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Müzeyyen Merve Şerifoğlu et Pelin Öge Güney

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Résumé de l'article

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The Effect of Different Fields of Tertiary Education on Economic Growth

MÜZEYYEN MERVE ŞERİFOĞLU
Development and Investment Bank of Turkey *

PELİN ÖGE GÜNEY
Hacettepe University

The purpose of this paper is to analyze empirically the contribution of tertiary level education by fields on economic growth for 29 developed and 25 developing countries over the period 1998-2012. Using the two-step System Generalized Method of Moments (GMM), we find that in the developed countries graduates from science faculties make the most contribution to economic growth, but in developing countries graduates from education, humanities and social sciences faculties contributed the most to economic growth. In addition, we focus on the effect of distribution of tertiary level graduates among different fields on economic growth and our results imply that, having human capital from different fields in both developed and developing countries positively affects economic growth.

Keywords: tertiary education, graduates by field, distribution, economic growth, system GMM

JEL Classifications: I23, J24, O1

1 Introduction

The dynamics of economic growth have always been an important subject for economists. Following the Neoclassical growth theory which focuses on the labor, capital and technology as sources of economic growth, growth theories developed in 1980s and called as Endogenous Growth Model underline knowledge and skills as the driving sources of economic growth. Lucas (1988) has been regarded as the pioneer economist who argued that human capital, like physical capital, is one of the production factors. Accordingly, as human capital accumulation increases through learning by doing, so does economic growth. Then, Sorensen (1991), Stokey

* Şerifoğlu: Development and Investment Bank of Turkey, İstanbul, Ümraniye, Turkey, mzymerve@gmail.com; Güney Department of Economics, Ankara, Turkey, *pelinoge@hacettepe.edu.tr*; corresponding author.

(1991) and Caballe and Santos (1993) developed models based on human capital extending Lucas (1988)'s model. Besides, Grossman and Helpman (1989), Romer (1990) and Mankiw-Romer-Weil (1992) are among other economists considering human capital as the key indicator in the production process.

In the line with these developments, the contribution of human capital on economic growth is widely investigated in the empirical studies. Considering human capital-growth literature, some studies employ cross-section data while others are based on time-series and panel data set which combine the time-series and cross-section data. However, findings obtained from studies generate different results. Different results may be due to data selection, model specification, method of measuring education, differences in parameters across countries or regions, and estimation methodology (Benos & Zotou, 2014). It is seen that while most of these studies emphasize that there is a strong relationship between human capital and economic growth (see Barro, 1991; Mankiw et al., 1992; Elias & Fernandez, 2000;Teal,2010; Banerjee, 2012; Qadri & Waheed,2013; Eigbiremolen & Anadauka,2014; Sunde & Vischer, 2015; Wang & Liu,2016; Peercy & Svenson, 2016; Aykırı, 2017; Ogundari & Awokuse, 2018; Ali et al., 2018), some studies do not find a significant effect of human capital on economic growth (see Benhabib & Spiegel, 1994; Islam, 1995; Pritchett, 1996; Asteriou & Agiomirgianakis, 2001; Henderson, 2010).

There are lots of variables effecting human capital accumulation. According to Becker (1964), human capital consists of various socio-economic factors such as educational level, on the job skills, healthcare and migration. Education may be accepted as a prominent indicator in gaining momentum to economy. Firstly, it is in close relationship with other human capital indicators such as health and nutrition. Education encourages a healthy lifestyle, and its beneficial effects continue lifetime. It has a positive impact on prosperity of individual by increasing employment opportunity and income level (Groot & Brink, 2006). With the increase in the importance of knowledge and advances in the technology, the countries start to need more educated people with higher abilities. Thus, the prominent role of education for countries' welfare and sustainable development has risen impressively (Sanchez & Singh, 2016). In this context, higher education is regarded as the main driver of economic growth by improving the skills of a country and creating the conditions for innovation and tertiary level graduates are increasingly sought by employees (McNeil & Slim, 2012). The role of higher education on economic growth is widely accepted and supported by the various empirical studies (see Agiomirgianakis et al., 2002; Petrakis & Stamatakis, 2002; Gyimah-Brempong et al., 2006; Bayraktar, 2015; Seetanah & Teeroovengodum, 2017). On the other hand, there are also studies which find a negative relationship between higher education and economic growth (see Banerjee, 2012; Barro & Sala-i Martin, 1995; Asteriou & Agiomirgianakis, 2001).

There is not any consensus among economists on what kind of education is most important for economic growth. Determining the impact of educated human capital on economic growth is important in planning government policies that support growth. Since the 1980s, the idea has been dominated in many developing countries that government investment in universities and colleges has a lower return than investment in primary and secondary level and higher education leads to income inequality. This has led governments to devote fewer resources to higher education. On the other hand, in developed countries, supports for higher education are continuously increasing (World Bank & UNESCO, 2000).

In this context, we attempt to provide different points of view in terms of the effect of tertiary level education on economic growth. Higher education has steadily increased in many countries over the last decades, but we do not have enough studies about which education field make the most contribution to economic growth. To the best of our knowledge, there is no study other than Tsai et al. (2010) on the contribution of higher education graduates by field to economic growth. One of the objectives of our paper is to examine the effect of graduates by field on economic growth. Thereby, we think that our results will help governments to determine the appropriate allocation of resources for higher education. In this study, different from previous studies, we investigate the contribution of the distribution of graduates among different fields on economic growth, as well. Countries need educated people with varied skills and high-level competencies to strengthen human capital and promote economic growth. However, the studies on dispersion- education nexus analyze the effect of different education levels and to the best of our knowledge, there is no study focusing on the effect of the distribution of graduates among different fields on economic growth. Considering that the graduates of each field obtained different skills, human capital dispersion in terms of tertiary education graduates may have influence on economic growth (Park, 2004).

To test the relationship between tertiary level education and economic growth, we use the number of graduates by field as the main indicator since there may be great differences between actual graduates and enrolled students (Maloney & Caicedo, 2014). The education fields in this paper are organized as follows: education, humanities, social sciences, sciences, engineering, agriculture and health. We attempt to examine the relationship between education fields and economic growth nexus through the percentage of graduates by field in the tertiary level for 29 developed and 25 developing countries for the 1998-2012 periods. We separate countries into two groups -due to different country dynamics. Countries are grouped as developed and developing countries according to UNESCO World Economic Situation and Prospects 2018 report. In this paper, we use two alternative methods to measure the distribution of graduates from different fields: standard deviation and relative dispersion method proposed by Ram (1990). We can say that the standard deviation method is one of the most basic and simple methods for showing the dispersion of data. The relative dispersion method is also based on the standard deviation method. In this method, we correlate the number of graduates by field with schooling years and calculate the dispersion of the sample in the model.

We employ two-step System Generalized Methods of Moments (GMM) developed by Arellano Bover (1995) and Blundell-Bond (1998), which has superior properties compared to other estimators and produce more efficient results by using more instruments. According to our results, graduates from science in developed countries and graduates from humanities, education and social science in developing countries make a positive and significant contribution to economic growth. In addition, our findings show that countries having graduates from different fields positively affect economic growth. Based on our findings, we can conclude that policy makers should take into consideration the distribution of tertiary level graduates. Besides, our results can assist governments and policy makers in distributing sources devoted to higher education in developed and developing countries.

2 Literature Review

Following Barro (1991), which can be accepted as one of the most prominent studies related to human capital and economic growth, many studies try to explain the link between tertiary education and economic growth. Barro (2001) pointed that there is a positive relationship between the years of school attainment of males at secondary and higher levels. Petrakis and Stamatakis (2002) found that the higher education has positive impact on economic growth for developed countries. Gyimah-Brempong et al. (2006) concluded that education variables including higher education has positive and statistically significant effect on economic growth. Neychava and Joensen (2017) showed that there is a positive effect of upper secondary and tertiary education on economic growth in Iceland.

On the other hand, there are studies that conclude that higher education has no or a negative impact on economic growth. Elias and Fernandez (2000) explored that primary schooling has a positive effect, while the secondary and high schooling rates have a negative impact on economic growth. Asteriou and Agiomirgianakis (2001) found that there was a correlation between primary and secondary education and economic growth, while there was not any relationship between higher education and economic growth. Banerjee (2012) showed that people with tertiary education do not have a significant impact on economic growth, but people with secondary and primary education are important for economic growth. Studies outlined above have focused on formal schooling inputs such as enrolment ratios, schooling years, and literacy rates, which have been commonly used as a standard approach in the measurement of human capital (Permani, 2009). Besides, the composition of tertiary education level can be an important area of research to explain the contribution of human capital to economic growth. As the number of graduates from different disciplines increases in a country, a diversity of skills and different labor market outcomes can be expected.

Murphy et al. (1991) is one of the studies that examine the relationship between graduates from different fields and economic growth. They emphasize that engineering students make more contribution to economic growth whereas law students do not. In another study focusing on engineering education, Fan and Zhang (2015) conducted an empirical analysis by using a model based on the Mincer model to calculate the rate of return to higher engineering education in China for 2003-2008 periods. The results indicate that the contribution of higher engineering education was 10.6% in 2003, whereas this ratio was realized at 14.7% in 2008. Similarly, Maloney and Caicedo (2014) attempted to explain the contribution of engineering graduates to income disparities between the United States and Latin American countries between 1860 and 1900. In the study, they apply OLS and FE estimators. The results suggest that there is a positive relationship between engineering graduates and income differences.

Colombo and Grilli (2005) find that human capital in the scientific and technical fields hasa positive impact on growth for 506 Italian firms operating in the high-tech industry. Tiago (2007) finds that the ratio of enrollment in engineering, mathematics and computer science in tertiary education affects economic growth positively. Tsai et al. (2010) construct alternative measures of human capital to test the effect of human capital on economic growth. They classified graduates into five fields. Using OLS and System-Generalized Method of Moments (GMM) for 60 countries over the 1999-2006 period, they show that education and high-tech human capital have made an important contribution to growth.

In addition to tertiary education graduates by fields, the dispersion of graduates at tertiary education level may have an influence on economic growth. In studies based on the dispersion of education and economic growth, the dispersion of different education levels, which consist of primary, secondary and tertiary level education, are generally used as the main indicators. Castello and Domanech (2002) use an educational attainment dataset based on the Gini coefficient including primary, secondary and tertiary level education for 108 countries. They find that the equal dispersion of different level of education fields has a negative effect on economic growth. Park (2004) considers the variance of educational attainment at primary, secondary and tertiary level education for 94 countries. Their findings show that there is a positive relationship between equal dispersion of different level of education fields and economic growth.

3 Empirical Analysis

3.1 Methodology

Considering the years and the number of countries in our models, it is appropriate to employ panel data analysis techniques. Nickell (1981) shows that estimating the dynamic panel data model by OLS and fixed effects generate biased and inconsistent results. Including the lagged dependent variable as an explanatory variable is one of the sources of Nickell bias.

Consider the following equation:

$$y_{i,} = \beta_1 + \rho y_{i,-1} + x_{i,t}\beta_2 + u_i + \varepsilon_{i,t} \quad (1)$$

where i=1, 2,..,n is the number of pairs, t=1,2,…,T is the time. $y_{i,}$ and $y_{i,-1}$ refer to dependent variable and lag of dependent variable, respectively. $x_{i,}$ is a column vector of explanatory variables, u_i represents individual effect and $\varepsilon_{i,}$ is an error term. There is a correlation between lagged dependent variable and error term (Baum, 2006).

To remove both constant term and individual effect, Anderson and Hsiao (1981) propose the first difference transformation. We can rewrite Equation (1) as follows:

$$\Delta y_{i,} = \rho \Delta y_{i,-1} + \Delta x_{i,t}\beta_2 + \Delta\varepsilon_{i,t} \tag{2}$$

According to Equation (2), individual effect swept out from model through the first difference transformation but, differenced lagged dependent variable $y_{i,t-1}$ term in $\Delta y_{i,t-1} = y_{i,t-1} - y_{i,t-2}$ is correlated with $\varepsilon_{i,t-1}$ in $\Delta\varepsilon_{i,t} = \varepsilon_{i,t} - \varepsilon_{i,t-1}$ (Roodman, 2009:104). Arellano and Bond (1991) propose to take the first difference of the variables and use the lagged value of the explanatory variables as instrumental variable in the model to eliminate potential endogeneity problem. Consider equations:

$$y_{i,} = x_{i,1} + w_{i,t}\beta_2 + \epsilon_{i,t} \tag{3}$$

$$\epsilon_{i,} = u_i + \varepsilon_{i,} \tag{4}$$

where $x_{i,t}$ covers strictly exogenous variables and $w_{i,t}$ are predetermined and endogenous variables, which include lags of y and suitable lags of the levels of the endogenous variables (Baum, 2006: 234). This method, developed by Arellano and Bond (1991), which uses the lags in differences of the variables as instruments, is called Difference GMM. However, there is considerable concern that the first difference GMM estimator can be performed poorly when time series are persistent, and the time dimension is small, because lagged levels of series are weak instruments for different equations. Another concern of differenced GMM is that information on the cross-country variation in the levels removes at the process of differencing (Blundell and Bond, 1998).

Following, Arellano and Bover (1995) propose a transformation based on "orthogonal deviations". In this method, instead of first difference transformation, the average of future observations of a variable is subtracted from the contemporaneous one to minimize data loss in the first difference GMM estimator. Then, Blundell and Bond (1998) showed that poor instruments can cause large finite sample bias for large sample models when using the first difference method. Parallel to Blundell and Bond (1998), Soto (2009) demonstrates that System GMM estimator is unbiased and efficient compared to other estimators when the number of cross sections is small.

The System GMM method developed by Arellano & Bover (1995) and Blundell & Bond (1998) is an optimal combination of first difference and level equations and includes both lagged levels and lagged differences (Baum, 2006; Roodman, 2009). There are two alternatives to the System GMM estimator analysis: One-step and two- step. To evaluate the precision of empiric results, we should check for serial correlation in the error terms and validity of instruments. The test for instrument validity differs between one-step and two-step estimators: Sargan (1958) test for one-step and Hansen (1982) J test statistic for two-step. For testing serial correlation in the error terms, Arellano and Bond autocorrelation test is recommended and generally, it is found that the disturbances are not serially correlated (Baum, 2006; Roodman, 2009).

3.2 Econometric Model

To investigate the contribution of graduates by field on economic growth, we mainly construct two dynamic panel data models. In the first model, we use the percentage of graduates by fields as main indicator of human capital. The Model 1 can be written as follows:

$$logy_{i,} - logy_{i,-1} = \beta_0 + \beta_1 logy_{i,t-1} + \beta_2 \log(Patents_{i,t}) + \beta_3 Education_{i,t-j} + \beta_4 Popgrowth_{i,t} + \beta_5 Capital\ Formation_{i,t} + \delta_{i,t} + \varepsilon_{i,t} \quad (5)$$

where $logy_{i,t} - logy_{i,t-1}$ is GDP per capita growth rate in country i, $logy_{i,t-1}$ is logarithm of lagged GDP per capita. $Education_{i,-j}$ is set of education variables including the percentage of total tertiary graduates in education, humanities, social sciences, science, engineering, agriculture and health and also primary and secondary education enrollment rate. Patents are the logarithm of number of patents, Capital Formation is gross capital formation in GDP (%) and popgrowth is annual population growth rate (%). $\delta_{,}$ refers time effect.

In the second model, we analyzed the contribution of distribution of graduates among different fields on economic growth. For this purpose, we used two approaches to measure dispersion of tertiary education level: In Equation 8, standard deviation (standard) approach is used and in Equation 9-10, relative dispersion (dispersion) is used. Thus, Model 2 is presented as below:

$$logy_{i,} - logy_{i,-1} = \alpha_0 + \alpha_1 logy_{i,t-1} + \alpha_2 \log(Patents_{i,t}) + \alpha_3 standarddeviation_{i,t-j} + \alpha_4 Popgrowth_{i,t} + \alpha_5 Capital\ Formation_{i,t} + \delta_{i,t} + \varepsilon_{i,t} \quad (6)$$

$$logy_{i,} - logy_{i,-1} = \gamma_0 + \gamma_1 logy_{i,t-1} + \gamma_2 \log(Patents_{i,t}) + \gamma_3 dispersion_{i,t-j} + \gamma_4 Popgrowth_{i,t} + \gamma_5 CapitalFormation_{i,t} + \delta_{i,t} + \varepsilon_{i,t} \quad (7)$$

In the models, "i" represents country, "t" indicates time and "j" refers lagged j periods for set of education variables. Considering the effects of human capital on economic growth, it takes time to convert the knowledge of tertiary education into productive gains. Accordingly, investment in the human capital will probably affect future economic growth rates rather than current rates. The optimal lag length can be greater than 1 year although it is unknown (Tsai et al., 2010). In this paper, we use education variables lagged 3 years due to limited data set for particularly developing countries. In the model, endogenous variables are logarithm of lagged GDP per capita, capital formation, patent and education indicators.

In the paper, population growth and physical capital formation are included in the model within the framework of the Neoclassical Growth Model. In the context of innovation, human capital has played an important role in developing firms' intellectual assets such as patents (Rothaermal & Hess, 2007; Liu, 2014). Additionally, we can see that some studies in the literature use the number of patents as an innovative capacity of human capital (Acs et al., 2002; Maloney, 2010; Liu, 2014; Pelinescu, 2015). Following these studies, in this paper, the patent variable has been used as an indicator of technological development. Given that the patent is an indicator of innovation, it can be thought to be linked to the education variable, for example see Maloney (2010). Additionally, one of the main assumptions of Neoclassical Growth Model is that of convergence. According to this hypothesis, poor countries grow faster than rich countries due to diminishing marginal returns of capital. In our model, we include the logarithm of lagged GDP per capita as a measure for the initial stage of economic growth to consider the convergence hypothesis.

After analyzing the Model 1 and Model 2, we exclude the time effect from the models. Then, Investment Freedom variable is also included in the model to test the consistency of the results. Investment Freedom is a component of the Economic Freedom Index and there are studies showing the impact of various freedom indices on economic growth (Rajasolu, 2003; Cebula, 2013; Cebula, Clarck & Mixon, 2013).

3.3 Data

Our data set consists of a total of 54 countries, 29 of which are developed and 25 are developing, for the period 1998-2012. In this paper, country classification is based on World Economic Situation Prospects (WESP). Table 1 shows country lists in the model.

GDP per capita, capital formation (share of gross capital formation in GDP), population growth rate (annual growth rate of population) and patents (the logarithm of number of the patent) are obtained from the World Bank (WB). Data on graduates by field are from OECD database, Eurostat and UNdata. The data for primary and secondary enrollment rates is borrowed from WB. Investment Freedom is also taken from heritage.org. Table 2 provides detailed information on data and their sources.

To determine the contribution of graduates by field of education on economic growth, we have firstly used the percentage of graduates by field in total graduates. Since education system varies across countries in terms of structure and circular content, International Standard Classification of Education (ISCED) was developed by UNESCO to compare and evaluate national education system at the cross-national level.

Table 1. Country List

Developed Countries		Developing Countries	
Australia	Japan	Argentina	Macedonia
Austria	Latvia	Belarus	Malaysia
Belgium	Lithuanian	Brazil	Mexico
Bulgaria	Malta	Chile	Mongolia
Canada	New Zealand	Colombia	Panama
Czech Republic	Norway	El Salvador	Saudi Arabia
Denmark	Portugal	Ethiopia	Tunisia
Estonia	Spain	Georgia	Turkey
Finland	Slovak Republic	Guyana	Ukraine
France	Slovenia	Iran	Vietnam
Germany	Sweden	Israel	
Holland	Switzerland	Korea	
Iceland	United Kingdom	Kyrgyzstan	
Ireland	United States	Lao	

There are various versions of ISCED classifications: ISCED 1997, ISCED 2011 and ISCED-F 2013. The scope of broad field of education changes in each classification. We have applied ISCED 1997 classification for field of tertiary level education because this classification has the longest data range. According to ISCED 1997 classification, tertiary level graduates comprise total number of graduates from tertiary type A programs (ISCED 5A-require professions with high skill requirement, such as medicine, dentistry or architecture) and advanced research qualifications (ISCED 6-refer to awards of an advanced research qualification e.g., PhD).

Secondly, we used two approaches to measure the distribution of graduates: standard deviation and relative dispersion method. In standard deviation approach, we construct an index including all tertiary level education variables by calculating standard deviation of each field by years. In Equation 8, Xi represents the percentage of graduates from each education fields, such as education, humanities graduate etc. in total tertiary level graduates.

$$X_i = \frac{The\ number\ of\ graduates\ from\ each\ fields_{\ i}}{The\ total\ number\ of\ tertiary\ level\ graduates} x100 \quad (8)$$

After we obtain X_i, we calculate the dispersion of education fields through the standard deviation method which is one of the methods to calculate dispersion. Indeed, the second dispersion calculation method we use is closely related to the first method.

Table 2 Definitions and Sources of Variables

Variable	**Definition**	**Source**
Log of GDP per capita	GDP per capita constant 2010 U.S. dollar	World Bank (WB)
Capital Formation	Share of gross capital formation in GDP	WB
Population growth rate	Annual growth rate of population	WB
Patents	The logarithm of number of patents	WB
Field[1]	The percentage of number of graduates in education. humanities and arts. social sciences. business and law. science. engineering. manufacturing and construction. agriculture. health and welfare in total tertiary graduates	OECD stat, Eurostat, UNdata
School life expectancy (years)	Tertiary education (ISCED 5 to 8)	UNdata
Primary	The percentage of the number of students enrolled in primary level education in total population ages 15-64	Author's calculation
Secondary	The percentage of the number of students enrolled in secondary level education in in total population ages 15-64	Author's calculation
Standard deviation	Standard deviation of the percentage of each education variable	Author's calculation
Dispersion	Standard deviation of the Share of each education variable based on school life expectancy	Author's calculation
Investment Freedom	Score	heritage.org

The main difference is that, in the second method, we use the number of schooling years for tertiary level education to calculate dispersion. In this method, our calculations are based on Ram (1990). Parallel to Ram (1990), we used the share of tertiary level graduates by field in total tertiary graduates which correspond to "L_i" in Equation 9. Depending on data availability, we also use same duration for all tertiary level categories and in Equation 9 "S_i" variable refers to the number of years of schooling which each educational category corresponds. The calculation consists of two steps: In the first step we obtain mean by combining graduates by field and schooling years with respect to the below equation:

[1]The classification is made according to ISCED 1997 definition.

$$\bar{S}\ (\text{Mean})=\sum_i L_i S_i \tag{9}$$

Then, we estimate relative standard deviation based on formula in the Equation (9):

$$SD = \sqrt{\sum_i L_i (S_i - \bar{S})^2} \tag{10}$$

Table 3 on the next page presents information on data description. It is seen that average GDP growth per capita in developed and developing countries were 0.009% and 0.013%, respectively for the 1998-2012 periods. It is also seen that the average patent application in developed countries (7.87%) is about 2.5 times larger than in developing countries (2.68%). In developed and developing countries, the average capital formation rate was realized at 23.8% and 24.6%, respectively.

In terms of average population growth rate, developing countries (1.134%) have a higher growth rate than developed countries (0.427%). In terms of educational variables, the highest average for two country groups belongs to social science graduates (34.63% for developed and 26.25% for developing countries). In developed countries, the dispersion of primary and secondary enrollment students is approximately 27%-28%, while in developing countries, it is between 5% and 6%.

3.4. Empirical Results and Discussions

Before panel regression was performed, we tested multicollinearity in independent variables for each model through Variance Inflation Factor (VIF) test. Based on our results, we can say that there is not any multicollinearity in our sample. To save space, we do not show the results in the paper. Then, we perform the Fisher ADF panel unit root test developed by Maddala and Wu (1999) and Choi (2001) to detect the stationary of the series. According to the Fisher ADF test presented in Table 4a and 4b, while null hypothesis refers that all series are non-stationary, at least one series in the panel is stationary under the alternative hypothesis. Our results show that, we can reject the null hypothesis for all series.

Tables 5a-5f and Table 6a-6d, which start on page 555, present estimation results for Model 1 and Model 2, respectively. After we provide results with and without time, we re-estimate our model including Investment Freedom. In all models, AR (2) test results show that there is no second order serial correlation in residuals and the models have valid instruments according to Hansen (1982) J-statistic. Our results also indicate that the convergence hypothesis is valid in most specifications for developed and developing countries. For developed and developing countries, it is seen that patent variables have positive and meaningful effect on economic growth. This result is consistent with previous studies such as Corsby (2002), Ortiz (2009), Kim et al. (2009) and Maloney and Caicedo (2014).

Table 3 Descriptive statistics

	Developed Countries					Developing Countries				
Variable	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max
GDP per capita growth	435	0.009	0.015	-0.067	0.052	375	0.013	0.173	-0.07	0.06
Log of GDP per capita	435	4.492	0.282	3.578	4.962	375	3.643	0.471	2.273	4.50
Patent	337	7.874	2.287	2.208	13.205	324	2.676	2.487	0.007	8.85
Capital Formation	435	23.84	4.281	12.371	41.538	373	24.652	8.371	0	58.15
Population Growth	435	0.427	0.771	-2.258	2.891	375	1.134	1.094	-1.32	6.91
Primary	434	17.33	27.340	0	192.079	350	12.701	6.110	0	24.95
Secondary	434	18.12	28.999	0	220.864	350	12.776	5.822	0	24.95
Education	388	12.01	4.811	0	30.182	375	12.271	13.452	0	94.09
Humanities	431	12.12	5.643	0	42.285	375	7.402	9.444	0	76.03
Social Sciences	431	34.64	12.430	0	56.657	375	26.251	20.474	0	87.17
Science	404	9.469	3.377	3.417	19.717	375	5.732	5.924	0	46.43
Engineering	428	12.46	5.240	0.172	34.300	375	10.397	9.463	0	43.37
Agriculture	428	1.878	1.263	0	13.481	375	2.255	3.353	0	37.36
Health	385	14.2	5.153	1.27	28.959	375	6.102	5.149	0	23.21
Standard deviation	428	11.5	3.775	0.046	45.807	375	9.643	7.312	0	33.3
Dispersion	435	5.61	2.089	0	9.63	375	1.431	1.361	0	5.403
Investment Freedom	435	71.71	11.976	50	95	371	49.111	19.13	0	90

According to our estimates, there is a negative relationship between population growth and economic growth, like Solow (1956), Mankiw, Romer, and Weil (1992), Yao, Kinugosa and Hamori (2013) and Banerjee (2012). Our results also indicate that capital formation is positively and significantly related to economic growth in all models for two country groups. While investment freedom is also correlated positively to economic growth in most models for developing countries, it does not have any effect on economic growth in developed countries.

Our results presented in Table 5a-5f show that the coefficient of primary school enrollment rate is insignificant in developed and developing countries, while secondary school enrollment rate is negatively correlated with economic growth. In Table 5c, where we include investment freedom, we see that our results for primary school enrollment rate remain unchanged, while the effect of secondary school enrollment rate is insignificant for both country groups. We can conclude that primary and secondary level education do not have any important role on economic growth for developed and developing countries.

Table 5a GMM test results for Model 1 (%) Developed Countries (without time)

Lagged log of GDP per capita	-0.0024*	-0.0034**	-0.0046**	-0.0042**	-0.0035**	-0.0014	-0.0041**	-0.0033**	-0.0058***
	(0.0014)	(0.0011)	(0.0004)	(0.0008)	(0.0012)	(0.0013))	(0.0015)	(0.0012)	(0.0012)
Patent	0.0128***	0.0128***	0.0134***	0.0131***	0.0132***	0.0118***	0.0122***	0.0128***	0.0132***
	(0.0005)	(0.0005)	(0.0006)	(0.0005)	(0.0005)	(0.0004)	(0.0006)	(0.0004)	(0.0034)
Capital Formation	0.0005***	0.0005***	0.0004***	0.0004***	0.0004) ***	0.0006***	0.0005***	0.0004***	0.0005***
	(0.0007)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Population Growth	-0.0049***	-0.0047***	-0.0040***	-0.0042***	-0.0040***	-0.0058***	-0.0052***	-0.0044***	-0.0037***
	(0.0002)	(0.068)	(0.0004)	(0.0003)	(0.0005)	(0.0003)	(0.0004)	(0.0004)	(0.0005)
L3.Primary	(0.00001)								
	(0.0000								
L3.Secondary		-0.00001*							
		(0.0000)							
L3.Education			0.0001						
			(0.0000)						
L3.Humanities				0.0001**					
				(0.0000)	0.0001***				
L3.Social Sciences					(0.0000)				
L3.Science						0.0003***			
						(0.0001)			
L3.Engineering							-0.0002**		
							(0.0001)		
L3.Agriculture								0.0001	
								(0.0003)	
L3.Health									0.0001***
									(0.0000)
Const	0.0008	0.0054	0.0121**	0.0089**	0.0060	-0.0076**	0.0104	0.0056	0.0143**
	(0.0055)	(0.0046)	(0.0054)	(0.0032)	(0.0048)	(0.0053)	(0.0070)	(0.0051)	(0.0052)
Number of countries	29	29	29	29	29	29	29	29	29
Number of Instruments	24	24	24	24	24	24	24	24	24
AR(1)	0.021	0.020	0.025	0.022	0.022	0.038	0.016	0.057	0.022
AR(2)	0.332	0.332	0.330	0.332	0.330	0.649	0.352	0.604	0.305
Hansen	0.501	0.511	0.724	0.720	0.756	0.5590	0.314	0.669	0.545
Observations	256	256	255	255	255	238	254	237	254

The standard error is in parentheses. ***. ** and * denote the rejection of the null hypothesis at 1%. 5% and 10% significance levels, respectively.

Table 5b Continued. Developed Countries (with time)

Lagged log of GDP per capita	-0.0018	-0.0021*	-0.0028*	-0.0030***	-0.0029**	0.0005	-0.0025**	-0.0017	-0.0046**
	(0.0013)	(0.0010)	(0.0015)	(0.0008)	(0.0013)	(0.0013)	(0.0012)	(0.0001)	(0.0013)
Patent	0.0132***	0.0131***	0.0138***	0.0133***	0.0134***	0.0006***	0.0129***	0.0129***	0.0135***
	(0.0005)	(0.0005)	(0.0005)	(0.0004)	(0.0000)	(0.0001)	(0.0005)	(0.0004)	(0.0004)
Capital Formation	0.0005**	0.0005***	0.0004***	0.0004***	0.0004***	0.0006***	0.0005***	0.0005***	0.0005) ***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Population Growth	-0.0049***	-0.0048***	-0.0041***	-0.0044***	-0.0041***	-0.0064***	-0.0050***	-0.0047***	-0.0039***
	(0.0002)	(0.0003)	(0.0005)	(0.0003)	(0.0004)	(0.0003)	(0.086)	(0.0003)	(0.0005)
L3.Primary	-0.00001								
	(0.0000)								
L3.Secondary		-0.00001*							
		(0.0000							
L3.Education			0.0001						
			(0.0000)						
L3.Humanities				0.0001*					
				(0.0000)					
L3.Social Sciences					0.0001***				
					(0.0000)				
L3.Science						0.0004***			
						(0.0001)			
L3.Engineering							-0.0001		
							(0.0001)		
L3.Agriculture								0.0005**	
								(0.0003)	
L3.Health									0.0002***
									(0.0003)
Const	-0.0020	-0.0011	0.0028	0.0031***	0.0031	-0.017**	0.0018	-0.0034***	0.00811
	(0.0054)	(0.0047)	(0.0073)	(0.0036)	(0.0053)	(0.0052)	(0.0053)	(0.0042)	(0.0057)
Number of countries	29	29	29	29	29	29	29	29	29
Number of Instruments	23	23	23	23	23	23	23	23	23
AR(1)	0.023	0.023	0.029	0.024	0.024	0.042	0.020	0.056	0.025
AR(2)	0.333	0.330	0.326	0.330	0.330	0.612	0.339	0.626	0.303
Hansen	0.428	0.427	0.780	0.696	0.801	0.508	0.240	0.642	0.502
Observations	256	256	255	255	255	238	254	237	254

The standard error is in parentheses. ***. ** and * denote the rejection of the null hypothesis at 1%. 5% and 10% significance levels, respectively.

TABLE 5c Continued. Developed Countries (without time) Including Investment Freedom

Lagged log of GDP per capita	-0.0021	-0.0020	-0.0029**	-0.0029**	-0.0037**	-0.0018	-0.0033**	-0.0018*	-0.0040**
	(0.0014)	(0.0012)	(0.0014)	(0.0011)	(0.0011)	(0.0014)	(0.0009)	(0.0009)	(0.0014)
Patent	0.0129***	0.0128***	0.0138***	0.0131***	0.0134***	0.0126***	0.0125***	0.0129***	0.0132***
	(0.0005)	(0.0005)	(0.0001)	(0.0001)	(0.0005)	(0.0001)	(0.0005)	(0.0005)	(0.0005)
Capital Formation	0.0005***	0.0005***	0.0004***	0.0004) ***	0.0005***	0.0005***	0.0005***	0.0005***	0.0005***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Population Growth	-0.0050***	-0.0050***	-0.0041***	-0.0042***	-0.0040***	-0.0055***	-0.0051***	-0.0048***	-0.0041***
	(0.0003)	(0.0003)	(0.0005)	(0.0003)	(0.0004)	(0.047)	(0.0004)	(0.0003)	(0.0006)
L3.Primary	-0.00001								
	(0.0000)								
L3.Secondary		-0.00001							
		(0.0000)							
L3.Education			0.0001						
			(0.0000)						
L3.Humanities				0.0001					
				(0.0000)					
L3.Social Sciences					0.0002**				
					(0.000)				
L3.Science						0.0004***			
						(0.0001)			
L3.Engineering							-0.0002***		
							(0.0001)		
L3.Agriculture								0.0004**	
								(0.0002)	
L3.Health									0.0002**
									(0.0000)
Investment Freedom	0.0002	0.0002	0.0001	0.00001	-0.00001	-0.0001	0.0001	0.0001*	0.0001
	(0.0000)	(0.0000)	(0.0000)	(0.0003)	(0.0001)	(0.0001)	(0.0001)	(0.0000)	(0.0001)
Const	-0.0031	-0.0035	0.0021	0.0019	0.0063	-0.0025	-0.0031	-0.0053	0.0047
	(0.0068)	(0.0064)	(0.0075)	(0.0052)	(0.0049)	(0.0069)	(0.0046)	(0.0042)	(0.0071)
Number of countries	29	29	29	29	29	29	29	29	29
Number of Instruments	24	24	24	24	24	24	24	24	24
AR(1)	0.021	0.021	0.029	0.022	0.021	0.023	0.017	0.058	0.022
AR(2)	0.335	0.333	0.327	0.330	0.329	0.351	0.347	0.592	0.308
Hansen	0.362	0.341	0.770	0.703	0.736	0.520	0.215	0.711	0.475
Observations	256	256	255	255	255	238	254	237	254

The standard error is in parentheses. ***. ** and * denote the rejection of the null hypothesis at 1%. 5% and 10% significance levels, respectively.

TABLE 5d Continued. Developing Countries (with time)

Lagged log of GDP per capita	-0.0182**	-0.0193***	-0.0235***	-0.0235***	-0.0243***	-0.0193***	-0.0284***	-0.0187***	-0.0258***
	(0.0055)	(0.0045)	(0.0051)	(0.0056)	(0.0041)	(0.0036)	(0.0045)	(0.0028)	(0.0053)
Patent	0.0049***	0.0005***	0.0052***	0.0062***	0.0062***	0.0041***	0.0064***	0.0056***	0.0063***
	(0.0005)	(0.0003)	(0.0001)	(0.0006)	(0.0008)	(0.0005)	(0.0009)	(0.0008)	(0.0001)
Capital Formation	0.0007)**	0.0009***	0.0009***	0.0009**	0.0007***	0.0009***	0.0009***	0.0010***	0.0008***
	(0.00017	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0001)
Population Growth	-0.0029***	-0.0032****	-0.0024***	-0.0021**	-0.0025***	-0.0025***	-0.0018**	-0.0019***	-0.0020**
	(0.0003)	(0.0002)	(0.0004)	(0.0007)	(0.0006)	(0.0004)	(0.0007)	(0.0004)	(0.0005)
L3..Primary	0.0004								
	(0.0001)								
L3.Secondary		-0.0002**							
		(0.0001)							
L3.Education			0.0002***						
			(0.0001)						
L3.Humanities				0.0002**					
				(0.0001)					
L3.Social Sciences					0.0001***				
					(0.0000)				
L3.Science						-0.0001			
						(0.0001)			
L3.Engineering							0.0001**		
							(0.0001)		
L3.Agriculture								-0.0013	
								(0.0001)	
L3.Health									0.0003***
									(0.0001)
Const	0.0574**	0.05913**	0.0668***	0.0680***	0.0737***	0.0600***	0.0844***	0.0519***	-2.953
	(0.0187)	(0.0149)	(0.0153)	(0.0159)	(0.0000)	(0.0107)	(0.0118)	(0.0065)	(0.643)***
Number of countries	25	25	25	25	25	25	25	25	25
Number of Instruments	24	24	24	24	24	24	24	24	24
AR(1)	0.016	0.042	0.062	0.075	0.080	0.061	0.072	0.080	0.087
AR(2)	0.084	0.086	0.089	0.107	0.108	0.084	0.134	0.121	0.114
Hansen	0.413	0.290	0.396	0.499	0.546	0.292	0.547	0.640	0.611
Observations	244	244	263	263	263	263	263	263	263

The standard error is in parentheses. ***. ** and * denote the rejection of the null hypothesis at 1%. 5% and 10% significance levels, respectively.

Table 5e Continued. Developing Countries (without time)

Lagged log of GDP per capita	-0.0122***	-0.0212***	-0.0269***	-0.0254***	-0.0245***	-0.0232***	-0.0287***	-0.0193***	-0.0282***
	(0.0053)	(0.0051)	(0.0052)	(0.0060)	(0.0042)	(0.0047)	(0.0048)	(0.0029	(0.0056)
Patent	0.0050***	0.0052***	0.0046***	0.0060***	0.0061***	0.0042***	0.0065***	0.0056***	0.0061***
	(0.0005)	(0.0046)	(0.0007)	(0.0008)	(0.0009)	(0.0006)	(0.0009)	(0.0007)	(0.0008)
Capital Formation	0.0006***	0.0007**	0.0007***	0.0007**	0.0007***	0.0006**	0.0006**	0.0009***	0.0007**
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0001)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Population Growth	-0.0032***	-0.0034***	-0.0031***	-0.0023**	-0.0025***	-0.0029***	-0.0022**	-0.0021***	-0.0024**
	(0.0003)	(0.0003)	(0.0005)	(0.0008)	(0.0006)	(0.0001)	(0.0007)	(0.0004)	(0.0007)
L3.Primary	0.0001								
	(0.0001)								
L3.Secondary		-0.0002**							
		(0.0001)							
L3.Education			0.0002***						
			(0.0001)						
L3.Humanities				0.0002**					
				(0.0001)					
L3.Social Sciences					0.0001**				
					(0.0000)				
L3.Science						-0.0001			
						(0.0001)			
L3.Engineering							0.0001*		
							(0.0001)		
L3.Agriculture								-0.0001	
								(0.0001)	
L3.Health									0.0002*
									(0.0001)
Const	0.0728***	0.07171***	0.0863***	0.0806***	0.0763***	0.0832***	0.09211***	0.0548***	0.0920***
	(0.0167)	(0.0156)	(0.0166)	(0.0179)	(0.0128)	(0.0176)	(0.0133)	(0.0067)	(0.0176)
Number of countries	25	25	25	25	25	25	25	25	25
Number of Instruments	23	23	23	23	23	23	23	23	23
AR(1)	0.014	0.023	0.053	0.072	0.079	0.064	0.080	0.080	0.084
AR(2)	0.082	0.079	0.074	0.093	0.106	0.074	0.121	0.119	0.107
Hansen	0.345	0.272	0.336	0.416	0.477	0.381	0.587	0.578	0.617
Observations	244	244	263	263	263	263	263	263	263

The standard error is in parentheses. ***. ** and * denote the rejection of the null hypothesis at 1%. 5% and 10% significance levels, respectively.

Table 5f Continued. Developing Countries (without time) Including Investment Freedom

Lagged log of GDP per capita	-0.0326***	-0.0282***	-0.0326***	-0.0281***	-0.0285***	-0.0284***	-0.0322***	-0.0284**	-0.0312***
	(0.0043)	(0.0036)	(0.0052)	(0.0049)	(0.0034)	(0.0038)	(0.0023)	(0.0031)	(0.0043)
Patent	0.0060***	0.0063***	0.0061***	0.0070***	0.0071***	0.0055***	0.0080***	0.0072***	0.0073***
	(0.0006)	(0.0005)	(0.0007)	(0.0007)	(0.0007)	(0.0005)	(0.0008)	(0.0008)	(0.0008)
Capital Formation	0.0009***	0.0011***	0.0010***	0.0008***	0.0008***	0.0008***	0.0008***	0.0012***	0.0008***
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0001)	(0.0002)	(0.0001)	(0.0001)	(0.0002)
Population Growth	-0.0017***	-0.0024**	-0.0031***	-0.0023**	-0.0024***	-0.0026**	-0.0022**	-0.0026**	-0.0026***
	(0.0005)	(0.0006)	(0.0004)	(0.0009)	(0.0006)	(0.0007)	(0.0007)	(0.0010)	(0.0004)
L3.Primary	0.0001								
	(0.0001)								
L3.Secondary		-0.0001							
		(0.0001)							
L3.Education			0.0002**						
			(0.0001)						
L3.Humanities				0.0002**					
				(0.0001)					
L3.Social Sciences					0.0001***				
					(0.0000)				
L3.Science						-0.0001			
						(0.0001)			
L3.Engineering							0.0001		
							(0.0000)		
L3.Agriculture								-0.0003**	
								(0.0001)	
L3.Health									0.0001
									(0.0001)
Investment Freedom	0.0005**	0.0004**	0.0003**	0.0002	0.0002**	0.0003**	0.0002	0.0003***	0.0002
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Const	0.0772***	0.0629***	0.0846***	0.0783***	0.0747***	0.0794***	0.0923***	0.0629***	0.0914***
	(0.0123)	(0.0137)	(0.0001)	(0.0139)	(0.0118)	(0.0001)	(0.0079)	(0.0079)	(0.0143)
Number of countries	25	25	25	25	25	25	25	25	25
Number of Instruments	24	24	24	24	24	24	24	24	24
AR(1)	0.029	0.032	0.070	0.083	0.093	0.078	0.079	0.096	0.098
AR(2)	0.161	0.154	0.120	0.116	0.139	0.114	0.158	0.176	0.138
Hansen	0.375	0.410	0.493	0.410	0.540	0.404	0.648	0.564	0.611
Observations	244	244	263	263	263	263	263	263	263

The standard error is in parentheses. ***. ** and * denote the rejection of the null hypothesis at 1%. 5% and 10% significance levels, respectively.

Table 6a GMM Test Results for Model 2 (Dispersion)

Developed Countries	with time		without time	
Lagged log of GDP per capita	-0.0035**	-0.0041**	-0.0029**	-0.0033**
	(0.0011)	(0.0012)	(0.0013)	(0.011)
Patent	0.0134***	0.0130***	0.0135***	0.0133***
	(0.0005)	(0.0001)	(0.0005)	(0.0001)
Capital Formation	0.0004***	0.0004***	0.0004***	0.0004***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Population Growth	-0.0038***	-0.0041***	-0.0040***	-0.0041***
	(0.0005)	(0.0005)	(0.0004)	(0.053)
L3.Standard deviation	0.0002***		0.0001***	
	(0.0001)		(0.0001)	
L3.Dispersion		0.00002**		0.00001**
		(0.000)		(0.0001)
Const	0.0056***	0.0088**	0.0027	-0.0051
	(0.0043)	(0.0048)	(0.0049)	(0.0053)
Number of countries	29	29	29	29
Number of Instruments	24	24	23	23
AR(1)	0.024	0.021	0.025	0.024
AR(2)	0.329	0.329	0.329	0.327
Hansen	0.731	0.635	0.808	0.800
Observations	254	257	254	257

The standard error is in parentheses. ***. ** and * denote the rejection of the null hypothesis at 1%. 5% and 10% significance levels, respectively.

Table 6b Continued

Developed Countries (without time) Including Investment Freedom		
Lagged log of GDP per capita	-0.0031**	-0.0035**
	(0.0011)	(0.0013)
Patent	0.0133***	0.0131***
	(0.0005)	(0.0004)
Capital Formation	0.0004***	0.0005***
	(0.0001)	(0.0001)
Population Growth	-0.0040***	-0.0043***
	(0.0005)	(0.0005)
L3.Standard deviation	0.0001***	
	(0.0002)	
L3.Dispersion		0.0000022*
		(0.000)
Investment Freedom	0.0000	0.0002
	(0.0000)	(0.0000)
Const	0.0027	0.0043
	(0.0002)	(0.0073)
Number of countries	29	29
Number of Instruments	24	24
AR(1)	0.023	0.021
AR(2)	0.329	0.329
Hansen	0.801	0.746
Observations	254	257

The standard error is in parentheses. ***. ** and * denote the rejection of the null hypothesis at 1%. 5% and 10% significance levels, respectively.

Table 6c Continued

Developing Countries	with time		without time	
Lagged log of GDP per capita	-0.0221***	-0.0296****	-0.0223***	-0.0306***
	(0.0043)	(0.015)	(0.0042)	(0.0058)
Patent	0.0055***	0.0067***	0.0054***	0.0066***
	(0.0007)	(0.110)	(0.0007)	(0.0007)
Capital Formation	0.0008***	0.0006**	0.0007**	0.0006**
	(0.0001)	(0.00029)	(0.0001)	(0.0002)
Population Growth	-0.0027***	-0.0018***	-0.0027**	-0.0019**
	(0.0005)	(0.0007)	(0.0005)	(0.0007)
L3.Standard deviation	0.0022**		0.0002**	
	(0.0001)		(0.0001)	
L3.Dispersion		0.0013**		0.0012**
		(0.0004)		(0.0004)
Const	0.0655***	0.0929***	0.0677***	0.0969***
	(0.0001)	(0.0167)	(0.0138)	(0.0170)
Number of countries	25	25	25	25
Number of Instruments	24	24	23	23
AR(1)	0.071	0.083	0.071	0.083
AR(2)	0.098	0.132	0.095	0.128
Hansen	0.496	0.695	0.411	0.615
Observations	263	263	263	263

The standard error is in parentheses. ***. ** and * denote the rejection of the null hypothesis at 1%. 5% and 10% significance levels, respectively.

Table 6d Continued

Developing Countries (without time) Including Investment Freedom		
Lagged log of GDP per capita	-0.0256***	-0.0336 ***
	(0.0034)	(0.0039)
Patent	0.0063***	0.0077***
	(0.0007)	(0.0001)
Capital Formation	0.0009**	0.0007***
	(0.0001)	(0.001)
Population Growth	-0.0028***	-0.0019**
	(0.0004)	(0.0008)
L3.Standard deviation	0.0002**	
	(0.0002)	
L3.Dispersion		0.0009**
		(0.0003)
Investment Freedom	0.0002**	0.0002**
	(0.0001)	(0.0001)
Const	0.0649***	0.9653***
	(0.0130)	(0.0131)
Number of countries	25	25
Number of Instruments	24	24
AR(1)	0.083	0.095
AR(2)	0.128	0.159
Hansen	0.501	0.650
Observations	263	263

The standard error is in parentheses. ***. ** and * denote the rejection of the null hypothesis at 1%. 5% and 10% significance levels, respectively.

4 Conclusions

Recently, the contribution of human capital to economic growth has been viewed as an important factor in studies on economic growth. On the other hand, there are some studies that do not find a significant effect of human capital on economic growth. Besides, the importance of higher education on the economy has been investigated recently. Although many studies have concluded that tertiary education is the driving force behind economic growth, one of the key questions is which field of tertiary education contributes more to economic growth. In this paper, unlike the previous studies that classified education levels as primary, secondary, and tertiary education graduates, we investigated the effect of each field of education at the tertiary level on economic growth. Additionally, we investigated the contribution of the dispersion of graduates among different fields to economic growth by constructing indicators through standard deviation and relative dispersion measurements.

When we consider the effect of graduates from different fields on economic growth, we find that all graduates, except for education and engineering graduates, in developed countries make a positive and significant contribution to economic growth. Especially, science graduates have a greater impact on economic growth than graduated from other fields. For education and engineering graduates, governments can make these fields more attractive for students through providing suitable employment opportunities and salaries in the line with market conditions.

In developing countries, we find that all fields are positively correlated with economic growth except for agriculture and science graduates. Unlike developed countries, engineering graduates have a positive impact on economic growth. In addition, it has been determined that science graduates do not have a significant impact on economic growth. It may be said that science graduates have limited job opportunities corresponding to their skills or they prefer to ongoing their education process instead of being included in the labor market. By collaborating with innovative firms, policy makers can identify necessary qualifications and the number of personnel requirements to obtain gains from science graduates.

Examining the number of graduates from certain fields in universities does not provide sufficient information about the qualifications of these graduates. It is also important whether the graduates have the qualifications required by the labor market. However, in line with our results, it can be said that policy makers can implement policies that will improve the skills of these graduates according to changing conditions and provide appropriate employment opportunities, especially for graduates from fields that do not contribute to economic growth.

Our results show that the dispersion of graduates in tertiary education has a significant and positive effect on economic growth, as well. Advanced knowledge which is expected to be supported by tertiary education is gradually gaining importance as one of the critical determinants of economic growth. This leads to a greater focus on the contribution of tertiary education to economic growth. Considering that different sectors require human capital with different skills, a country's human capital with advanced knowledge in different fields can have a positive effect on economic growth by meeting the labor needs of different sectors. According to our results, we can conclude that, graduates from each field will have a limited effect on economic growth, as the tertiary educated human capital in other fields may not exist. This finding implies that planning education policy in a way that creates more dispersion of graduates among different fields will support economic growth.

Understanding the impact of education on economic activity is important for implementing more complementary and sustainable economic development policies. One of the important issues in this context is how educated human capital is linked to economic growth. Many factors may play key roles in this relationship, such as management of human resources, the economic structure of the countries, i.e. which sector makes more contribution to economic growth, opportunities for graduates from different fields to be employed in their own fields, etc. Governments can take into account the contribution of graduates from different fields to the economic growth when determining the allocation of resources for tertiary education. They may also take this relationship into account when improving the quality of graduates and arranging jop opportunities for them. Effective labor policies, investments and trade regulations will help increase the return on education. Besides, allocation of all resources to only one study field may not provide the desired results for economic growth.

One limitation of this study is the lack of more recent data on graduates from different fields. Future studies may extend the period analyzed as data become available and consider different proxies for education, such as the quality of graduates, whenever possible.

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