Journal of Research in Economics • İktisat Araştırmaları Dergisi • Cilt: 6 / Issue • Sayı: 2 October • Ekim 2022 • ss/pp. 135-146
ISSN: 2636-8307 • DOI: http://dx.doi.org/10.29228/JORE.18

ARAŞTIRMA MAKALESİ / RESEARCH ARTICLE

HUMAN CAPITAL AND ECONOMIC GROWTH: EVIDENCE FROM WESTERN EUROPEAN AND CEECS COUNTRIES

BEŞERİ SERMAYE VE EKONOMİK BÜYÜME: BATI AVRUPA VE CEE ÜLKELERİNDEN KANITLAR

Kıvanç Halil ARIÇ[*]
Siok Kun SEK[**]
Vladan PAVLOVİC[***]
Goranka KNEZEVİC[****]

Abstract

In the economic literature, human capital is examined as a factor of economic growth by enhancing labor productivity. Human capital increases the marginal product of physical capital, which leads to further accumulation of physical capital, thereby increasing production and economic growth. In this study, the effects of human capital factors on economic growth is examined for European countries for the periods of 2008 to 2017. The European countries are categorized into two groups according to their location. The human capital factors to be tested include educational and training side of human capital. Panel data analysis is used for the estimation of the relationship. It is concluded that the quality of mathematics and science schools has a positive effect on the growth of CEECs and the extension of staff training has a positive effect on growth in Western European countries.
Keywords: Human Capital, Economic Growth, European Countries, CEECs, Panel Data
JEL Classification: F00, R1, E24, F43

Öz

Ekonomi literatüründe beşeri sermaye, emek verimliliğine yol açması nedeniyle ekonomik büyümeye neden olan faktörlerden biri olarak ele alınmaktadır. Beşeri sermaye, fiziksel sermayenin marjinal ürününü artırarak gelecek dönemde fiziksel sermayenin birikimine neden olmakta, böylelikle üretim

* Sivas Cumhuriyet University, Faculty of Economics and Administrative Sciences, E-mail: kharic@cumhuriyet.edu.tr, ORCID ID: 0000-0002-7631-1783

** Universiti Sains Malaysia, School of Mathematical Sciences, E-mail: sksek@usm.my, ORCID ID: 0000-0002-3616-9815

*** University of Pristina in Kosovska Mitrovica, Faculty of Economics, Serbia, E-mail: vladan.pavlovic@pr.ac.rs, ORCID ID: 0000-0002-2228-7095

**** Singidunum University, Department of Accounting, E-mail: gknezevic@singidunum .ac.rs, ORCID ID: 0000-0003-3642-7682

Submission Date: 31.03.2022
Revision Date: 25.06.2022
Acceptance Date: 10.07.2022

miktarı ve ekonomik büyüme artmaktadır. Bu çalışmada beşeri sermayenin, ekonomik büyüme üzerindeki etkileri 2008-2017 döneminde Avrupa ülkeleri açısından incelenmiştir. Avrupa ülkeleri coğrafi açıdan iki grupta ele alınmıştır. Beşeri sermaye faktörleri eğitim ve mesleki tecrübe yönleriyle test edilmiştir. Analiz sürecinde panel veri yöntemi kulanılarak tahminler yapılmıştır. Sonuç olarak matematik ve bilim okullarının CEE (Orta ve Doğu Avrupa) ülkelerinde ekonomik büyümeyi pozitif yönde etkilediği ve çalışanların mesleki tecrübelerinin Batı Avrupa Ülkelerinde ekonomik büyümeyi pozitif yönde etkilediği sonuçlarına ulaşılmıştır.
Anahtar Kelimeler: Beşeri Sermaye, Ekonomik Büyüme, Avrupa Ülkeleri, CEECs, Panel Veri
JEL Sınıflandırması: F00, R1, E24, F43

1. Introduction

The educational structure of the European region differs according to the influence of the Soviet Union. Soviet domination mainly affected the countries of Central and Eastern Europe (CEECs) such as the economic, social, governance, and educational aspects of these countries. Contemporary European countries located to the west of Europe established their education system based on the need of industries. In these countries, the practical aspect of education comes to the fore. However, the education system in CEEC countries is heavily dependent on central government planning, these systems being almost far from meeting the demands of the market economy. Formal education which includes schools, hierarchical structures, and diplomas has mainly shaped the CEECs countries' educational system.

The objective of this study is to examine the effects of human capital on economic growth in European countries. European countries are held separately by groups from Western Europe (Germany, France, Netherlands, Denmark, and Italy) and Central and Eastern European Countries (CEECs) (Romania, Bulgaria, Hungary, Czech Republic, and Poland). Data is collected from the Global Competitiveness Report published by the World Economic Forum. The analysis covers the period from 2008 to 2017, and the assessment of panel data was used in the analysis process.

In general, knowledge capital originates from cognitive skills. Cognitive skills are mainly formed in schools and decently measured by the results of international math and science tests. Conversely, test results do not accurately measure the effect of cognitive skills on the labor market. Other factors impact skill development (Diebolt and Hippe 2018). Gundlach (1996) criticized human capital studies because they mainly used indicators of formal education. He argued that these indicators pose certain measurement problems when examining the effects of human capital on the economy and that to solve measurement problems, other human capital factors should be taken into account, such as the quality of education, workforce experience, health status, etc. In this regard, we established our model by adding education and training variables so the effects of human capital on economic growth are captured more accurately.

In the literature, studies that applied panel data approaches in examining the effects of human capital on growth are based on estimation of fixed effect (Pelinescu 2015; Tahir et al. 2020) and the

estimation of pooled panel data (Bassanini and Scarpetta 2001; Vinod and Kaushik 2007). These studies did not clarify the discrepancies in the basic assumptions in OLS such as autocorrelation and heteroskedasticity. In this study initially, we determine the fixed and random effects by using Hausman's test. After that, autocorrelation, heteroscedasticity, and correlation between unit tests were implemented. Finally, a robust estimation test was applied to achieve accurate results.

2. Theoretical View

Under the standard neoclassical production function with decreasing returns to capital, Solow (1956) considered savings and population growth rates as exogenous variables in the growth model. According to this model, savings and population growth rates determine the equilibrium level of per capita income. The levels of these variables differ from country to country and therefore, different countries reach different levels of steady-state. As a consequence, higher savings rates lead countries to be richer and higher population rates lead to countries being poorer. Mankiw et al. (1990) extended Solow's model by incorporating the accumulation of human capital in the same way as physical capital. They claimed that when the accumulation of human capital is added, higher savings or lower population growth lead to a higher level of income and a higher level of human capital. Therefore, physical capital and population growth have important income effects. Otherwise, human capital accumulation is probably correlated with savings rates and population growth rates. In this regard, human capital should be taken into account to overcome the gaps in the coefficients for estimating savings and population growth.

Mincer (1958) argued that education increases productivity, which can be observed by increasing wages. He further pointed out that wage rates and productivity levels differ from country to country due to the difference in the education and training of the countries' workforce. The growth of human capital increases the marginal product of physical capital which leads to further accumulation of physical capital, thereby increasing production and economic growth. Likewise, the accumulation of physical capital increases the marginal product of human capital. Hence, if human capital is more related to physical capital than to unskilled labor, this process increases the demand for skilled labor (human capital) than for unskilled labor.

In the recent growth literature, the importance of the accumulation of human capital comes to the fore in growth models. Becker (1962) reveal fundamental theory on human capital and he emphasis that investment in education is the main engine of long run growth. Lucas (1988) considered human capital as an input in the production process like other inputs. Human capital accumulation refers to the deepening of capital during the period of a new stable growth path of production. Romer (1990) and Aghion and Howitt (1992) shared the same view that human capital is essential for the discovery of new technologies and therefore, human capital is persistently associated with the growth rate of production.

Theoretically, human capital contributes to economic growth in two different ways. First, referred to as the level effect, human capital, can participate directly in the production process as a factor

of production. Thus, human capital plays a significant role in constituting production growth. Second, called the rate effect, human capital can be indirectly affected by economic growth. In this situation, while education facilitates innovation, diffusion, and adoption of new technologies, technical advances may have occurred (Freire-Seren 2001).

Nelson and Phelps (1966) discussed the effect of human capital on technological progress. They argued that investing in people through education is the definition of human capital and that human capital drives technological progress. In this sense, the accumulation of human capital has a more dynamic effect on technological progress than the accumulation of tangible capital. Collin and Weil (2018) suggested that increasing investment in human capital can be an effective policy argument for increasing income and reducing poverty. However, the time dimension is important because it takes a long time to obtain the benefits of human capital, which requires upgrading the skills of the workforce through education and training over a long period. They found that the output growth response is more sensitive to investment in physical capital than to invest in human capital. Investing in physical capital brings growth benefits faster than investing in human capital. On the other hand, the costs of these types of investments differ. Investing in human capital costs less than investing in physical capital.

3. Literature Review

From a theoretical point of view, human capital plays a crucial role in the growth process, because developed countries also have a high accumulation of human capital. However, the empirical evidence is unclear. Results are varying in terms of the variables used and the methods applied. Studies that examined the effect of human capital on growth for a group of countries have primarily used the pooled panel data methodology. Bassanini and Scarpetta (2001) and Awad (2020) used the Pooled Mean Group (PMG) estimation that allows short-run coefficients, error variances, and speed of adjustment to differ from country to country.

The PMG estimator increases the efficiency of the estimates compared to the estimators of the Mean Group (MG) under long-term homogeneity (Pesaran et al. 1999). Vinod and Kaushik (2007) implemented an estimation of pooled panel data and found significant heteroskedasticity and correlation between countries. Pelinescu (2015) used a pooled least squares model with fixed effects in terms of national and specific changes during different periods affecting the relationship between indicators. However, Bassanini and Scarpetta (2001), Vinod and Kaushik (2007) and Pelinescu (2015) did not specify the robustness of the results. Tahir et al. (2020) applied Hausman's test to determine fixed or random effects and they used the fixed-effect (FE) procedure in processing panel data. They applied the FE estimation to control for the serial correlation and White Robust estimation to tackle the heteroscedasticity problem. Additionally, the panel co-integration process was implemented by Mehrara and Musai (2013), and Akpolat (2014) in examining the relationship between human capital and economic growth.

In the literature, different explanatory variables are considered as representative of human capital. Freire-Seren (2001) used the level of education of the population aged 25 and over, the average number of years education, Pelinescu (2015) used education expenditure in GDP, number of employees with secondary education, number of patents, Vinod and Kaushik (2007) used the percentage of literate adults, Akpolat (2014) implemented education expenditure and life expectancy at birth, Bassanini and Scarpetta (2001) used the average number of years of formal education of the working-age population, Diebolt and Hippe (2018) considered literacy and numeracy for human capital, patent applications per million inhabitants for innovation, Mehrara and Musai (2013) used the enrollment rate at all levels of education, public spending education in relation to total public expenditure, Tahir et al. (2020) used human capital in two aspects. One is the human capital index which derives from years of schooling and returns to education and the other is the annual average of hours worked by full-time employees.

Most of the studies reported a positive effect from human capital on economic growth. Benhabib and Spiegel (1994) estimated per capita growth rates using physical and human capital in the aggregate Cobb-Douglas production function, but they did not find a significant effect. They specified another model which is the rate of growth of total factor productivity linked to the level of the stock of human capital. Then, they concluded a positive effect from human capital on economic development.

Freire-Seren (2001) studied three groups (oil producers, small countries, OECD countries) of countries and found that education has a level effect on growth and that production has a positive effect on the accumulation of human capital. Pelinescu (2015) analyzed the impact of the number of patents and secondary education on economic growth in EU countries and found a positive effect. However, expenditure on education has a negative effect on growth. Vinod and Kaushik (2007) focused on the study on developing countries and found that human capital has a significant positive effect on economic growth. Akpolat (2014) examined the long-run effect of physical capital and human capital on economic growth in developed and developing countries. He concluded that in developed countries the effect of physical capital and education expenditures on GDP is higher than that in developing countries. In addition, the effect of life expectancy at birth on GDP is much higher in developing countries.

Bassanini and Scarpetta (2001) focused on 21 OECD countries and found that human capital accumulation has a positive and significant effect on the growth of output per capita. Similar results were obtained by Ogbeifun and Shobande (2021). They found that human capital, the savings rate, and the openness of trade play a vital role in OECD countries' economic growth. Diebolt and Hippe (2018) examined the European regions and found that the historical human capital formation is significantly related to recent economic welfare in the European regions.

Mehrara and Musai (2013) investigated developing countries and concluded that there is a long-run relationship between human capital and GDP. In addition, there is a one-way causality between GDP and investment and human capital. Awad (2020) investigated the influence

of human capital on the economic growth of countries in the Middle East and North Africa (MENA). He finds that education has a positive long-term effect and that health has a positive short-term effect on economic growth. Tahir et al. (2020) examined the OECD countries and found that the human capital index has a negative significant effect on economic growth. They linked this result to the findings of Pelinescu (2015) that heterogeneity between countries might be the reason for this conclusion. Another aspect of human capital, the average working time has a positive but with no significant effect on growth.

4. Data and Methodology

The data of human capital are collected from The Global Competitiveness Report published by the World Economic Forum. The WEF collected the data by using survey methodology. These data are treated as the independent variables and they consist of quality of the education system (EDU), quality of schools of mathematics and science (QMS), local availability of research and training services (LOA), and extent of staff training variables (EST). Dependent variable is GDP per capita growth (GDPG) obtained from the World Bank Data Base. Data are collected separately for Western European countries (Germany, France, Netherlands, Denmark, and Italy) and CEEC groups (Romania, Bulgaria, Hungary, Czech Republic, and Poland). The data are in an annual frequency ranging from the year 2008 to 2017. The period is limited due to a lack of data because after 2017 the content of the Global Competitiveness Report does not include this data.

In accordance with the theoretical perspective, it is expected that human capital affects growth positively. Thereby, the model of the study established as Equation (1)

$$GDPG_{it} = \beta_0 + \beta_1 EDU_{it} + \beta_2 QMS_{it} + \beta_3 LOA_{it} + \beta_4 EST_{it} + u_{it} \quad (1)$$

Balance panel data set was used in the analysis process which implies that all year's data have been acquired for each country. There is no missing data. In the Equation (1) I symbolizes country and t symbolizes time; for developed EU countries, i=1-5 (5 countries) and t=2008-2017 (10 years), total number of observations in data set (i x t = 50); for developing EU countries, i=1-5 (5 countries) and t=2008-2017 (10 years) total number of observations in data set (i x t = 50).

5. Analysis Process

To assess the stationary properties of the variables we use ADF unit root test. The unit root test results shown in Table 1.

Table 1: Unit Root Test Results

Variable	ADF – t statistics Levels	ADF – t statistics First differences
GDPG	-1.192 (1)	-4.770 (1)***
EDU	-2.184 (1)***	
EST	-3.265 (1)***	
QUA	-1.820 (1)***	
LOC	-2.791 (1)***	

Notes: Lag lengths are determined by SIC and are in parentheses, ***,**,* denote significance at 10, 5 and 1% levels, respectively.

It is clear from Table 1 that quality of the education system (EDU), extent of staff training (EST), quality of schools of mathematics and science (QUA), local availability of research and training services (LOA) are *I(0)* and GDP per capita growth (GDPG) is *I(1)*.

Equation (1) is estimated separately for Western European and CEECs countries. If the data are homogenous, pooled OLS method is applicable in estimating Equation (1). If the data exhibit cross-section and/or time effects, fixed-effects or random-effects models can be applied (Yerdelen Tatoğlu 2012). The likelihood ratio (LR) test was used to test for the existence of cross-section and time effects. In the LR test, it is determined whether the variance of standard error of cross-section effect and the variance of time effect are equal to zero (H_0: $\sigma\mu = 0$; H_0: $\sigma\lambda = 0$). If unit and time effects are not specified in the LR test, then pooled OLS model can be established.

Table 2: LR Test

	Western EU Countries	CEECs
Cross-section Effect	χ^2 0.00 *prob.* 1.000	χ^2 0.00 *prob.* 1.000
Time Effect	χ^2 45.03 *prob.* 0.000	χ^2 16.20 *prob.* 0.000

From the results reported in Table 2, the LR test fails to reject the null hypothesis of the existence of cross-section effect but rejects the null hypothesis of the existence of time effect. This result holds for both groups of countries. Hence, there is only a time effect should be included in the estimation function. The Hausman test is implemented to specify whether the time effect is fixed or random.

The Hausman test indicates that both fixed effects and random effects estimators are appropriate if there is no correlation between error components (u_i) and explanatory variables (x_{kit}). However, a random effects estimator is inappropriate if there is a correlation between error components and explanatory variables. In the Hausman test, the null hypothesis infers that there is no correlation between error components and explanatory variables (Hill et al. 2011). It can be said that random effects are appropriate if there is no correlation between u_i and x_{kit}, and fixed effects are appropriate when there is a correlation between u_i and x_{kit} (Gujarati 2003).

Table 3: Hausman Test

Western EU Countries	CEECs
χ^2 1.57 *prob.* 0.81	χ^2 0.18 *prob.* 0.99

In Table 3, the results of the Hausman test indicate that the time effect is random for the two models. Thereby, analysis is made with a one-sided random effect model for both models.

Then, the models are examined in the context of deviations from the basic assumptions. The Levene, Brown and Forsythe test is used to determine heteroskedasticity, Modified Bhargava et al. Durbin-Watson test, and Baltagi-Wu LBI test are implemented to specify autocorrelation and finally, Pesaran test is used to identify the correlation between units.

Table 4: Tests of Deviation from Assumptions

	Western EU Countries	CEECs
Levene, Brown and Forsythe Test	W_0 0.990 *prob.* 0.42 W_{50} 0.804 *prob.* 0.52 W_{10} 0.868 *prob.* 0.48	W_0 0.997 *prob.* 0.41 W_{50} 0.853 *prob.* 0.49 W_{10} 0.993 *prob.* 0.42
Modified Bhargava et al. Durbin-Watson Test and Baltagi-Wu LBI Test	2.044 2.105	1.854 2.143
Pesaran Test	Cross. Sect. Indep. 28.331 *prob.* 0.000	Cross. Sect. Indep. 5.371 *prob.* 0.000

According to the results represented in Table 4, there are no heteroscedasticity and autocorrelation issues for the two models. However, it can be seen that there is a correlation between the units. Parks-Kmenta estimator is used to resolving the correlation between units.

6. Analysis Results

Parks-Kmenta estimator is used to resolving the correlation between units. Table 5 represents the results of this process.

Table 5: Analysis Results

	Western EU Countries			CEECs		
Explanatory Variables	**Coef.**	**z-stat**	**p-value**	**Coef.**	**z-stat**	**p-value**
EDU	-1.8537	-2.90	0.004***	-1.9060	-2.76	0.006***
QMS	-0.7532	-1.50	0.133	0.9084	1.67	0.009***
LOA	2.3265	2.93	0.003***	1.1638	2.74	0.006***
EST	1.2104	2.89	0.004***	-1.0336	-1.21	0.228
Wald χ^2	*25.42*			*43.95*		
prob.	*0.000*			*0.000*		

Note: significance at (***) %1, (**) %5, (*) %10.

According to the results of the analysis for Western European countries, EDU negatively and statistically significantly affects GDP. The 1% increase in EDU results in a 1.8% decrease in GDP. LOA and EST have a positive and statistically significant effect on GDP. It can be concluded that a unit increase in LOA leads to an increase of %2.3 in GDP and a unit increase in EST leads to an increase of 1.2% of the GDP. However, QMS has a statistically insignificant effect on GDP.

The results for CEE countries show that EDU has a statistically significant and negative impact on GDP. A unit increase in EDU causes a decline of 1.9% of GDP. QMS and LOA affect GDP positively and this effect is statistically significant. A unit increase in QMS leads to an increase in GDP of 0.9%, and an increase in LOA leads to an increase in GDP of 1.1%. However, EST has a statistically insignificant effect on GDP.

The results show that the quality of the education system has a negative and statistically significant effect on economic growth in both Western Europe and the CEECs. A possible explanation can be put forward that the efforts and expenditures devoted to improving the quality of the education system do not correspond exactly to the requirements of economic growth. It can be said that the structure of the education system is not related to the production side of the economies of EU countries. This result could be related to high expenditure to invest in education expenditure, causing higher cost relative to output.

The local availability of research and training services has a positive and statistically significant effect on the economic growth of all Western European and CEEC countries. This result implies that the framework of research and training services leads to the enhancement of the productivity of human capital for these groups of countries. However, Local availability of research and training services contribute to much more positive effect in Western European Countries than CEECs countries. The possible reason might be due to the availability of institutional and opportunities of educational and training in Western European countries than in CEECs countries.

For Western European countries, the quality of mathematics and science schools has no statistically significant effect on economic growth. However, this observation is contrary to the CEECs that this variable positively affects economic growth. This result can be explained by different implications for the education system in Western Europe and in the CEECs. The extent of staff training has a positive and significant effect on economic growth in Western European countries, but there is no significant effect for CEECs. It can be said that staff training services are more effective in Western European countries than in CEECs.

When we compare the education systems of these two groups of countries, the educational experiences are different from each other. After the industrial revolution, the countries of Western Europe for the most part based their education systems on the training process and governments oriented their citizens towards jobs in which they have more productive jobs. However, the Soviet domination affected the education system of the CEECs as the system depended mainly on central planning and was insufficient to meet the demands of the market. Formal education stands out in those countries which include schools, hierarchical structures, and degrees. Therefore, the

effects of human capital on economic growth differ in the European region depending on the educational experiences and implications of these countries.

7. Conclusion

From a theoretical point of view, human capital is mainly considered as an important factor in contributing to economic growth. This process occurs because human capital leads to the improvement of education, training, and the discovery of new technologies. We used human capital in the model on both the education and training side for Western European countries and CEECs during the period 2008-2017. The results revealed that both quality of Mathematics and science and the local availability of research and training services contribute positively to the GDP growth in the developing CEE countries. On the other hand, the local availability of research and training services and extent of staff training stimulates GDP growth in the developed Western European countries. The quality of mathematics and science does not have significant contribution to growth in the Western European countries. However, the quality of educational system adversely deteriorates GDP growth in both groups of countries. The differences of results might be due to the different educational system, funding availability, educational cost and opportunities in both groups of countries. In terms of policy implication and implementation through human capital to foster economic growth, our recommendations are as follows:

The combination of education expenditure could be reconsidered in the context of the qualification of lecturers who are well educated in their fields. To lead these highly qualified individuals from the private sector to the education system, high wage policy implementation could be used for all country groups. After then education expenditure might have improved the quality of education structure and this variable could have a positive effect in Western European and CEECs countries.

When we considered that the effect of the quality of math and science schools on economic growth, it can be seen that contemporary Western European countries do not have a goal about the inducement of students to the production side of the economy. However, after the school term, these countries have had success to lead the individuals to the staff training process to adopt them to be more productive in the economy. Conversely, the CEECs countries could have allocated a more budget to extent of staff training to enhance labor productivity. To enhance the effect of local availability of research and training services in the CEECs countries, governments could have spread these services across the country. After then individuals will have more opportunities to reach the research and training services that they could have contributed to the production side of the economy. In accordance to resolve the human capital differences between Western Union and CEECs countries, European Union could have focused on to financing the CEECs countries' training service infrastructure.

This study has revealed the new findings on the different effects of human capital factors in the developing versus developed European countries in enhancing economic growth. However, it

should be noted that many educated people, especially in mathematics and engineering, have moved from the CEEC countries, as well as other less developed countries, to the countries of Western Europe. The study can be extended to test other human-related factors such as technology/knowledge transfer, the effectiveness of policy to attract the migration of professional/skillful workers, etc. This study does not cover these factors due to the data availability constraint.

References

Aghion, P. and Howitt, P. (1998). *Endogenous growth theory.* The MIT Press, Cambridge, MA.

Akpolat, A. G. (2014). The long-term impact of human capital investment on GDP: a panel cointegrated regression analysis. *Economics Research International*, 2014 :1-10.

Awad, A. (2020). Which contributes more to economic growth in the Mena region: health or education? An empirical investigation. *Journal of the Knowledge Economy*, *12*: 1119-1133.

Bassanini, A. and Scarpetta, S. (2001). Does human capital matter for growth in OECD countries? evidence from pooled mean-group estimates. OECD *Economics Department Working Papers,* No. 282 :1-30.

Becker, G. S. (1962). Investment in human capital: A theoretical analysis. *Journal of Political Economy*, 70 :9-49.

Benhabib, J. and Spiegel, M. M. (1994). The role of human capital in economic development evidence from aggregate cross-country data. *Journal of Monetary Economics*, *34* (2): 143-173.

Collin, M. and Weil, D. (2018). The effect of increasing human capital investment on economic growth and poverty. *World Bank, Policy Research Working Paper*, No. 8590 :1-28.

Diebolt, C. and Hippe, R. (2018). The long-run impact of human capital on innovation and economic development in the regions of Europe. *Applied Economics, 51* (5):1-22.

Freire-Seren, M. J. (2001). Human capital accumulation and economic growth. *Investigaciones Economicas, 25* (3): 585-602.

Gujarati, D.N. (2003). *Basic econometrics*. Fourth Edition. McGraw-Hill. USA

Gundlach, E. (1996). Human capital and economic development: a macroeconomic assessment. *Kiel Working Paper*, No. 778 :1-43.

Hill, R.C., Griffiths, W.E. and Lim, G.C. (2011). *Principles of econometrics*. Fourth Edition. Wiley. USA

Lucas, R.E. (1988). On the mechanics of economic development. *Journal of Monetary Economics*, *22* :3-42.

Mankiw, N. G.; Romer, D. and Weil, D. N. (1990). A contribution to the empirics of economic growth. *NBER Working Paper Series* No. 3541 :1-45.

Mehrara, M. and Musai, M. (2013). The relationship between economic growth and human capital in developing countries. *International Letters of Social and Humanistic Sciences*, *5* :55-62.

Mincer, J. (1958). Investment in human capital and personal income distribution. *Journal of Political Economy*, 66 (4): 281-302.

Nelson, R. R. and Phelps, E. S. (1966). Investment in humans, technological diffusion, and economic growth. *The American Economic Review, 56* (½): 69-75.

Ogbeifun, L. and Shobande, O. A. (2021). A reevaluation of human capital accumulation and economic growth in OECD. *Journal of Public Affairs*

Pelinescu, E. (2015). The impact of human capital on economic growth. *Procedia Economics and Finance*, *22* :184-90.

Pesaran, M.H., Shin Y. and Smith R. (1999). Pooled Mean Group estimation of dynamic heterogeneous panels. *Journal of the American Statistical Association*, *94* :621-634

Romer, P. (1990). Human capital and growth: theory and evidence. *NBER Working Paper*, 3173.

Solow, R. M. (1956). A Contribution to the theory of economic growth, *The Quarterly Journal of Economics*, *70* (1): 65-94.

Tahir, M.; Hayat, A., Rashid K., Afridi, M. A. and Taiq, Y. B. (2020). Human capital and economic growth in OECD countries: some new insights. *Journal of Economic and Administrative Sciences*, *36* (4): 367-380.

Vinod, H. D. and Kaushik, S. (2007). Human capital and economic growth: evidence from developing countries. *The American Economist*, *51* (1): 29-39.

Yerdelen Tatoğlu, F. (2012). *Panel veri ekonometrisi: stata uygulamalı*. İstanbul. 1. Baskı. Beta Yayınları.