. Higher education expenditures in OECD countries are increasing more than those expenditures made on primary education and secondary education (Altundemir, 2008: 69).

Güngör (1997) reveals that educated workforce employed in 67 provinces of Turkey has a positive effect on production; while Asteriou and Agiomirgianakis (2001) state that there is a positive relationship between long-run education variables in Greece and GDP per capita. Li and Huang (2009) stated that education in China's 28 provinces makes a positive contribution to economic growth. Özsoy (2008) found a long- run and consistent relationship between education and growth in Turkey.

Barro (2001: 16) states that there is a positive correlation between men's average school year and growth who visited high school or equivalent schools and took higher education and this group of people adapt better to new technologies, hence education is crucial in the dissemination of technology. Wolff (2001) concluded that workforce needs a certain level of education for adaptation to the technology, and education is one of the basic descriptive actors of economic growth. Gyimah-

Brempong et al. (2006: iii, iv) emphasizes that increase in the education expenditures for higher education in Sub-Saharan Africa will accelerate the process of catching-up technology and contribute to economic growth and development by increasing the country's output ability.

Hojo (2002), concluded in his study that education will accelerate economic growth through increased efficiency. Saygılı et al. (2005) have reached findings showing that improvement of all human capital variables make a significant contribution to productivity growth and increase the rate of convergence. Saygılı et al. (2006: 135-139) found out that improvement in school enrolments rate in the primary, secondary and higher education in about 50 countries including Turkey and in the average education time of labor force has an important contribution to productivity. On the other hand, schooling rate in the pre-school level of education also affect productivity in a positive way.

Musil and Belassi (2004) indicate that increase in public education expenditures per worker in Uganda also affects economic growth positively. Keller (2006) in his study covering 107 developed and developing countries points out the fact that public education expenditures per capita affect mostly GDP per capita in both developing and developed countries. Baldacci et al. (2008) states that education expenditures in developing countries have a direct positive impact on the human capital accumulation and that these expenditures lead to a higher economic growth.

Islam and at all. (2007) finds a bi-directional causality relationship between education expenditures in Bangladesh and economic growth, while Al-Yousif (2008) has found a unidirectional causality running from education to growth in the Middle East countries. Pradhan (2009), in India, Yıldırım and others (2011) in Turkey have found a unidirectional causality from economic growth to education expenditures.

As seen the literature, as a result of practical studies it can be inferred that there is a positive relationship between education and economic growth in general. However, there are also studies in the opposite direction that could not get a significant result between these two variables. Levine and Renelt (1992: 952) stated there is a strong nexus between educational indicators and economic growth rate. Türkmen (2002: 94) could not find a significant relationship between education expenditures and school enrolment rates and economic growth. Self and Grabowski (2003) state that vocational education does not have a direct effect on economic growth. Özsoy (2008) could not find a causality relationship between higher education and the GDP in Turkey. Ay and Yardımcı (2008) point out that they could not find a long-run relationship between these variables and growth, considering the number of high school students as the level of human capital.

Data Set and Econometric Method

Data Set

The panel data analysis covers 25 selected OECD[4] (Organization for Economic Cooperation and Development) countries including Turkey. In the selection of countries priority was given to the countries with available data for the 1980-2008 periods and application is limited to 25 OECD countries as required. In the study, public education expenditure rate per capita was used as an indicator of education. Data on public education expenditure per capita has been obtained from the World Bank database. As the indicator of economic growth, data on GDP per worker that shows the productivity has been used. These data illustrating economic growth has been obtained from the Penn World Table. Firstly, the logarithm of our data has been decided to make analysis of our data.

[4] OECD countries within the frame of the analysis of panel data; Germany, France, Italy, the Netherlands, Belgium, Luxembourg, United Kralik, Ireland, Denmark, Greece, Portugal, Spain, Sweden, Finland, Austria, Australia, Canada, Japan, South Korea, Mexico, New Zealand, Norway, Switzerland, USA, and Turkey.

Econometric method

There are three kinds of data in the econometric analysis, namely time series, cross-sectional data and pooled (i.e., combination of time series and crosssection) data (Gujarati, 2004: 25). These types of data can be examined with a model appropriate to their structure and analysis can be performed separately or combined. (Pazarlıoğlu and Kiren Gürler, 2007: 37).

The panel data regression model can be illustrated as follows (Baltagi, 2011: 305; as cited in: Gülmez and Yardımcıoğlu, 2013: 56);

$$y_{it} = \alpha + X'_{it}\beta + u_{it} \quad \textbf{(1)}$$

i , $i = 1, 2, ...N$ represents cross- section while $t = 1, 2, ...T$ represents the time period. α shows the amaount of data (scalar), the number of observations. β illustrates K × 1 and x_{it} is the number of observations it' regarding K explanatory variables. The first T observations on households is to follow the T observations on the second households and it continues in this manner until the Nth household. Components of the error term can be expressed as follows (Baltagi, 2011: 306; as cited in: Gülmez and Yardımcıoğlu, 2013: 56);

$$u_{it} = \mu_i + v_{it} \quad \textbf{(2)}$$

And μ_i shows some certain components of cross-section and v_{it} remaining (remainder) effects (Baltagi, 2011: 306; as cited in: Gülmez and Yardımcıoğlu, 2013: 56). That is to say μ_i which is not time-dependent and differs from section to section is denominated as individual effect, while v_{it} is assumed to vary according to both time and section. Accordingly, μ_i shows an unobservable cross-section effect and v_{it} symbolizes the stochastic error term (Yılmaz, 2008: 100; as cited in: Gülmez and Yardımcıoğlu, 2013: 56). For example, μ_i may represent individual talents in income equality or administrative skills in a production function or a certain effect of a country. These effects change over time (Baltagi, 2011: 306; as cited in: Gülmez and Yardımcıoğlu, 2013: 56).

Empirical Results and Discussion

Empirical Results of Panel Unit Root Test and Comments

To investigate the presence of unit root in the panel data analysis, DF (Dickey-Fuller) and the ADF (Augmented Dickey - Fuller) tests are extended for panel data analysis and multi-unit root test in the panel data analysis is based on the expansion of ADF test. However, time period in the panel data analysis is more complex than time series analysis. The most important factor of panel data analysis is heterogeneity. In particular, each individual in the panel may not have the same characteristics, so that all are different in terms of being stationary or non-stationary (to be co-integrated or not co-integrated). If some panels have unit roots while others do not have, unit root test to be done will complicate the situation (Asterion and Hall, 2007: 366; as cited in: Yardımcıoğlu and Gülmez, 2013: 128). Studies of Levin, Lin and Chu (2002) , Im, Pesaran and Shin (2003) , Maddala and Wu (1999) , Choi (2001) and Breitung (2000) are among the leading works proposing the unit root tests in panel data models. In our study, aforementioned unit root tests have been applied. The logarithm variables of economic growth (gdp) and education expenditure (edex) has been decided and then the unit root test is performed using logarithmic values of the variables. Appropriate lag length that addresses the issue of autocorrelation between errors is chosen according to the Schwarz information criterion.

As seen from Table 1, in the unit root tests results applied to the levels of variables, t statistics and probability results show that they are non-stationary in the econometric analysis to be used in series level [I (0)] and series contain unit root problem. Therefore the primary differences of the series

were investigated. Considering the primary differences of the series for variables and primary difference of lngdp and lnedex series was observed to be stationary [I (1)] .

Table 1.
Results for panel unit root tests (Level and First Diffirences)

	Economic Growth (lngdp)							
	Constant				Constant and Trend			
	t Statistic I(0)	*Probability I(0)*	*t Statistic I(1)*	*Probability I(1)*	*t Statistic I(0)*	*Probability I(0)*	*t Statistic I(1)*	*Probability I(1)*
Levin,Lin&Chu	-1.17130	0.1207	-13.9561*	0.0000	-0.28492	0.3879	-11.5981*	0.0000
Im,Pesaran&Shin	5.68110	1.0000	-15.0310*	0.0000	-0.05999	0.4761	-12.3069*	0.0000
Maddala and Wu	14.3283	1.0000	297.171*	0.0000	55.6439	0.2707	238.615*	0.0000
Choi	5.58394	1.0000	-13.2787*	0.0000	0.02926	0.5117	-10.4491*	0.0000
Breitung t-stat					3.53238	0.9998	-6.19691*	0.0000
	Education Expenditures (lneduex)							
	Constant				Constant and Trend			
	t Statistic I(0)	*Probability I(0)*	*t Statistic I(1)*	*Probability I(1)*	*t Statistic I(0)*	*Probability I(0)*	*t Statistic I(1)*	*Probability I(1)*
Levin,Lin&Chu	1.90855	0.9718	-18.0898*	0.0000	-0.31546	0.3762	-15.3916*	0.0000
Im,Pesaran&Shin	6.42666	1.0000	-17.6148*	0.0000	-2.44037*	0.0073	-14.8441*	0.0000
Maddala and Wu	9.60258	1.0000	314.045*	0.0000	82.1758*	0.0028		0.0000
Choi	6.35181	1.0000	-13.8523*	0.0000	-1.93119**	0.0267		0.0000
Breitung t-stat					-4.39632*	0.0000		

1. * and ** indicates statistical significance at 1 and 5 percent level of significance, respectively.
2. Newey–West bandwidth selection with Bartlett kernel was used for the LLC test.

Panel cointegration findings and comments[5]

After investigation of unit roots, cointegration analysis is carried out. Cointegration analysis is a process in which it is investigated whether there is a long-run mutual relationship between the series. Within this context, in our study two different analysis methods such as Pedroni cointegration and Kao cointegration analysis were used. Pedroni suggested several tests that allow heterogeneity in the cointegration analysis in 1997, 1999, 2000 and 2004 (Asterion and Hall , 2007: 373; as cited in: Gülmez and Yardımcıoğlu, 2012: 345). This test is a test that allows heterogeneity in the cointegration vector. This test does not only allow dynamic and fixed effects to be different between panel sections, but also it allows co-integrated vector to differ between sections under the alternative hypothesis (Güvenek and Alptekin, 2010: 181; as cited in: Gülmez and Yardımcıoğlu, 2012: 345). Pedroni's approach differs from McCoskey and Kao in the context of the section assumption and null hypothesis of cointegration. Pedroni tests allow multiple explanatory variables (regressor), diversification in different parts of cointegration vector of panel and also mistakes permit heterogeneity along the cross-sectional units. Seven different cointegration tests[6] are presented in order to cover within and between effects on the panel and these tests are divided into two different categories. The first category contains four tests pooled "within" size. The second category includes three other tests in the size "between" (Asteriou and Hall , 2007: 374; as cited in: Gülmez and Yardımcıoğlu, 2012: 345). "The first three of the four tests in the first category are non-parametric tests. The first test is a statistical variance ratio type. The second is similar to Phillips - Peron (PP) (rho) statistics and the third statistics is similar to statistical PP (t). The fourth statistics is a parametric statistics similar to Augmented Dickey Fuller (ADF) (t). In the second category the first of three tests is similar to PP (rho) statistics, the other two are similar to PP (t) and ADF (t) statistics. "(Güvenek and Alptekin, 2010: 181; as cited in: Gülmez and Yardımcıoğlu, 2012: 345). Another cointegration test to be used in the study is Kao cointegration test.

[5] The unit root tests and panel cointegration test results were obtained with an econometric package of the E-views 7.0

[6] Please look at the mathematical presentation of these tests; Asteriou and Hall, 2007: 374.376.

Kao presented a cointegration test in 1999 for panel data analysis by using DF and ADF tests (Baltagi, et al.., 2000: 13; Asteriou and Hall, 2007: 372; as cited in: Gülmez and Yardımcıoğlu, 2012: 345).

As education expenditure (lnedex) and economic growth (lngdp) variables are stationary at I (1) level, cointegration test has been started in the second stage. The long-term relationship between these series is examined by Kao cointegration and Pedroni cointegration tests. As seen from Table 2, according to the cointegration analysis, four of the seven statistics in the Pedroni cointegration test of education expenditure and economic growth show that there is cointegration while the other three shows the opposite. According to Kao cointegration test results cointegration relationship in the long-run was determined. Within this context it can be stated that these two variables are cointegrated in the longrun.

Table 2.
Results for panel cointegration tests

$$\ln GDP_{it} = \alpha_{it} + \beta \ln EDEX_{it} + u_{it}$$

Results for Pedroni panel cointegration tests

(Within-Dimension)				
	t- statistic	probability	Weighted t-statistic	probability
Panel v-Statistic	1.187.768	0.1175	0.528905	0.2984
Panel rho-Statistic	**-1.366.848*** **	0.0858	-1.003.934	0.1577
Panel PP-Statistic	**-1.996.889** **	0.0229	-1.510.011**	0.0655
Panel ADF-Statistic	**-3.013.943***	0.0013	-2.425.344*	0.0076
(between-dimension)				
	t- statistic	probability		
Group rho-Statistic	0.391623	0.6523		
Group PP-Statistic	-0.935465	0.1748		
Group ADF-Statistic	**-2.646.868***	0.0041		

Results for Kao panel cointegration tests

	t- statistic	probability
ADF	**-3.618.010***	0.0001
Residual variance	0.001024	
HAC variance	0.001689	

1. *, ** and *** indicates statistical significance at 1, 5 and 10 percent level of significance, respectively.

According to Pedroni cointegration test the hypothesis H_0 (there is no cointegration between the series) was rejected. Form test results the Panel rho- statistic is at 10%, panel PP-statistic is at 5% and panel ADF-statistic and group ADF-statistic are statistically at 1% and it suggests that there is cointegration. Other statistics are not statistically significant. Generally evaluated according to the results of these four tests it can be reported that Pedroni cointegration test results show cointegration relationship between the series. According to Kao cointegration test, H_0 hypothesis (there is no cointegration between the series) was rejected. Therefore, the alternative hypothesis (there is cointegration between the series) was adopted. In this context, it can be stated that there is significant relationship between the variables of education expenditure and economic growth in the long term. Therefore, public education expenditure and economic growth act together in long-term among OECD countries and analyzes show that there is a long-run relationship between variables

Findings on Cointegration Coefficients of DOLS, FMOLS and Discussion[7]

After the application of cointegration tests, DOLS (Dynamic Ordinary Least Square) method developed by Pedroni (2000, 2001) and FMOLS (Full Modified Ordinary Least Square) method were used to estimate ultimate coefficients of this relationship. The main purpose of why two different methods were given is to test the consistency of both methods effectiveness in accordance with our expectations.

[7] DOLS and FMOLS test results were obtained with econometric packages Rats.v08.

FMOLS method corrects deviations in the standard fixed effect estimator (problems resulting from autocorrelation, heteroscedasticity). The DOLS method has a feature of resolving deviations in the static regression (particularly problems arising from endogeneity), including dynamics elements to the model (Kök et al.., 2010:8). This FMOLS method of Pedroni allowing significant heterogeneity between the individual sections takes into account the existence of a possible correlation between the constant and error term and the independent variables. Pedroni (2000) has researched the power FMOLS method in small samples and has calculated that t statistic's performance in small samples is good with Monte Carlo simulations (Kök and Simsek, 2006: 7-8).

Table 3.
Results for Panel DOLS

Countries	$\ln GDP_{it} = \alpha_{it} + \beta \ln EDEX_{it} + u_{it}$ DOLS		$\ln EDEX_{it} = \alpha_{it} + \beta \ln GDP_{it} + u_{it}$ DOLS	
	Coefficient	t statistic	Coefficient	t statistic
Turkey	0.209*	11.064640	4.399*	9.645428
Panel	**0.283***	**51.778880**	**2.931***	**42.430844**

* indicates statistical significance at 1 percent level of significance.

Table 3 shows DOLS test results. According to the test results of DOLS public education expenditures in the long-run affect economic growth significantly both in a positive and statistical way as expected. The elasticity of public education expenditure across the panels was calculated as 0.283. That is to say a 1% increase in public education expenditure in the 25 OECD countries cause approximately 0.283% percent increase on economic growth in the long-run. Elastic coefficients of public education expenditures in Turkey are calculated as 0.209%. So an increase of 1% in public education expenditure in Turkey constitutes a positive effect on the economic growth at the rate of approximately 0.209%.

As can be seen from the second part of Table 3, according to the test result of DOLS economic growth also affects public education expenditures in a positive and statistically significant way as expected. The elasticity of economic growth on the panels was calculated as 2.931%. So across the 25 OECD countries, a 1% increase in economic growth over the long-term public education expenditures of approximately 2.931% 'constitute an increase. Economic growth in Turkey of modulus of elasticity is calculated as 4.399%. So in Turkey public education spending in economic growth, an increase of 1% over the rate of approximately 4.399% constitutes a positive effect.

Table 4.
Results for Panel FMOLS

Countries	$\ln GDP_{it} = \alpha_{it} + \beta \ln EDEX_{it} + u_{it}$ FMOLS		$\ln EDEX_{it} = \alpha_{it} + \beta \ln GDP_{it} + u_{it}$ FMOLS	
	Coefficient	t statistic	Coefficient	t statistic
Turkey	0.20*	8.48	3.94*	8.30
Panel	**0.25***	**35.13**	**2.82***	**36.66**

* indicates statistical significance at 1 percent level of significance.

Table 4 shows FMOLS test results. According to the FMOLS test results public education expenditure in the long-run affect economic growth, as expected, in a positive and statistically significant in way. The elasticity of public education expenditure across the panels was calculated as 0.25%. That is to say a 1% increase in public education expenditure in the 25 OECD countries cause an increase of approximately 0.25% on economic growth in the long-run. The elasticity coefficients of public education expenditures in Turkey are calculated as 0.20%. More precisely, a 1% increase in Turkey's public education expenditures constitutes a positive effect on economic at 0.20%.

As can be seen from the second part of the Table 4, according to FMOLS test results economic growth also affects public education expenditures in a positive and statistically significant way, as expected. The elasticity of the economic growth on the panel was calculated as 2.82%. So a 1% increase

in economic growth in the 25 OECD countries constitutes approximately 2.82% increase in long term over public education expenditures. The elasticity coefficient of economic growth in Turkey is calculated as 3.94%. In other words, an increase of 1% in Turkey's economic growth constitutes a positive effect of approximately 3.94% on public education expenditures in the long-term.

Panel Causality Findings and Comments[8]

Causality relationship between education and economic growth has been investigated using the method recommended by Canning and Pedroni (2008) and showing long-run panel causality relationship among the variables and coefficients of this relationship. This method is of crucial importance in that it provides information about the direction of existence of a causality relationship between the variables in the long term as well as the sign of this causality (Gülmez and Yardımcıoğlu, 2012: 349).

Table 5.
Results for panel causality of Education and Economic Growth

	$\lambda_2 = edu_{it} \rightarrow gdp_{it}$			$\lambda_1 = gdp_{it} \rightarrow edu_{it}$			$-\lambda_2 / \lambda_1$
	Coefficient	t statistic	Probability	Coefficient	t statistic	Probability	Medyan
Lambda-Pearson		**75.19***	-0.01		**156.75***	0.00	-0.06
Group Mean	0.03	0.83	0.80	-0.31	**-1.91****	0.03	0.07

1. * and ** indicates statistical significance at 1 and 5 percent level of significance, respectively.

As seen from Table 5 in the causality analysis according to Lamda-Pearson statistics the panel causality results indicate a bi-directional causality between education and growth. Across the panel in the first phase when causality running from education expenditures to the economic growth is investigated, H0 hypothesis (There is no a long term causality relationship) is rejected at the level of 1% significance and in this context panel causality results indicate the presence of causality relationship in the long term from education expenditures to economic growth. (75.19 [0.01]). In the second step when causality from economic growth to education expenditures was investigated in the long term, H0 hypothesis (There is no a long term causality relationship) is rejected at the level of 1% significance. In this context panel causality results indicate the presence of causality relationship of economic growth and education expenditure in the long-run. (156.75 [0.00]). The group average statistic values do not show causality relationship from education to growth but they show a causality relationship at 5% significance level from economic growth towards education expenditures. Considering both statistics values together, a mutual causality between education and growth is available.

Discussion and Conclusions

In this study, the reciprocal relationship between education and economic growth was investigated using data of 25 OECD countries. In the study, it was observed that primary differences of series used in the analysis of panel unit roots are stationary at the one percent significance level, meaning that all the variables are integrated of order [I (1)]. As education expenditure (lnedex) and economic growth (lngdp) variables [I (1)] are stationary, cointegration tests that is the second stage has been conducted. This long-run relationship between the series was examined by Kao and Pedroni cointegration tests. It has been concluded that both variables have cointegration relationship in the long-run. In this context, a positive and significant correlation between variables of the education expenditures and economic growth in long-run was detected.

The coefficients of the long-run cointegration relationship variables were investigated with FMOLS and DOLS methods. According to the DOLS test results, national income elasticity of public education expenditures is calculated as 0.283%. That is to say a 1% increase in public education expenditures in the 25 OECD countries brings an approximately 0.283% percent increase on economic

[8] Test results were obtained with an econometric package E-views 7.0

growth in the long-run. In addition, according to the DOLS results the elasticity of public education expenditures of economic growth in the panel is calculated as 2.931%. In other words, a 1% increase in economic growth across the 25 OECD countries constitutes an increase of approximately 2.931% on public education expenditures in the long-run.

According to FMOLS test results, national income elasticity of public education expenditures across panel is calculated as 0.25%. Namely a 1% increase in public education expenditures across the 25 OECD countries brings an increase of approximately 0.25% on economic growth in the long-run. In addition, according to FMOLS test results the public education expenditure elasticity of economic growth across the panel is calculated as 2.82%. More precisely a 1% increase in economic growth across the 25 OECD countries constitutes an increase of approximately 2.82% over the long-run on public education expenditures. Both FMOLS and DOLS test results are consistent with each other.

According to the DOLS test results regarding Turkey national income elasticity of public education expenditures are calculated as 0.209%. That is to say a 1% increase in public education expenditures in Turkey constitutes an increase of approximately 0.209 % 'on economic growth in the long-run. Public education expenditures elasticity of the economic growth is calculated as 4.399%. In other words, a 1% increase in economic growth constitutes an increase of approximately 4.399% on public education expenditures in the long-run. According to the FMOLS test results national income elasticity of public education expenditures is calculated as 0.20%. A 1% increase in public education expenditures constitutes an increase of approximately 0.20% on economic growth in the long-run. Public education expenditure elasticity of economic growth is calculated as 3.94%. More clearly, a 1% increase in economic growth in Turkey constitutes an increase of approximately 3.94% on public education expenditures in the long-run.

According to the statistics of Lamda-Pearson, panel causality results show bidirectional causality relationship between education and growth for the general panel while the group average statistical values show a unidirectional causality relationship from the growth towards education at the 5% significance level.

As a conclusion in the study, variables of public education expenditures and economic growth affect each other positively as expected. However, the impact of economic growth on public education expenditures is greater. This can be interpreted as follows; the state allocates more resources to public education expenditures from their budgets because of the increase in public revenues (particularly tax revenues) as a result of economic growth and during periods of economic growth demand for public education services increase.[9] Although the impact of public education expenditures has a positive impact on economic growth, the fact that they are at a lower rate can be attributed to the consideration that only public education expenditures have been taken into consideration in this study excluding private expenditures on education. Undoubtedly, taking private education expenditures into account may increase the effect of education on growth. In this context, the countries that desire to provide a sustainable economic growth should allocate more resources to education.

[9] Undoubtedly, during periods of economic growth, demand for special education may increases.

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