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Distribution of Graduates by Fields and Economic Growth[1]

*Müzeyyen Merve ŞERIFOĞLU – Pelin ÖGE GÜNEY**

Abstract

This paper investigates the effect of distribution in terms of tertiary education graduates by fields on economic growth over the 1998 – 2012 periods for 27 OECD countries by using a two-step System GMM method proposed by Arellano and Bover (1995) and Blundell and Bond (1998). We calculate distribution of graduates from education, humanities and arts, social sciences, sciences, engineering, agriculture, and health and welfare through standard deviation methods. Our results reveal that for all fields, except education and agriculture, the distribution of graduates among the sub-fields of the mentioned fields has a positive and significant effect on economic growth. The results obtained from this study may help universities, governments and enterprises plan their investments on human capital. In addition, governments can consider our results to determine the allocation of resources for tertiary education and to develop effective employment policies.

Keywords: *distribution, tertiary level education, economic growth, system GMM*

JEL Classification: O40, I20, J24, F63

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Introduction

Higher education[2] is regarded as the main driver of economic growth by improving skills of country and creating the conditions for innovation (McNeil and Slim, 2012). It affects the economic growth through at least three channels: the accumulation of skills and capabilities, the generation of new knowledge and the

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[1] This paper is based on Phd. Thesis of Müzeyyen Merve Şerifoğlu (supervised by Pelin Öge Güney).

[2] In this paper, higher education and tertiary education are used in the same sense.

adaptation of new technology. So, tertiary level graduates are increasingly sought by employers since they easily adapt to progress in new technologies, such as computer and innovation (Holmes, 2013).

Ensuring human capital supply, with the right skills, plays a central role in determining education policy and meeting the labor market's needs for changing the world economy. Although it is important to evaluate the impact of fields on an individual basis, we can also say that the distribution of fields is an important indicator for developing sound policies. If graduates from different fields play a complementary role in the production process, then the importance of distribution of graduates becomes apparent. In this case, the production process will bring together people with different abilities and equipment. Secondly, education provides positive externalities through learning spillovers and different faculty graduates reflect their skills and knowledge to society (Gille, 2015). The fact that a country has a specialized human capital in different fields can have an impact on the country's adaptation and fluent use of new technologies.

It is seen that the effect of overall tertiary level education on economic growth is investigated in the majority of studies (Murphy, Shleifer and Vishny, 1991; Agiomirgionakis, Astreriou and Monastiriotis, 2002; Petrakis and Stamatakis, 2002; Tiago, 2007; Colombo and Grilli, 2005; Tsai, Hung and Harriot, 2010; Fan and Zhang, 2015; Maloney and Caicedo, 2016; Bayraktar, 2015; Seetanah and Teeroovengodum, 2017) while there is scarce literature that examines the relationship between tertiary level graduates by fields and economic growth. However, to the best of our knowledge, there is not any study that links the distribution of tertiary level education by fields and economic growth in that literature. Contribution of graduates to production may depend on the existence of people with tertiary education in other sub-fields.

Unlike the studies examining the effect of graduates by field, the main contribution of this paper is to show the effect of distribution of tertiary level graduates (by sub-fields of different fields) on economic growth over the 1998 – 2012 period for 27 OECD countries. For this purpose, we use the distribution of graduates from education, humanities and arts, social sciences, sciences, engineering, agriculture and health and welfare. Based on the literature on distribution, we calculate distribution of graduates for each field category through the standard deviation method since it is simple and an empirically significant method (Marin and Psacharopoulos, 1976; Winegarden, 1979; Ram, 1984; 1990; Birdsall and Londono, 1997; Park, 2004; Iacopetta, 2006; Lee and Lee, 2018). We think that the results obtained from this study will guide governments, countries and policy makers in determining resource allocation for higher education and organizing employment opportunities for graduates.

Considering time dimension and cross section of our sample, we apply the System GMM method developed by Arellano and Bover (1995) and Blundell and Bond (1998), which allows identification of country-specific effect and controls the potential endogeneity for all independent variables, and produces efficient results under minimum assumptions (Roodman, 2009). This method has two alternatives as one-step and two-step. We prefer to use a two-step estimator since literature indicates that two-step estimators produce more efficient results (Labra and Torrecillas, 2018, p. 37). We also measure the consistency of two-step GMM estimator through the Hansen (1982) J test for over identification, and AR test for serial correlation between error terms. Our findings show that to understand the role of tertiary education on economic growth, the distribution of graduates also matters.

The rest of the paper is organized as follows: in the first section, we present literature. In the second section, we give brief information about tertiary education by fields in OECD countries. In the third section, econometric model and results are explained. Our paper ends with conclusion.

1. Literature Review

In the empiric and theoretical literature, there are lots of studies related to the indicators of economic growth. The Solow-Swan growth model, known as the neoclassical model developed separately by Solow (1956) and Swan (1956), can be regarded as a pioneer in understanding the dynamics of economic growth. According to this model, it is necessary to take advantage of technological development in order to maintain economic growth. However, technological development is not endogenously determined in the model (Solow, 1956; Sala-i-Martin, 1990; Romer, 2012).

Following, Romer (1986) and Lucas (1988) begin examining the Neoclassical Production function and its assumptions to explain the difference in income distribution between developed and developing countries. In the new model named as Endogenous Growth Model, human capital is considered as a main driver of economic growth, unlike the Neoclassical Growth Model. According to Endogenous Growth Model, investing in human capital increases the efficiency of labor force and provide externalities and spillover effects on economy and reduces the diminishing of return to capital accumulation.

Lucas (1988) associates the human capital investments with the education level of the workforce. He indicated that the increase in human capital leads to economic growth and human capital accumulation can be increased through learning by doing.

Mankiw, Romer and Weil (1992) attempted to prove if the assumptions of the Solow growth model were consistent with the evidence. They extended the Neoclassical Solow Model by including human capital as well as physical capital. In addition to these studies, Grossman and Helpman (1989) and Romer (1990) highlighted the role of human capital on the economic growth process by emphasizing the increasing return of capital. Romer (1990) showed that economic growth is based on development and research activities. Grossman and Helpman (1989) also developed a model in which economic growth is endogenized through vertical product development and technological progress.

As summarized above, the contribution of human capital on economic growth is supported by theoretical literature. In this context, various indicators such as education and health are used as an indicator of human capital in the empirical literature. Based on the literature about tertiary level graduates by field, Murphy, Shleifer and Vishny (1991), who may be regarded as pioneer economists investigating the relationship between different fields and economic growth, emphasized that engineers contribute more to economic growth in the United States. Colombo and Grilli (2005) found that the graduates from the scientific and technical field have a positive impact on growth for 506 Italian firms operating in the high-tech industry. Tiago (2007) showed that the ratio of enrollment in engineering, mathematics and computer science in tertiary level education has a positive effect on economic growth. Tsai, Hung and Harriot (2010) conclude that graduates from the field of high tech have an important contribution to growth in both developed and developing countries. Fan and Zhang (2015) point out that the contribution of higher engineering education in China regions was 14.7% in 2008 while it was 10.6% in 2003. Maloney and Caicedo (2016) suggest that there is a positive relationship between engineering graduates and income differences.

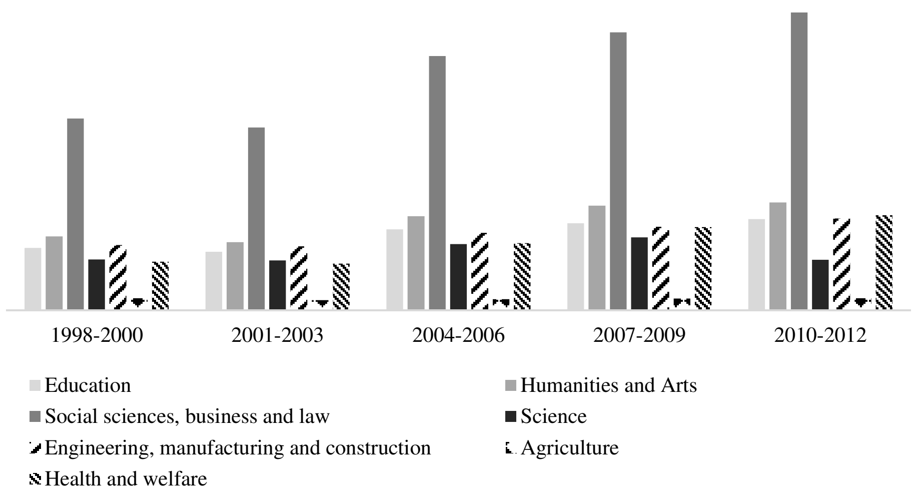
Considering distribution and economic growth nexus, it appears that there are only few papers available and the distribution of human capital among different education levels (e.g. primary, secondary, tertiary) are mainly used as education indicators in these studies. For example, Castello and Domanech (2002) calculated Gini coefficient related to human capital by using an educational attainment data set, including different levels of education (primary, secondary and tertiary level education) for 108 countries between 1960 and 2000. Their findings show that there is a negative correlation between human capital inequality and economic growth. Park (2004) defined an index based on distribution of population in terms of educational attainment levels and analyzed 94 countries from the 1960 to 1995 periods. He found that equal distribution has a positive effect on economic growth. Apart from previous studies, this paper aims to investigate the effect of distribution of tertiary level graduates on economic growth.

2. Higher Education and Economic Growth across OECD Countries

With advances in technology, especially the rise of artificial intelligence, and increasing globalization, intellectual capital has become a most valuable source in the world. The core of intellectual capital is knowledge and tertiary level education plays a key role in the developing and transferring of knowledge and adapting societies to these changes (OECD, 2019, p. 9).

Since 2000, it is seen that the share of people with higher education in the workforce has increased across OECD countries and partners. Today, while the majority of the 25 – 34 age group has tertiary level education degree, upper secondary level education was the highest level of education among most young adults in 2000 (OECD, 2017, p. 23). As a result of expansion of tertiary level education, 39% of adults aged 25 – 64 hold a tertiary degree on average across OECD countries by records in 2018 (OECD, 2019, p. 41). Figure 1 shows distribution of graduates by fields across OECD countries for three -year average from 1998 to 2012.

F i g u r e 1
Distribution of Graduates by Field (number of graduates)



Source: OECDstat.

Considering education fields by years, most graduates have a degree in social sciences, business and law. Following social science graduates, humanities are the most common fields across OECD countries. On the other hand, we may say that agriculture is less attractive than other fields.

3. Econometric Model and Results

3.1. Econometric Model

In this paper, we examine the relationship between distribution of graduates by seven education fields and economic growth. The econometric model can be shown as below:

$$logy_{i,t} - logy_{i,t-1} = \beta_0 + \beta_1 logy_{i,t-1} + \beta_2 DistGraduates_{i,t-j} + \\ + \beta_3 Capitalformation_{i,t} + \beta_4 Taxburden_{i,t} + \beta_5 Inflation_{i,t} + \delta_{i,t} + \varepsilon_{i,t} \quad (1)$$

where $logy_{i,t} - logy_{i,t-1}$ is GDP per capita growth rate in country i and for t time, $logy_{i,t-1}$ is logarithm of lagged GDP per capita which shows convergence idea and its coefficient is expected to be negative. $DistGraduates_{i,t-j}$ is set of education variables which lagged j period including the distribution of graduates from each fields (education, humanities and arts, social sciences, sciences, engineering, agriculture and health and welfare) among their sub-fields. $Capitalformation_{i,t}$ is gross capital formation in GDP (%). $Inflation_{i,t}$ is annual percentage change in consumer prices index and $Taxburden_{i,t}$ refers a scale of 0 and 100. Besides, we include unemployment (% total labor force) and openness (the percentage of sum of export and import in total GDP) to check whether our results is robust.

The knowledge of tertiary education graduates can be expected to take time to convert into productive gains. Therefore, it may be reasonable to expect that the investment in current human capital affects the future rate of economic growth rather than current rates. The optimal time length can be considered greater than one year although is not known exactly (Tsai, Hung and Harriot, 2010). In this context, we presented the estimation results related to two lag periods.

We employ a two-step System GMM method proposed by Arellano and Bover (1995) and Blundell and Bond (1998), which is quite common in recent growth literature. The method is an extremely popular method in the econometric research on labor, development, health and internal economics since it produces efficient results under the minimum assumptions (Bun and Kleibergen, 2010). The System GMM is also consistent when the analyzed period is short and cross section dimension is large in the micro-economics panel data models. Besides, it can deal with endogenous regressors and reverse causality. The estimator combines both first differenced and level equations, which include time-invariant variables in the level equation. It performs as one-step and two-step. One-step GMM does not produce consistent results in the presence of heteroscedasticity and serial correlation in the residuals. Besides, it is efficient under those circumstances of homoscedasticity and not correlation of the error terms. Then, two-step GMM was developed by Arellano and Bover (1995) and Blundell and Bond (1998). To measure the consistency of two-step GMM estimator, we apply the over identification test developed by Hansen (1982) J-test statistic for validity instruments and AR test for the serial correlation between error terms.

3.2. Data

The data set consists of 27 OECD countries[3] in the period of 1998 – 2012 due to the availability of data. Our dependent variable is the GDP per capita growth (constant 2010 USD). GDP per capita is an important indicator which shows economic performance and allows us to compare cross-country of average living standards and economic well-being. The main determinants of economic growth are classified as human resources, natural resources, capital formation and technology. On the other hand, economic growth is related to other macroeconomic (e.g. size of aggregate demand, saving rates) and institutional factors (e.g. efficiency of the financial system, budgetary and fiscal policies) (Boldeanu and Constantinescu, 2015). In this context, we use distribution of graduates as an indicator of human resources, capital formation as the main determinant of growth, inflation as an indicator of macroeconomic factors and also; the tax burden to represent efficiency of the financial system. In addition to our main control variables, we include the unemployment rate (as a macroeconomic indicator) and openness (component of trade) to show that our results are consistent with each other. The GDP per capita, inflation and capital formation are obtained from World Bank (WB). In terms of education variables, data for sub-field tertiary level education graduates are collected from OECD stat, Eurostat and UNData. The tax burden data obtained from heritage.org. Additionally, we take other explanatory variables including unemployment and openness from WB. Detailed data and data sources are given in the Annex 2.

There are four commonly method used for measures of dispersion: the range, interquartile range, standard deviation and variance. The standard deviation is a common method to calculate dispersion in economics due to its statistical superiorities (Lewis, 2012). For example, it is resistant to sampling variation and it gives information on whether data is close to the average. Additionally, there are different types of methods used in the literature to calculate dispersion such as

[3] These countries consist of Australia, Austria, Belgium, Canada, Czechia, Denmark, Estonia, Finland, France, Germany, Iceland, Ireland, Israel, Italy, Korea, Latvia, Mexico, Holland, New Zealand, Norway, Slovak Republic, Spain, Sweden, Switzerland, Turkey, United Kingdom, and United States.

relative dispersion. In our case, to measure dispersion with relative dispersion method we need schooling years for each field. Due to lack of data on schooling years for each field, we use standard deviation method to calculate distribution of graduates from education, humanities and arts, social sciences, sciences, engineering, agriculture and health and welfare fields. The formula is as follows:

$$X_i = \frac{The\, number\, of\ sub - fields\ \ graduates_i}{The\, number\, of\ \ graduates_{\,i}} \times 100 \tag{2}$$

where X_i is the percentage of sub-fields graduates in total number graduates from field *i*. The number of graduates refers to graduates from fields. "Field" refers to general education fields such as education, humanities, social sciences. Each field consist of "sub-fields". The sub-field graduates, for example for field of education, involves teacher training and education science. Teacher training and education science are sub-field of education. Annex 1 show the field and sub-fields in this paper. After calculating standard deviation for each field, we obtain distribution of seven education field.

Table 1 presents descriptive statistics of the variables used in the paper for 27 OECD countries over 1998 – 2012 periods.

T a b l e 1

Descriptive Statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
GDP per capita growth	405	0.001	0.018	–0.067	0.114
Log of lagged GDP per capita	405	4.504	0.267	3.780	4.962
Capital Formation	405	24.037	4.337	13.781	41.538
Inflation	405	3.656	7.058	–4.478	84.64
Tax burden	405	59.814	14.571	29.8	89.5
Education	377	0.440	0.189	0.000	0.938
Humanities	376	0.251	0.142	0.000	0.707
Social sciences	376	0.214	0.055	0.000	0.364
Engineering	378	0.288	0.099	0.000	0.577
Agriculture	377	0.388	0.183	0.000	0.707
Health	378	0.425	0.183	0.000	0.718
Unemployment	405	7.389	3.763	1.87	24.79
Openness	405	83.036	35.957	22.154	191.537

Source: Authors' calculations based on data from World Bank, OECD stat, Eurostat, UNdata, heritage.org.

According to Table 1, it is seen that average GDP per capita growth was 0.001% and the values for capital formation, inflation and tax burden realized 3.656%, 59.814% and 59.814% respectively over the period 1998 through 2012. The average for unemployment and openness was 7.384% and 83.036%, respectively. In terms of educational variables, it seems that graduates from education faculties have the highest average as 0.440% compared to others.

3.3. Empirical Results and Discussions

Table 2, 3 and 4 give empirical results of Equation (1) across 27 OECD countries for 1998-2012 periods. We employed two-step System GMM estimation method and checked the serial correlation by AR test and, the validity of instruments by Hansen (1982) J statistic. In all estimates, we used logarithm of lagged GDP per capita, capital formation and inflation as endogenous variables. After we estimate the baseline model (Equation 1), we add openness and unemployment variables to the model to check consistency of our results.

In terms of serial correlation, we present AR (2) test results and find that there is not second autocorrelation for all specifications. Our Hansen (1982) J statistic results also show that instrumental variables are valid for all models.

According to our results, in all specification, capital formation has a positive and significant effect on economic growth. On the other hand, we find that inflation and tax burden have a negative impact on economic growth.

Similar to Lucas (1988), Mankiw, Romer and Weil (1992) and Barro (1991), the estimated coefficient of logarithm of lagged GDP per capita is negative and significant, which supports to convergence hypothesis We also find that openness does not have any impact on economic growth in most models. In addition, unemployment is negatively correlated with economic growth in all models as expected.

In terms of distribution of graduates by field, our results show that distribution of social science graduates makes the highest contribution on economic growth in OECD countries. The coefficient of distribution of social science is 0.0630 in the baseline equation while the coefficients in the models we include openness and unemployment are 0.0610 and 0.0611, respectively. Following social science graduates, the second largest contribution is from distribution of science graduates. While the coefficient is 0.0345 according to our results in baseline equation, the coefficients are 0.0294 and 0.0339 for models including openness and unemployment.

Then, we also find that distribution of health, humanities and health graduates have positive impact on economic growth for all models. On the other hand, distribution of education graduates is statistically insignificant in the base model. When we include openness and unemployment in the model, we see that our results for education graduates remain unchanged, as well. Considering the distribution of agriculture graduates, the coefficient is statistically insignificant, except for the model in which we include unemployment. When we include unemployment in the model, we find that the coefficient of agriculture graduates is negative and significant.

T a b l e 2

System GMM Test Results, OECD Countries

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Log of the lagged GDP per capita	–0.0359*** (0.0029)	–0.0270*** (0.0024)	–0.0363*** (0.0026)	–0.0372*** (0.0019)	–0.0356*** (0.0019)	–0.0383*** (0.0031)	–0.0292*** (0.0015)
Capital Formation	0.0028*** (0.0001)	0.0029*** (0.0001)	0.0027*** (0.0001)	0.0028*** (0.0006)	0.0027*** (0.0001)	0.0028*** (0.0001)	0.0029*** (0.0001)
Inflation	–0.0015*** (0.0002)	–0.0016*** (0.0002)	–0.0017*** (0.0000)	–0.0016**** (0.0002)	–0.0014*** (0.0002)	–0.0016*** (0.0002)	–0.0016*** (0.0002)
Tax burden	–0.0004*** (0.0007)	–0.0004*** (0.0001)	–0.0005*** (0.0000)	–0.0005**** (0.0000)	–0.0039**** (0.0001)	–0.0004**** (0.0001)	–0.0003*** (0.0001)
L2.education	0.0012 (0.0026)						
L2.humanities		0.0180*** (0.0037)					
L2.social science			0.0630*** (0.0090)				
L2.science				0.0345*** (0.0106)			
L2.engineering					0.0067** (0.0024)		
L2.agriculture						–0.0107 (0.0064)	
L2.health							0.0199*** (0.0030)
Const	0.1336*** (0.0026)	0.0833**** (0.0132)	0.1291*** (0.0139)	0.1362*** (0.0105)	0.1309*** (0.0111)	0.1487*** (0.0172)	0.0889*** (0.0080)
Number of Countries	27	27	27	27	27	27	27
Instrument number	25	25	25	25	25	25	25
AR(2)	0.107	0.101	0.109	0.102	0.101	0.109	0.107
Hansen	0.234	0.192	0.379	0.207	0.23	0.216	0.257

Note: Dependent variable is the GDP per capita growth and field variables refer to distribution of each field. Standard errors are in rackets. *, **, *** denote statistical significance level at 10%, 5% and 1%, respectively.

Source: Authors' calculations based on data from World Bank, OECD stat, Eurostat, UNdata, heritage.org.

T a b l e 3

System GMM Test Results, OECD Countries, Including Openness

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Log of the lagged GDP per capita	–0.0331*** (0.0033)	–0.0261*** (0.0025)	–0.0337*** (0.0029)	–0.0348*** (0.0028)	–0.0344*** (0.0022)	–0.0359*** (0.0033)	–0.0285*** (0.0022)
Capital Formation	0.0029*** (0.0001)	0.0030*** (0.0001)	0.0028*** (0.0001)	0.0029*** (0.0001)	0.0028*** (0.0001)	0.0029*** (0.0001)	0.0029*** (0.0001)
Inflation	–0.0016*** (0.0002)	–0.0017*** (0.0002)	–0.0018*** (0.0002)	–0.0018*** (0.0002)	–0.0015*** (0.0002)	–0.0016*** (0.0002)	–0.0017*** (0.0002)
Tax burden	–0.0004*** (0.0001)	–0.0004*** (0.0001)	–0.0004*** (0.0001)	–0.0004*** (0.0001)	–0.0004*** (0.0001)	–0.0004** (0.0001)	–0.0003** (0.0001)
Openness	–0.0000* (0.0000)	–0.0000 (0.0000)	–0.0001 (0.0000)	–0.0001 (0.0000)	–0.0000 (0.0000)	–0.0000 (0.0000)	–0.0000 (0.0000)
L2.education	–0.0009 (0.0026)						
L2.humanities		0.0168*** (0.0035)					
L2.social science			0.0610*** (0.0099)				
L2.science				0.0294** (0.0102)			
L2.engineering					0.0066* 0.0036		
L2.agriculture						–0.0095 (0.0062)	
L2.health							0.0202*** (0.0032)
Const	0.1219*** (0.0026)	0.0797*** (0.0139)	0.1170*** (0.0152)	0.1262*** (0.0138)	0.1251*** (0.0126)	0.1370*** (0.0176)	0.0853*** (0.0116)
Number of Countries	27	27	27	27	27	27	27
Instrument number	26	26	26	26	26	26	26
AR(2)	0.106	0.103	0.111	0.104	0.102	0.109	0.106
Hansen	0.216	0.18	0.409	0.233	0.234	0.192	0.266

Note: Dependent variable is the GDP per capita growth and field variables refer to distribution of each field. Standard errors are in rackets. *, **, *** denote statistical significance level at 10%, 5% and 1%, respectively.

Source: Authors' calculations based on data from World Bank, OECD stat, Eurostat, UNdata, heritage.org.

Table 4

System GMM Test Results, OECD Countries, Including Unemployment

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Log of the lagged GDP per capita	–0.0455*** (0.0044)	–0.0345*** (0.0045)	–0.0429*** (0.0039)	–0.0434*** (0.0042)	–0.0460*** (0.0036)	–0.0502*** (0.0063)	–0.0365*** (0.0034)
Capital Formation	0.0024*** (0.0001)	0.0026*** (0.0001)	0.0024*** (0.0001)	0.0026*** (0.0001)	0.0023*** (0.0002)	0.0024*** (0.0002)	0.0025*** (0.0002)
Inflation	–0.0018*** (0.0002)	–0.0018*** (0.0002)	–0.0019*** (0.0002)	–0.0017*** (0.0001)	–0.0017*** (0.0002)	–0.0019*** (0.0002)	–0.0019*** (0.0002)
Tax burden	–0.0004*** (0.0001)	–0.0003*** (0.0000)	–0.0004*** (0.0000)	–0.0004*** (0.0004)	–0.0003*** (0.0001)	–0.0004*** (0.0000)	–0.0003*** (0.0001)
Unemployment	–0.0011*** (0.0002)	–0.0008** (0.0002)	–0.0009** (0.0003)	–0.0009** (0.0003)	–0.0012*** (0.0002)	–0.0013*** (0.0003)	–0.0009** (0.0003)
L2.education	–0.0007 (0.0030)						
L2.humanities		0.0158*** (0.0034)					
L2.social science			0.0611*** (0.0086)				
L2.science				0.0339** (0.0109)			
L2.engineering					0.0075** (0.0027)		
L2.agriculture						–0.0119** (0.0061)	
L2.health							0.0197*** (0.0032)
Const	0.1942*** (0.0233)	0.1299*** (0.0245)	0.1704*** (0.0214)	0.1747*** (0.0229)	0.1940*** (0.0199)	0.2208*** (0.0347)	0.1352*** (0.0193)
Number of Countries	27	27	27	27	27	27	27
Instrument number	26	26	26	26	26	26	26
AR(2)	0.109	0.104	0.112	0.105	0.103	0.112	0.107
Hansen	0.291	0.271	0.447	0.17	0.303	0.257	0.288

Note: Dependent variable is the GDP per capita growth and field variables refer to distribution of each field. Standard errors are in rackets. *, **, *** denote statistical significance level at 10%, 5% and 1%, respectively.

Source: Authors' calculations based on data from World Bank, OECD stat, Eurostat, UNdata, heritage.org.

Recently, science, technology, engineering and maths (STEM) have been considered as a driving force of knowledge economy. The highest employment rate belongs to STEM graduates, especially for innovative sector, although the employment rate changes in science related fields (OECD, 2017). Considering our results, the distribution of science and engineering graduates contributes positively to economic growth, but their effect is unequal. The coefficient of science graduates is higher than engineering graduates. In most OECD countries, we can see that most of the students have upper secondary vocational degrees rather than tertiary education in engineering, manufacturing and construction, due to their strong ties with the industry (OECD, 2017, p. 23). Additionally, OECD (2019) indicates that popularity in engineering fields is less common among women.

Based on our results, the impact of distribution of social science graduates on economic growth are larger than other fields. OECD (2019) also shows that larger shares of adults have tertiary level degree in business, administration or law in OECD countries.[4] Similarly, Garcia-Aracil, Gabaldon-Estevan and Villa (2015) showed that social sciences had the highest percentage of graduates in Europe due to some reasons such as social prestige and possibility of making money. So, we may say that social science attracts more attention than other fields. According to the report by the Campaign for Social Science (2020), social science graduates after completing their bachelor’s degree have higher employment participation than in fields such as science and arts.

Following, it is found that the coefficients of distribution of education and agriculture graduates are statistically insignificant according to our results. We see that the production is mostly based on family farmers in agriculture sector despite the increase in the number of corporate farms (Daly, 1981). So, we may say that the interest of students remains low due to restricted employment opportunity in terms of corporate.

Finally, we see that the distribution of health and humanities graduates make the second highest contribution to economic growth after the distribution of social science and science graduates. OECD (2017) reported that this study field is one of the most expensive study fields together with engineering in terms of programme fees. It may be the reason why the impact of distribution of health graduates on economic growth is slightly lower than the distribution of social science and science graduates.

Overall, according to our results, we can say that higher education plays an important role to encourage economic growth across OECD countries. In addition,

[4] We use ISCED 1997 education classification for our analysis since our sample cover 1998 – 2012 periods. According to ISCED 1997, business, administration and law categorize under degree in social sciences (please see Annex 1).

our findings reveal that the distribution of tertiary graduates is a factor affecting economic growth. This result can be explained by the fact that there may be complementarities and externalities between graduates as emphasized by Gille (2015). Especially, analyzing of study fields can provide an insight for policy makers to implement more complementary and sustainable economic development policies. A variety of factors, such as labor-market prospects, expected salaries and economic structures of countries can influence young people's choice of study field. Additionally, gender imbalance can be one of the important factors in selection of study field. In majority of OECD countries, there are not many women with a tertiary degree in some fields of study, such as engineering and science (OECD, 2019). In this context, countries can guide young people in field choices in line with their market needs and encourage women to choose faculties with a large number of men. Finally, it can be said that, the impact of graduates from each subfield on economic growth is limited when human capital with higher education in other fields is not available.

Conclusion

The relationship between tertiary education and economic growth is one of the topics that have been extensively analyzed in the economic growth literature. However, there is not any study on the contribution of distribution of tertiary education graduates by fields on economic growth. In this study, we try to show whether the distribution of graduates among sub-fields has a significant impact on economic growth. We calculate distribution of tertiary graduates by field of study through standard deviation method for 27 OECD countries. In addition to education variables, other variables extensively used in growth literature such as capital formation, inflation, tax burden, openness and unemployment are also included in our model.

Employing two-step System GMM estimator, we find that the variables of capital formation has a positive impact on economic growth as expected. Moreover, the empirical results indicate that inflation, unemployment and tax burden are negatively correlated with economic growth, while openness is insignificant in most models. In terms of education variables, our results show that distribution of graduates among sub-fields has a positive and significant effect on economic growth except for distribution of education and agriculture graduates. We also find that distribution of social science graduates has a greater effect on economic growth than other fields. Following these results, we can conclude that highly educated people are driving force for economic growth and so; it should be well monitored which faculty graduates contribute more to the economic growth.

It is expected that the countries with a higher quality education system have better quality labor force which may create more productive goods and services by creating new ideas and therefore, higher economic gains. So, the policy makers should take into account the relationship between human capital and innovation to support economic growth. In this context, understanding the impact of education on economic activity is important to implement more complementary and sustainable economic development policies. Labor policies, investments and trade regulations may increase the return on education. Another important issue is how human capital is linked to the economic growth. Many factors play key roles in this relationship such as management of human resources, economic structure of the countries, i.e. which sector makes more contribution to economic growth, opportunities for different faculty graduates to be employed in their own fields etc. Considering the increasing number of university graduates and the resources allocated to these fields, our findings show that the role of distribution of tertiary graduates on economic growth should be well monitored. Governments can take into account this contribution when determining the allocation of resources for education. They may also consider this relationship in improving the quality of graduates and in arranging employment opportunities for graduates.

Overall, this finding suggests that planning education policies in such a way that graduates are more dispersed among different fields will support economic growth.

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Annex 1

Table 5

The List of Fields and Sub-fields in ISCED 1997

Education (ISC 14)
Teacher training (ISC 141)
Education science (ISC 142)
Humanities and Arts
Arts (ISC 21)
Humanities (ISC 22)
Social sciences, business and law
Social and behavioral science (ISC 31)
Journalism and information (ISC 32)
Business and administration (ISC 34)
Law (ISC 38)
Science
Life sciences (ISC 42)
Physical sciences (ISC 44)
Mathematics and statistics (ISC 46)
Computing (ISC 48)
Engineering, manufacturing and construction
Engineering and engineering trades (ISC 52)
Manufacturing and processing (ISC 54)
Architecture and building (ISC 58)
Agriculture
Agriculture, forestry and fishery (ISC 62)
Veterinary (ISC 64)
Health and welfare
Health (ISC 72)
Social Services (ISC 76)

Annex 2

Table 6

List of Variables, Variables Definitions and Sources

Variable	Definition	Source
GDP per capita	GDP per capita (2010 constant USD)	World Bank (WB)
Capital Formation	Share of gross capital formation in GDP	WB
Inflation	Consumer prices (annual %)	WB
Tax burden	A score which shows a scale between 0 and 100	heritage.org
Graduates	Author's calculation	OECD stat, Eurostat, UNdata
Unemployment	% total labor force	WB
Openness	Author's calculation	WB