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The Effect of Human Capital on Economic Growth: A Panel Data Analysis

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Abstract
We examine the empirical relationship between human capital and economic growth in a panel of 65 countries covering 1967 through 2011. For this purpose, index of human capital per person based on years of schooling and returns to education and mortality rate infant (per 1,000 live births) which are regarded as main components of human capital in economic literature and GDP per capita (constant 2005 US$) as a proxy for economic growth have been utilized. In this context, firstly, countries are classified by using K-means clustering procedure. Then, all clusters are analyzed by panel data analysis. Estimate for the coefficient education and health shows that the effect of human capital on economic growth is positive and statistically significant in developing countries.
Keywords: *Economic Growth, Human Capital, Panel Data Analysis*
JEL Codes: *047, O15, C23*

Beşeri Sermayenin Ekonomik Büyümeye Etkisi: Panel Veri Analizi

Abstract
Bu çalışmada beşeri sermaye ile ekonomik büyüme arasındaki ampirik ilişki 65 ülke için 1967-2011 dönemini kapsayacak şekilde analiz edilmiştir. Bu amaçla, ekonomi literatüründe beşeri sermayenin ana belirleyicileri olarak gösterilen eğitim (beşeri sermaye endeksi) ve sağlık (yetişkinlerde ölüm oranı) modele ayrı ayrı dâhil edilmiş, ekonomik büyümenin göstergesi olarak ise kişi başına GSYH kullanılmıştır. Bu bağlamda, ilk olarak, 65 ülke 2011 yılı kişi başına GSYH (2005 sabit fiyatlarla Amerikan Doları) değerleri ile 3 gruba ayrılmıştır. Ardından, bütün kümeler ayrı ayrı panel veri yöntemi ile analiz edilmiştir.
Eğitim ve sağlık değişkenleri için elde edilen katsayılar beşeri sermaye-

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nin ekonomik büyüme üzerindeki etkisinin gelişmekte olan ülkeler için pozitif ve istatistiki olarak anlamlı olduğunu göstermiştir.
Anahtar Kelimeler: *Ekonomik Büyüme, Beşeri Sermaye, Panel Veri Analizi*

1. INTRODUCTION

Neoclassical growth theory of Solow[1] and Swan[2] has been built on aggregate production function of the form $Y = F(K, L, A)$ where Y is output, K is physical capital, L is labor and A is an index of technology or efficiency. The neoclassical growth theory assumes the rate of technological progress to be determined by a scientific process that is separate from economic forces. Hence, theory implies that economists can take the long-run growth rate as given exogenously from outside the economic system. However, the exogeneity of technological progress in the neoclassical growth model and the difficulty of explaining long-term economic growth have restricted the analytical capacity of the neoclassical model and its empirical verification. This problem is solved by endogenous growth models giving emphasis on human capital accumulation. In other words, endogenous growth theory challenges neoclassical growth theory and attempts to endogenize the sources of growth, so that the rate of economic growth would be determined within the model. In this model economic actors can influence long-run rate of economic growth. Thus, endogenous growth literature emphasize the role of human capital in the process of economic growth, innovation and adoption of new technologies. From that day to this, the relationship between human capital and economic growth has been started to be discussed among economists[3].

Human capital was generally defined into five categories: (1) health facilities and services; (2) on-the-job training; (3) formally organized education at the elementary, secondary and higher levels; (4) study programs for adults; (5) migration of individuals and families to adjust to changing job opportunities[4]. In other words, the concept of human capital refers to the abilities and skills of human resources of countries, while human capital formation refers to the process of acquiring and increasing the number of

1 Robert Solow, 'A Contribution to the Theory of Economic Growth', The Quarterly Journal of Economics, Vol. 70, No.1, 1956, s. 65-94.

2 Trevor Swan, 'Economic Growth and Capital Accumulation', Economic Record, Vol. 32, 1956, s. 334-361.

3 Florian Schütt, 'The Importance of Human Capital for Economic Growth', Institute for World Economics and International Management, Vol. 27, 2003.

4 Theodore Schultz, 'Investment in Human Capital', The American Economic Review, Vol. 51, No. 1, 1961, s.1-17.

people who have the skills, good health, education and experience that are critical for economic growth. Thus, investment in education and health are considered as human capital components[5].

Human capital affects growth through two mechanisms. Firstly, human capital directly participate in production as a productive factor. In this sense, the accumulation of human capital would directly generate the growth of output. This is level effect. Secondly, human capital can contribute to raising technical progress. In this way, the level of human capital affects productivity growth. This is rate effect[6].

The main objective of this study is to examine relationship between human capital and economic growth. For this purpose, this paper is organized as follows. The next section discusses theoretical framework showing how human capital has impact on economic growth. Section 3 presents empirical literature related to relationship between human capital and economic growth. Section 4 describes data and presents empirical results. Section 5 concludes.

2. THEORETICAL BASELINE

In this section, the theoretical model, human capital augmented Solow model, will be derived. Starting from the Solow model, the simplest way to introduce human capital as a separate input is the one developed by Mankiw, Romer and Weil[7]. They expanded the Solow model to include human capital. Thus, the production function in this model takes the form[8]:

$$Y_t = K_t^{\alpha} H_t^{\beta} (A_t L_t)^{1-\alpha-\beta} \tag{1}$$

where Y is output or gross domestic product, K is physical capital, L is labor, H is the stock of human capital and A is the level of technology. L and A are assumed to grow exogenously at rats n and g:

$$L_t = L(0)e^{nt} \tag{2}$$

$$A_t = A(0)e^{gt} \tag{3}$$

5 Sushil K. Haldar and Girijasankar Mallik, 'Does Human Capital Cause Economic Growth? A Case of India', International Journal of Economic Sciences and Applied Research', Vol. 3, No. 1, 2010, s. 7-25.

6 Maria J. Freire Seren, 'Human Capital Accumulation and Economic Growth', Investigaciones Economicas, Vol. 25, No. 3, 2001, s. 585-602.

7 Gregory Mankiw, David Romer and David Weil, 'A Contribution to the Empirics of Economic Growth', The Quarterly Journal of Economics, Vol. 107, No. 2, 1992, s.407.437.

8 This part of study was arranged by Mankiw, Romer and Weil (1992) and Schütt' s (2003) works.

Rewriting equation (1) in intensive form (units of effective labor) yields:

$$\hat{y}_t = \hat{k}_t^{\alpha}\, \hat{h}_t^{\beta} \quad \alpha + \beta < 1 \tag{4}$$

where $\hat{y} = Y/AL\,, \hat{k} = K/AL \; and \; \hat{h} = H/AL$ are quantities per effective unit of labor. Mankiw, Romer and Weil[9] assume that $\alpha + \beta < 1$ which implies that there are decreasing returns to scale in the reproducible factors. In addition to this, s_k is the fraction of income invested in physical capital and s_h is the fraction of income invested in human capital. Human capital depreciates at the same constant rate δ as a physical capital. One unit of consumption can be transformed costlessly into either one unit of physical capital or one unit of human capital. The time path of k and h is described by

$$\dot{\hat{k}}_t = s_k y_t - (n + g + \delta)\hat{k}_t = s_k \hat{k}_t^{\alpha}\, \hat{h}_t^{\beta} - (n + g + \delta)\hat{k}_t \tag{5}$$

$$\dot{\hat{h}}_t = s_h y_t - (n + g + \delta)\hat{h}_t = s_h \hat{k}_t^{\alpha}\, \hat{h}_t^{\beta} - (n + g + \delta)\hat{h}_t \tag{6}$$

Equation (5) and (6) imply that the economy converges to a steady state defined by

$$\hat{k}^* = \left(\frac{s_k^{1-\beta} s_h^{\beta}}{n + g + \delta} \right)^{1/(1-\alpha-\beta)} \tag{7}$$

$$\hat{h}^* = \left(\frac{s_k^{\alpha} s_h^{1-\alpha}}{n + g + \delta} \right)^{1/(1-\alpha-\beta)} \tag{8}$$

Substituting (7) and (8) into the production function and taking logs gives an equation for income per capita:

$$ln\left[\frac{Y_t}{L_t}\right] = lnA(0) + gt - \frac{\alpha + \beta}{1 - \alpha - \beta}\ln(n + g + \delta) + \frac{\alpha}{1 - \alpha - \beta}\ln(s_k) + \frac{\beta}{1 - \alpha - \beta}\ln(s_h)$$

Equation (9) shows how income per capita depends on population growth and accumulation of physical and human capital. Besides that, as the steady state equations (7) and (8) indicate, the level of steady state income per capita is positively related to the rates of investment in physical capital and human capital and negatively related to the rate of population growth. Therefore, an increase in the fraction of income devoted to the accumulation of human capital shifts the steady state level of income upwards and leading to a higher long run growth path[10].

9 Gregory Mankiw, David Romer and David Weil, 'A Contribution to the Empirics of Economic Growth', The Quarterly Journal of Economics, Vol. 107, No. 2, 1992, s.407.437.

10 Florian Schütt, 'The Importance of Human Capital for Economic Growth', Institute for World Economics and International Management, Vol. 27, 2003.

3. LITERATURE

The effect of human capital on economic growth has been debated since 1980 in terms of endogenous growth models developed by Romer, Lucas and Barro. From that day to this, series of empirical studies have been conducted by economists. In this section, we will focus on these studies analyzing quantative relationship and interaction between human capital and economic growth. For this purpose, firstly, we will present the summary of empirical literature related to this field in Table 1, then discuss the details of these studies.

Table 1: Summary of Empirical Literature

Author(s)	Country	Period	Result(s)
Romer[11]	112 Countries	1960-1985	↑ HC >>GRO ↑
Benhabib and Spiegel[12]	78 Countries	1965-1985	↑ HC>>GRO ↑
Freire-Seren[13]	72, 65 and 22 Countries	1960-1990	↑ GRO >>HC ↑
Ljunberg and Nilsson[14]	Sweden	1870-2000	↑ HC>>GRO ↑
Aka and Dumont[15]	USA	1929-1996	HC>>GRO
Ramos, Surinach and Artis[16]	229 and 190 Regions in EU	1995-2000 2000-2005	↑ HC>>GRO ↑
Haldar and Mallik[17]	India	1960-2006	↑ HC>>GRO ↑
Yaylalı and Lebe[18]	Turkey	1938-2007	↑ HC>>GRO ↑
Koç[19]	27 EU Countries	2012	↑ HC>>GRO ↑

11 Paul Romer, 'Human Capital and Growth: Theory and Evidence', NBER Working Paper Series, No. 3173, 1989, s.1-41.

12 Jess Benhabib and Mark Spiegel, 'The Role of Human Capital in Economic Development Evidence from Aggregate Cross-Country Data', Journal of Monetary Economics, No. 34, 1994, s.143-173.

13 Maria J. Freire Seren, 'Human Capital Accumulation and Economic Growth', Investigaciones Economicas, Vol. 25, No. 3, 2001, s. 585-602.

14 Jonas Ljunberg and Anders Nilsson, 'Human Capital and Economic Growth: Sweden 1870-2000', Journal of Historical Economics and Econometric History, Vol. 3, No. 1, 2009, s. 71-95.

15 Bedia Aka and Jean C. Dumont, 'Health Education and Economic Growth: Testing for Long Run Relationships and Causal Links', Applied Econometrics and International Development, Vol. 8, No. 2, 2008, s. 101-113.

16 Raul Ramos, Jordi Surinach and Manuel Artis, 'Regional Economic Growth and Human Capital: The Role of Overeducation', The Institute for the Study of Labor Discussion Paper Series, No. 4453, 2009.

17 Sushil K. Haldar and Girijasankar Mallik, 'Does Human Capital Cause Economic Growth? A Case of India', International Journal of Economic Sciences and Applied Research', Vol. 3, No. 1, 2010, s. 7-25.

18 Muammer Yaylalı and Fuat Lebe, ' Beşeri Sermaye ile İktisadi Büyüme Arasındaki İlişkinin Ampirik Analizi', Vol. 30, No. 1, 2011, s. 23-51.

19 Aylin Koç, 'Beşeri Sermaye ve Ekonomik Büyüme İlişkisi: Yatay Kesit Analizi ile AB Ülkeleri Üzerine Bir Değerlendirme', Maliye Dergisi, No. 165, 2013, s.241-285.

Romer[20] investigates theoretical framework for thinking about the role of human capital in a model of endogenous growth. The empirical findings show that initial level of literacy effects the subsequent rate of investment and indirectly the rate of growth. Benhabib and Spiegel[21] examine impact of human capital on the growth of total factor productivity and obtain positive link. In this model, human capital affects growth through two mechanisms. Firstly, human capital levels directly influence the rate of domestically produced technological innovation. Second, human capital stock affects the speed of adoption of technology from abroad. Freire-Seren[22] analyze the empirical link between human capital and economic growth across countries. This estimation concludes that the level of income has a positive and significant effect on the process of human capital accumulation. Ljunberg and Nilsson[23] suggest that human capital due to education was a driving cause in the late 19th and early 20th century and after WWII for Sweden. On the other hand, higher education is often a result of economic growth. In addition to this, Aka and Dumont[24] examine the causal relationship between human capital (education and health) and economic growth for USA over the period 1929-1996. The results show bi-directional causality between human capital variables and economic growth. Ramos, Surinach and Artis[25] analyze link between human capital and regional economic growth in the European Union. They conclude that the recent economic performance of European regions is associated with an increase in overeducation. In addition to this, Haldar and Mallik[26] investigate behavior of investment in physical capital, human capital and output. The results suggest that physical capital investment has no long-run nor short-run effect but human capital investment has significant

20 Paul Romer, 'Human Capital and Growth: Theory and Evidence', NBER Working Paper Series, No. 3173, 1989, s.1-41.

21 Jess Benhabib and Mark Spiegel, 'The Role of Human Capital in Economic Development Evidence from Aggregate Cross-Country Data', Journal of Monetary Economics, No. 34, 1994, s.143-173.

22 Maria J. Freire Seren, 'Human Capital Accumulation and Economic Growth', Investigaciones Economicas, Vol. 25, No. 3, 2001, s. 585-602.

23 Jonas Ljunberg and Anders Nilsson, 'Human Capital and Economic Growth: Sweden 1870-2000', Journal of Historical Economics and Econometric History, Vol. 3, No. 1, 2009, s. 71-95

24 Bedia Aka and Jean C. Dumont, 'Health Education and Economic Growth: Testing for Long Run Relationships and Causal Links', Applied Econometrics and International Development, Vol. 8, No. 2, 2008, s. 101-113.

25 Raul Ramos, Jordi Surinach and Manuel Artis, 'Regional Economic Growth and Human Capital: The Role of Overeducation', The Institute for the Study of Labor Discussion Paper Series, No. 4453, 2009.

26 Sushil K. Haldar and Girijasankar Mallik, 'Does Human Capital Cause Economic Growth? A Case of India', International Journal of Economic Sciences and Applied Research', Vol. 3, No. 1, 2010, s. 7-25.

long-run effect on per capita GNP. Yaylalı and Lebe[27] analyze quantative relationship between economic growth and education as a component of human capital by using annual data including years between 1938 and 2007. Their investigations show that there is a log-term relationship and bi-directional causality between education and economic growth. Koç[@] investigate the impact of human capital on economic growth for 27 EU countries and find that human capital has statistically significant and positive effect on economic growth.

4. EMPIRICAL ANALYSIS

We examine the empirical relationship between human capital and economic growth in a panel of 65 countries covering 1967 through 2011. Specifically, we consider the following empirical model:

$$LOGGDPPER_{it} = \beta_{1i} + \beta_{2i}LOGEDU_{it} + \beta_{3i}LOGMORT_{it} + u_{it}$$

where LOGGDPPER is GDP per capita (constant 2005 US$) as a proxy for economic growth, LOGEDU is index of human capital per person based on years of schooling and returns to education as a proxy for education collected from Penn World Table and LOGMORT is mortality rate, infant (per 1,000 live births) representing health. All the variables appear in logarithmic form.

Due to the fact that we are interested in estimating the effect of human capital on economic growth, first of all, all countries will be divided into subgroups by using clustering analysis.

4.1. Clustering Analysis

Purpose of clustering analysis is to group objects (countries) based on the characteristics they possess and if clustering is successful, object (countries) within clusters will be close together and different clusters will be far apart. In this method, the requirements of normality, linearity and homoscedasticity which are so crucial in other methods really have little bearing on clustering analysis[28].

There are two major clustering methods in the literature: Hierarchical clustering method and nonhierarchical clustering methods. Hierarchical

27 Muammer Yaylalı and Fuat Lebe, ' Beşeri Sermaye ile İktisadi Büyüme Arasındaki İlişkinin Ampirik Analizi', Vol. 30, No. 1, 2011, s. 23-51.

28 Joseph Hair et al., Multivariate Data Analysis, (New Jersey: Prentice Hall, 1995).

clustering techniques proceed by either a series of successive mergers or a series of successive divisions. On the other hand, nonhierarchical methods start from either an initial partition of items into groups or an initial set of seed points which will form the nuclei of clusters. These procedures also frequently referred to as K-means clustering. K-means method is the most popular nonhierarchical procedures. The number of clusters must be defined in advance in K-means clustering procedure. Criteria for K-means is to minimize within cluster sum of squares[29]. In this study, K-means clustering procedure were utilized and the results were reported in Table 2.

Table 2: *Results of Clustering Analysis*

Cluster 1		**Cluster 2**		**Cluster 3**	
Australia	Austria	Botswana	Brazil	Bangladesh	Benin
Belgium	Barbados	Chile	Colombia	Bolivia	Burundi
Canada	Denmark	Congo Rep.	Costa Rica	Cameroon	Cent. Afr.
Finland	France	Dom. Rep.	Ecuador	Cote d'Ivoire	Ghana
Greece	Iceland	Fiji	Guatemala	India	Kenya
Italy	Japan	Honduras	Malaysia	Lesotho	Malawi
Korea Rep.	Luxembourg	Mexico	Panama	Mauritania	Nepal
Netherlands	Norway	Peru	Sri Lanka	Niger	Pakistan
Portugal	Singapore	Turkey	Uruguay	Philippines	Rwanda
Spain	Sweden	Venezuela		Senegal	Sierra Leo.
UK	Tri. Tob.			Togo	Zambia
USA				Zimbabwe	
23 Countries		**19 Countries**		**23 Countries**	
Total: 65 Countries					

Note: Country membership is classified based on GDP per capita (constant 2005 US Dollar) in 2011.

The results show that cluster 1 consists of 23 developed countries like Australia, Norway, Denmark, and Sweden. On the other hand, while cluster 2 consists of 19 developing countries such as Turkey, Uruguay and Brazil, cluster 3 consists of 23 less developed countries like Senegal, Benin, Zimbabwe, Niger and Rwanda. Thereby, it can be concluded that result of clustering analysis is successful to satisfy and present real world scene. Thus, our models take the form:

29 Richard Johnson and Dean Wichern, Applied Multivariate Statistical Analysis, (New Jersey: Prentice Hall, 2007) Seyed Mohammadi and Boddupalli Prasanna, 'Analysis of Genetic Diversity in Crop Plants Salient Statistical Tools and Considerations' Crop Science, No. 43, 2003, s.1235-1248.

$$LOGGDPPER1_{it} = \beta_{1i} + \beta_{2i}LOGEDU1_{it} + \beta_{3i}LOGMORT1_{it} + u1_{it} \quad (11)$$

$$LOGGDPPER2_{it} = \beta_{4i} + \beta_{5i}LOGEDU2_{it} + \beta_{6i}LOGMORT2_{it} + u2_{it} \quad (12)$$

$$LOGGDPPER3_{it} = \beta_{7i} + \beta_{8i}LOGEDU3_{it} + \beta_{9i}LOGMORT3_{it} + u3_{it} \quad (13)$$

4.2. Cross-Sectional Dependence and Homogeneity

There exists a growing literature on econometric methods for representing and measuring cross sectional dependence in panel data regression models. Conditioning on variables specific to the cross section units alone typically does not deliver cross section error independence and it is well known that neglecting cross sectional dependence can lead to biased estimates and spurious inference[30].

The Breusch-Pagan (Breusch and Pagan, 1980) LM test based on the squares of ρ_{ij} is valid for $T \to \infty$ and then $N \to \infty$ is defined as[31]

Although is applicable even if and are large, it is likely to exhibit substantial size distortions if is large and is small. Thus, Pesaran (2004) proposed the following cross-sectional dependence test when N is large and T is small.

$$CD_{LM1} = \sqrt{\frac{1}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} T\left(\hat{\rho}_{ij}^{2} - 1\right) \sim N(0,1) \quad (14)$$

All statistic have the following hypothesis:

$$CD_{LM2} = \sqrt{\frac{2T}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \left(\hat{\rho}_{ij}^{2}\right) \sim N(0,1) \quad (15)$$

Determining whether slope coefficients are homogeneous or heterogeneous is also important in panel data analysis. In this study, we employed (Delta) test proposed by Pesaran and Yamagata (2008)[32].

$$H_0: no\ cross - \ sectional\ dependence$$
$$H_1: cross - \ sectional\ dependence$$

30 Chudik, Alexander et. al., 'Weak and Strong Cross Section Dependence and Estimation of Large Panels,' CESifo Working Paper Series 2689, CESifo Group Munich, 2009, s. 6.

31 Pesaran, Hashem, 'General Diagnostic Tests for Cross Section Dependence in Panels', IZA Discussion Paper Series, No. 1240, 2004, s. 4.

32 Hashem Pesaran and Takashi Yamagata, 'Testing Slope Homogeneity in Large Panels', Journal of Econometrics, No. 142, 2008, s. 50-93.

***Table 3:** Cross-Sectional Dependence and Homogeneity Test*

Cross Sectional Dependence		
	CD_{LM1}	CD_{LM2}
LOGGDPPER1	480.020 (0.000)	10.092 (0.000)
LOGEDU1	1311.920 (0.000)	47.075 (0.000)
LOGMOR1	485.336 (0.000)	10.329 (0.000)
LOGGDPPER2	277.266 (0.000)	5.746 (0.000)
LOGEDU2	793.631 (0.000)	33.668 (0.000)
LOGMOR2	267.231 (0.000)	5.204 (0.000)
LOGGDPPER3	385.977 (0.000)	5.912 (0.000)
LOGEDU3	1216.245 (0.000)	42.821 (0.000)
LOGMOR3	436.828 (0.000)	8.172 (0.000)
Homogeneity Test		
	$\tilde{\Delta}$	$\widetilde{\Delta_{adj}}$
Cluster 1	51.527 (0.000)	53.925 (0.000)
Cluster 2	47.120 (0.000)	49.313 (0.000)
Cluster 3	61.966 (0.000)	64.850 (0.000)

It is clearly seen that the null of no cross-sectional dependence across variables is strongly rejected. The results from cross sectional dependence test indicate that a shock in a country spillovers on other countries due to high degree of international trade and financial liberalization. In addition to this, the homogeneity test rejects null hypothesis and supports that the parameters are heterogonous.

4.3. Panel Unit Root Analysis

Ordinary Least Squares estimator, hereafter OLS, with non-stationary variables leads to spurious regression problem in an empirical analysis. Hence, panel unit root tests developed by Hadri and Kurozumi (2012)[33], hereafter HK, are employed which allow cross sectional dependence.

Hadri and Kurozumi (2012) develop a simple Pesaran (2007) for the null hypothesis of stationarity in heterogeneous panel data with cross sectional dependence in the form of a common factor in the disturbance. They also allow for serial correlation.

33 Kaddour Hadri and Eiji Kurozumi, 'A Simple Panel Stationarity Test in the Presence of Serial Correlation and a Common Factor', Economic Letters, No. 115, 2012, s. 31-34.

Table 4: Results for Panel Unit Root Tests

Variables	HK			
	Constant		Constant and Trend	
	ZA^{SPC}	ZA^{LA}	ZA^{SPC}	ZA^{LA}
LOGGDPPER1	-1.987 (0.976)	3.514*** (0.000)	1.746** (0.040)	19.124*** (0.000)
LOGEDU1	6.317*** (0.000)	132.969*** (0.000)	6.658*** (0.000)	86.672*** (0.000)
LOGMOR1	23.645*** (0.000)	107.653*** (0.000)	19.561*** (0.000)	94.584*** (0.000)
LOGGDPPER2	-1.567 (0.941)	-1.125 (0.869)	0.811 (0.208)	1.939** (0.026)
LOGEDU2	7.332*** (0.000)	26.481*** (0.000)	0.783 (0.216)	9.344*** (0.000)
LOGMOR2	336.378*** (0.000)	998.325*** (0.000)	411.512*** (0.000)	531.666*** (0.000)
LOGGDPPER3	52.310*** (0.000)	55.376*** (0.000)	0.227 (0.409)	5.883*** (0.000)
LOGEDU3	42.845*** (0.000)	203.126*** (0.000)	29.715*** (0.000)	407.203*** (0.000)
LOGMOR3	181.318 (0.000)***	1582.530 (0.000)***	1177.498 (0.000)***	2690.287 (0.000)***

Note: *, ** and *** denote, respectively, significance at the 10%, 5% and 1% levels. Numbers in brackets are p-values. Null hypothesis for HK is that variable has no unit root. The maximum lag lengths were set to 3.

The panel unit root test results are reported in Table 4. The results show that the null of no unit root can be rejected for the levels of the variables. Hence, we can conclude that the variables are I (1) except LOGGDPPER2 and first difference of the variables can be utilized in an OLS regression.

4.4. Empirical Results

Panel data analysis that combines time series and cross sections allow researchers great flexibility in modelling differences. The basic model of panel data analysis takes the form

$$y_{it} = x_{it}'\beta + z_i'\alpha_i + \varepsilon_{it} \tag{15}$$

$z_i'\alpha$ contains a constant term and set of individual or group specific variables which may be observed (race, sex, location) or unobserved (family specific characteristics). If z_i is observed for all individuals, the entire model can be treated as an ordinary linear model and fit by least squares. We can consider various cases[34]:

34 William Greene, Econometric Analysis, (New Jersey: Prentice Hall, 2004), s. 285.

- Fixed Effects: if unobserved, but correlated with, fixed effects takes to be a group specific constant term in the regression model. It should be noted that the term fixed indicates that the term does not vary over time.
- Random Effects: if the unobserved individual heterogeneity can be assumed to be uncorrelated with the included variables, the model can be formulated as

$$y_{it} = x_{it}'\beta + E[z_i'\alpha] + \{z_i'\alpha - E[z_i'\alpha]\} + \varepsilon_{it} \quad (15)$$

$$y_{it} = x_{it}'\beta + \alpha + u_i + \varepsilon_{it} \quad (16)$$

Random effects approach specifies that $u_i u_i$ is a group specific random element except that from each group, there is but a single draw that enters the regression identically in each period[35].

The fixed effects model is an appropriate specification if we focus on a specific set of N firms, N OECD countries or N American states. On the other hand, the random effects model is an appropriate specification if we draw N individuals randomly from a large population[36]. Results of model specification and diagnostic tests for fixed and random effects model is illustrated in table 5 and 6.

***Table 5:** Model Specification and Diagnostic Tests (Fixed Effects Models)*

Tests	Model 1	Model 2	Model 3
$\boldsymbol{F_{group}}$	7.731 (0.000)	152.106 (0.000)	2.066 (0.002)
$\boldsymbol{F_{time}}$	13.200 (0.000)	65.506 (0.000)	2.293 (0.000)
$\boldsymbol{F_{group+time}}$	11.092 (0.000)	125.970 (0.000)	2.233 (0.000)
$\boldsymbol{LM_{heteroscedasticity}}$	202.537 (0.000)	806.048 (0.000)	376.498 (0.000)
$\boldsymbol{LM_{autocorrelation}}$	137.844 (0.000)	719.449 (0.000)	0.009 (0.923)

Note: Numbers in brackets are p-values

35 William Greene, Econometric Analysis, (New Jersey: Prentice Hall, 2004), s. 285.

36 Badi Baltagi, Econometric Analysis of Panel Data, (West Sussex: John Wiley Sons, 2005), s.12.

Table 6: *Model Specification and Diagnostic Tests (Random Effects Models)*

Testler	Model 1	Model 2	Model 3
LM_{group}	94.364 (0.000)	4811.051 (0.000)	8.762 (0.003)
LM_{time}	968.493 (0.000)	8.017 (0.004)	27.405 (0.000)
$LM_{group+time}$	1062.858 (0.000)	4819.069 (0.000)	36.167 (0.000)
$HONDA_{group}$	9.714 (0.000)	69.361 (0.000)	2.960 (0.001)
$HONDA_{time}$	31.120 (0.000)	-2.831 (0.997)	5.235 (0.000)
$HONDA_{group+time}$	28.874 (0.000)	47.043 (0.000)	5.794 (0.000)
$Hausman$	7.117 (0.028)	0.588 (0.745)	1.814 (0.403)
$LM_{heteroscedasticity}$	231.459 (0.000)	684.537 (0.000)	346.109 (0.000)
$LM_{autocorrelation}$	192.319 (0.000)	4831.896 (0.000)	9.061 (0.010)

Note: Numbers in brackets are p-values

The Hausmann test confirms that there is no correlation between individual random effects and explanatory variables, indicating that the Random Effects Model is consistent and efficient. Furthermore, test result for heteroscedasticity and autocorrelation shows that the null of homoscedasticity and no autocorrelation is rejected at the %1 level. We therefore estimate our model under the heteroscedasticity and autocorrelation by using White's correction.

Table 7: *Estimates of Equation (11) Through (13)*

Fixed Effects Model			
	Equation (11) Cluster (1)	**Equation (12) Cluster (2)**	**Equation (13) Cluster (3)**
CONSTANT	0.024*** (0.000)	8.035*** (0.000)	-0.010* (0.075)
DLOGEDU	-0.045 (0.797)	1.252* (0.100)	0.135 (0.723)
DLOGMORT	-0.011 (0.811)	2.301** (0.025)	-0.746*** (0.000)
Random Effects Model			
CONSTANT	0.022*** (0.000)	8.044*** (0.000)	-0.009* (0.061)
DLOGEDU	0.120 (0.513)	0.231 (0.810)	0.104 (0.732)
DLOGMORT	-0.040 (0.404)	2.269** (0.024)	-0.743*** (0.000)

Note: *, ** and *** denote, respectively, significance at the 10%, 5% and 1% levels. Numbers in brackets are p-values.

Table 7 contains the principal results from panel data. It is clearly seen that the coefficient estimate of DLOGEDU and DLOGMORT in cluster 1 is statistically insignificant. In addition to this, the coefficient estimate of DLOGEDU in cluster 2 and 3 is positive but statically insignificant (except in cluster 2 fixed effects model). Lastly, while the coefficient estimate of DLOGMORT is positive and statistically significant in cluster 2, this coefficient is negative and statistically significant in cluster 3.

The estimates of cluster 2 lead to conclusion that the effect of health and education on economic growth is positive. The fixed effects coefficient estimate of DLOGEDU and DLOGMORT is 1.25 and 2.30, respectively. The random effects coefficient estimate of DLOGEDU and DLOGMORT is 0.23 (insignificant) and 2.26, respectively. It indicates that a %1 increase in education leads to economic growth by %1.25; a %1 increase in health leads to economic growth by %2.26-2.30.

The estimates of cluster 3 show the effect of health on economic growth is negative. The fixed and random effects coefficient estimate DLOGMORT is -0.74. This means that health and economic growth negatively related in cluster 3.

5. CONCLUSION

In other words, the concept of human capital refers to the abilities and skills of human resources of countries, while human capital formation refers to the process of acquiring and increasing the number of people who have the skills, good health, education and experience that are critical for economic growth. Thus, investment in education and health are considered as human capital components. In this study, we are interested in examine the impact of human capital components (education and health separately) on economic growth in a panel of 65 countries covering 1967 through 2011. For this purpose, index of human capital per person based on years of schooling and returns to education and mortality rate infant (per 1,000 live births) which are regarded as main components of human capital in economic literature and GDP per capita (constant 2005 US$) as a proxy for economic growth have been utilized.

Our results suggest that while the effect of health and education on economic growth ın cluster 2 including developing countries is positive, the effect of health on economic growth in cluster 3 including less developed countries is negative.

It is shown that education, health and economic growth have positive relationship. This positive relationship can be clearly seen in cluster 2 which is including developing countries in this study. Hence, we can conclude that education and health to ensure economic growth in developing countries is crucial. It is well known that a better educated and healthy population in developing countries is likely to participate more effectively in the process of economic growth and development. Improved health and education status will accelerate the quality of life in these countries. Education can also encourage use of health services and empowers women in society

In conclusion, education and health promise a wide range of potential benefits. There is no doubt that one of the most important benefit of education and health in developing countries is economic growth. Thus, especially developing countries should give priority to education and health to ensure economic growth.

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