Relationship Between Human Capital and Economic Growth: Panel Causality Analysis for Selected OECD Countries

Ferdi KESİKOĞLU

Bülent Ecevit University,
Zonguldak, Turkey
fkesikoglu@yahoo.com

Zafer ÖZTÜRK

Bülent Ecevit University,
Zonguldak, Turkey
zaferoz@hotmail.com

ABSTRACT

In this study, the relation between education and health expenditures that are accepted as an indicator of human capital and economic growth is tested empirically. According to the findings of the study, based on 1999 – 2008 period for 20 OECD countries that are selected by the panel casuality test, a bidirectional casuality relation is observed between the education and health expenditures and economic growth in the period and country group under discussion. The obtained findings both support the intrinsic growth theories and tally with the empirical studies on the subject.

JEL Code: O10, O15

Introduction

Studies on growth in the economics literature are usually divided into two groups. The first one is the Neo-classical growth theory that was dominant until 1980s and it identifies the source of economic growth with technology and increase in population which is considered as external in the model. The Neo-classical growth theories, which take shape depending upon savings, capital-labour and income variables, propound that there will be no long-term discrepancy between countries in terms of level of development. The theories that emerged as alternatives to the Neo-classical theory are called as endogenous growth theories. Emerging endogenous growth theories bring forward the idea that endogenous conditions like human capital, foreign trade policies, financial development and public expenditures of a country can affect economic growth.

Considering the subject within the frame of endogenous growth theories, it is ascertained that the human capital resources of a country have a great impact on growth. In recent years, the empirical studies on economic growth also increasingly emphasize the role of human capital in economic growth process. As often expressed in the empirical studies, the most important indicators of the human capital are health care and education. For education and health, the number of people graduated from collages and life expectancy at birth or total public expenditure intended on education and health care are used as variables in empirical models. Education and health care expenditures increase the quality of labour force and positively contribute to the production capacity and thus to the economic growth. It is also emphasized by the endogenous growth theories that in the development process, health care and education expenditures play an important role in the formation of human capital and have a significant contribution to the sustainable economic growth in long-term.

In this study, within the frame of theoretical and empirical arguments presented above in summary, the relationship between education, health care expenditures and economic growth is tested by the panel causality test for 20 OECD member countries that are selected considering data sufficiency for 1999 – 2008 period. In the first part of the study that composed of three parts, the theoretical frame is presented. After the second part that summarizes the findings of relevant empirical studies, the empirical model and the findings of the model are evaluated. The study reveals the importance of human capital for economic development.

Empirical Literature

Empirical literature about the relationship between human capital and economic growth is summarized in Table 1.

Table 1. The Empirical Literature

Author	Method	Period	Country	Result
Romer (1989)	Endegenous Growth Model	1960-1985	Transnational	Positive effect of education on growth
Mulligan and Sala-i Martin (1992)	Endegenous Growth Model			Economic growth increases the rate of return on human capital
Barro and Lee (1993)	Panel Method	1960-1985	189 Country	Positive effect of education on growth
Kelly (1997)	Ordinary Least Squares	1970-1989	73 Country	Do not have any effect on economic growth of health spending
Rivera and Currais (1998)	Ordinary Least Squares	1960-1990	OECD Countries	Positive effect of health spending on economic growth
Freire-Serén (2001)	Two-Step OLS	1960-1990	Transnational	There are two-way causal relationship between human capital and economic growth
Kar and Ağır (2003)	Granger Causality, VECM	1926-1994	Turkey	-causality of education spending to economic growth -causality of economic growth to health spending
Serel and Masatçı (2005)	Johansen cointegration	1950-2000	Turkey	-Human capital has a positive effect on growth in the long term -Causality of economic growth to human capital
Taban (2006)	Johansen cointegration, Granger Causality	1968-2003	Turkey	Two-way causal relationship between health indicators and economic growth
Taban and Kar (2006)	Granger Causality	1969-2001	Turkey	Two-way causal relationship between educaiton and economic growth
Haldar and Mallik (2010)	Johansen cointegration, ARDL	1960-2006	India	investment in education and health are very important and has a significant positive long run effect on per capita GNP growth
Şimşek and Kadılar (2010)	Cointegraiton, granger causality, ARDL	1960-2004	Turkey	-Causality of human capital to GDP in the short and long term - Causality of GDP to human capital in the short term
Keskin (2011)	Multiple Linear Regression	Cross-Sectional Data	177 BM Countries	Has important effects on economic development, educaiton and health spending
Yaylalı and Lebe (2011)	Cointegraiton and VAR	1938-2007	Turkey	Two-way causal relationship between educaiton and economic growth

Model, Data and Methods

In this study, the estimated models are shown in the following equations.

$$GDP_t = \alpha_0 + \sum_{B=1}^{m} \alpha_B GDP_{t-B} + \sum_{k=1}^{n} \delta_k EDUC_{t-k} + u_t \qquad (1)$$

$$EDUC_t = \alpha_0 + \sum_{B=1}^{m} \alpha_B EDUC_{t-B} + \sum_{k=1}^{n} \delta_k GDP_{t-k} + u_t \qquad (2)$$

$$GDP_t = \alpha_0 + \sum_{B=1}^{m} \alpha_B GDP_{t-B} + \sum_{k=1}^{n} \delta_k HEALTH_{t-k} + u_t \qquad (3)$$

$$HEALTH_t = \alpha_0 + \sum_{B=1}^{m} \alpha_B HEALTH_{t-B} + \sum_{k=1}^{n} \delta_k GDP_{t-k} + u_t \qquad (4)$$

In the model, GDP symbolizes the rate of growth, EDUC symbolizes the GDP ratio of total education expenditures, HEALTH symbolizes the GDP ratio of total health expenditures, a and ds symbolize the parameters and m and n symbolize the lag length. According to Schwarz information criterion 3 is determined as the length of delay. Besides, employment (EMP) is added as a control variable to the model as it can be in relation to growth, education and health. The data used in the analysis is obtained from World Bank WDI, OECD-STAN data bases. The data set used icludes 1999 – 2008 period and 20 OECD member countries: Austria, Czech Republic, France, Hungary, Ireland, Israel, Italy, Japan, Holland, Spain, UK, Denmark, Germany, Poland, Portugal, Slovakia, Finland, Iceland and USA.

According to Holtz-Eakin, Newey and Rosen (1988), the hypothesis test can be made in equation 5 in order to examine whether model in equation 1 cause GDP to EDUC and model in equation 2 EDUC to GDP. This hypothesis test can also be made for equations 3 and 4 that present the relation between GDP and HEALTH.

$$\delta_1 = \delta_2 = \delta_3 = 0 \qquad (5)$$

The economics literature suggests three approaches to test casuality in panel data set. The first approach is based on the generalized method of moments (GMM) and the Wald test in equation 3. The GMM method requires the panel data set to be N>T. The second one is suggested by Hurlin (2008) and fixed effects are based on panel data approach. The fixed effect panel data approach can be applied only for static series. The third one is proposed by Kónya (2006) and it is based on the estimates of seemingly unrelated regression (SUR). The last approach requires the panel data set

to be T>N. In this study, the GMM - system approach is preferred since the data set used is N>T and some variables in the model are I(1).

Holtz-Eakin, Newey and Rosen (1988), Arellano and Bond (1991), Arellano and Bover (1995) and Blundell and Bond (1998) developed the GMM – system approach which can solve the endogeneity and it can be and applied to T<N feature samples. This method is basically an instrumental variable method. It is based on producing instrumental variables which have the similar characteristics of moment instead of variables that are considered to have the problem of endogeneity and using instrumental variables in regression model. It is possible to express GMM β estimator as in equation 6 for a model in the form of $y_i = x_i\beta + u_i$ (Cameron and Triverdi, 2009, p. 175):

$$\hat{\beta}_{GMM} = \left(X'ZWZ'X\right)^{-1} X'ZWZ'y \tag{6}$$

In equation 6, X represents the matrix of independent variable, Z represents the matrix instrumental variable, Y represents the matrix of dependent variable and W represents the matrix of symmetric weight. The GMM β estimator minimizes the objective function. The objective function is indicated in equation 7.

$$Q(\beta) = \left\{\frac{1}{N}\left(y - X\beta\right)' Z\right\} W \left\{\frac{1}{N} Z'\left(y - X\beta\right)\right\} \tag{7}$$

When the matrix of weight is taken in the quadratic form, it is equal to $Z'\left(y - X\beta\right)$. However, when the matrix of weight is selected as in two-staged least square the optimal GMM estimator is reached. The optimal GMM is indicated in equation 8.

$$\hat{\beta}_{OGMM} = \left(X'Z\hat{S}^{-1}Z'X\right)^{-1} X'Z\hat{S}^{-1}Z'y \tag{8}$$

In the equation 8 $\hat{S}$ is the estimation of $Var\left(N^{-1/2}Z'u\right)$. The efficiency of the GMM estimator depends on selecting the right matrix of instrumental variable. There are three tests used for this purpose. The first one is the AR(1) and AR(2) tests developed by Arellano and Bond (1991). The AR(1) test examines the null hypothesis in the form of "no first-order autocorrelation." Because of the method of obtaining instrumental variable, first-order autocorrelation should be observed automatically in the error term of the model and the null hypothesis should be rejected at a %5 statistical significance level. Otherwise, it is understood that the instrumental variables cannot be determined correctly. On the other hand, AR(2) test examines the null hypothesis in the form of "no second-order autocorrelation." The no second-order autocorrelation should not be rejected at a %5 statistical significance level in the model. Oth-

erwise, it is again understood that the instrumental variables cannot be determined correctly. The second test is known as the Sargan test. It examines the null hypothesis in the form of "instrumental variable is valid." Therefore, the null hypothesis should not be rejected at a %5 statistical significance level. The last test is known as Hansen's J test. The J test also examines the null hypothesis in the form of "instrumental variable is valid" and the null hypothesis should not be rejected at a %5 statistical significance level. Furthermore, if the tests are ranked according to the degree of reliability, AR(1) and AR(2) tests are in the first place, the Sargan test is in the second and the J test take the last place. Particularly, as the number of instrumental variables increase the success of the J test decreases (Roodman, 2006, p. 14).

Finally, Windmeijer (2005) proved that the GMM estimate is exposed to small sample deviation in a finite number of observations and proposed a method to correct this small sample deviation that emerge in standart errors. Moreover, the author proves that when this deviation arising from the small sample is corrected, the deviations observed in standard errors and coefficients decrease as well. In order to correct the results of the GMM method used in this study, the correction proposed by Windmeijer (2005) is followed. The only code that can implement this correction is written by Roodman (2006). For this reason, the code written by Roodman (2006) is used for GMM estimation.

Findings

In table 2, the results of the model estimation that examines whether there is a casual relationship from education to growth is shown.

Table 2. Estimation Results of Model 1

Independent Variables	Coefficient	Corrected Standard Error	T Statistics	Probability
GDP_{t-1}	0.67*	0.111	6.05	0.000
EDUC	-6.19*	0.980	-6.32	0.000
$EDUC_{t-1}$	7.72*	1.502	5.14	0.000
$EDUC_{t-2}$	-0.75	1.471	-0.52	0.607
$EDUC_{t-3}$	-0.84	0.964	-0.88	0.382
Arellano-Bond AR(1) Statistics	-4.21 (0.000)		F Statistics	18.56 (0.000)*
Arellano-Bond AR(2) Statistics	-0.79 (0.429)		No. Of Observations	120
			Cross-Section	20
			Time Dimension	10 years
Wald Statistics ($EDUC_{t-1}$ = $EDUC_{t-2}$ = $EDUC_{t-3}$ = 0) 10.94 (0.0071)			Method	Two Staged Panel GMM-system

Note: * symbol shows the %1 statistically significant coefficients. In the statistics related to the model, the values before the parentheses show the related statistic values and the values in parentheses indicate the possibilities.

According to the findings, the F statistics show that the model, as a whole, is statistically significant at a %5 significance level. The AR(1) statistics show first-order autocorrelation is observed in the error terms of the model and AR(2) statistics show no second-order autocorrelation. The Wald statistics that examine $EDUC_{t-1}$ = $EDUC_{t-2}$ = $EDUC_{t-3}$ = 0 hyphothesis is rejected at a significance level of %1. This finding means that the education expenditures are the reasons of growth.

In table 3, the results of the model estimation that examines whether there is a casual relationship from growth to education expenditures is shown.

Table 3. Estimation Results of Model 2

Independent Variables	Coefficient	Corrected Standard Error	T Statistics	Probability
$EDUC_{t-1}$	0.954*	0.038	25.03	0.000
GDP	-0.041*	0.009	-4.28	0.000
GDP_{t-1}	0.010	0.015	0.65	0.515
GDP_{t-2}	0.034**	0.015	2.20	0.030
GDP_{t-3}	0.006	0.012	0.56	0.577
Arellano-Bond AR(1) Statistics	-4.48 (0.000)		F Statistics	165.54 (0.000)*
Arellano-Bond AR(2) Statistics	0.56 (0.577)		No. Of Observations	120
			Cross-Section	20
			Time Dimension	10 years
Wald Statistics (GDP_{t-1} = GDP_{t-2} = GDP_{t-3} = 0) 10.49 (0.0071)			Method	Two-Staged Panel GMM-system

Note: * symbol shows %1 ** shows %5 statistically significant coefficients. In the statistics related to the model, the values before the parentheses show the related statistic values and the values in parentheses indicate the possibilities.

According to the no. 2 model estimation results, the model is significant at a %1 significance level and the instrumental variables are valid. Besides, the Wald statistics cannot reject the H_0 hypothesis at %1, %5 and %10 significance levels in the form of growth is not the reason of education expenditures.

In table 4, there are the results of a casual relationship research from health expenditures to growth that is stated above in no. 3 model.

Table 4. Estimation Results of Model 3

Independent Variables	Coefficient	Corrected Standard Error	T Statistics	Probability
GDP_{t-1}	0.462*	0.131	3.52	0.001
HEALTH	-5.529*	0.732	-7.55	0.000
$HEALTH_{t-1}$	6.072*	1.260	4.82	0.000
$HEALTH_{t-2}$	-0.674	1.292	-0.52	0.603
$HEALTH_{t-3}$	-0.467	0.824	-0.57	0.572
Arellano-Bond AR(1) Statistics		-4.20 (0.000)	F Statistics	24.09 (0.000)*
Arellano-Bond AR(2) Statistics		-0.65 (0.513)	No. Of Observations	120
			Cross-Section	20
			Time Dimension	10 years
Wald Statistics ($HEALTH_{t-1} = HEALTH_{t-2} = HEALTH_{t-3} = 0$) 17.05 (0.0000)			Method	Two-Staged Panel GMM-system

Note: * symbol shows %1 ** shows %5 statistically significant coefficients. In the statistics related to the model, the values before the parentheses show the related statistic values and the values in parentheses indicate the possibilities.

According to the no. 3 model estimation results, the model is significant at a %1 significance level and the instrumental variables are valid. Besides, the Wald statistics cannot reject the H_0 hypothesis at %1, %5 and %10 significance levels in the form of growth is not the reason of health expenditures.

In table 5, there are the results of a casual relationship research from growth to health expenditures that is stated above in equation 4.

Table 5. Estimation Results of Model 4

Independent Variables	Coefficient	Corrected Standard Error	T Statistics	Probability
$HEALTH_{t-1}$	0.928	0.257	36.06	0.000
GDP	-0.769	0.013	-5.84	0.000
GDP_{t-1}	-0.005	0.020	-0.25	0.805
GDP_{t-2}	0.009	0.021	0.46	0.645
GDP_{t-3}	0.040	0.015	2.56	0.012
Arellano-Bond AR(1) Statistics		-3.57 (0.000)	F Statistics	527.27(0.000)*
Arellano-Bond AR(2) Statistics		-0.18 (0.860)	No. Of Observations	120
			Cross-Section	20
			Time Dimension	10 years
Wald Statistics ($GDP_{t-1} = GDP_{t-2} = GDP_{t-3} = 0$) 18.06 (0.0000)			Method	Two-Staged Panel GMM-system

Note: * symbol shows %1 ** shows %5 statistically significant coefficients. In the statistics related to the model, the values before the parentheses show the related statistic values and the values in parentheses indicate the possibilities.

According to results of no.4 model estimation results that is summarized in table 5, the model is significant at a %1 significance level and the instrumental variables are valid. Besides, the Wald statistics accept the that there is a casual relationship from growth to health expenditures at %1significance level .

Conclusion

In economic literature, two theoretical structures about economic growth that are endogenous and neo-classical, attract the attention. These theories, taking into account different criteria, provide a theoretical framework for growth. Endogenous growth theories discuss investments in human capital among the sources of growth. Studies that are done within the context of endogenous growth theories, variables are generally used as education and health expenditures for human capital.

In this study the nexus between human capital and economic growth was tested empirically using panel causality test for 20 OECD countries. Achieved evidence indicates that there are bi-directional causal relationship between education expenses and economic growth. Furthermore two-sided causal relationship between health expenses and economic growth was found. These findings support the suggestion of endogenous growth theory which is a competitor of Neo classical growth theory. The findings prove similar results for the studies done with different countries, different time zones and different methods. In this context, the human capital investments that are represented by education and health expenditures have a positive effect on the economic growth of the countries.

References

Arellano, M. & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment. *The Review of Economic Studies*, 58(2), 277-297.

Arellano, M. & Bover, O.(1995). Another look at the instrumental variable estimation of error-components models. *Journal of Econometrics*, 68, 29-51.

Barro, R. J. & Lee J. W. (1993). International comparisons of educational attainment. *NBER Working Paper Series,* WP No: 4349.

Blundell, R. W. & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*, 87, 115-143.

Cameron, A. C. & Trivedi, P. K. (2009). Microeconometrics Using Stata. Stata Pres, Texas.

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

Haldar, S. K. & Mallik, G. (2010). Does human capital cause economic growth? A case study of India. *International Journal of Economic Sciences and Applied Research,* 3 (1): 7-25.

Holtz-Eakin, D., Newey, W. & H. Rosen (1988). Estimating vector autoregressions with panel data. *Econometrica*, 56, 1371-1395.

Hurlin, C. (2008). Testing for Granger non-causality in heterogeneous panels, *Hyper Articles en Ligne Sciences de I'Homme et Société*, http://halshs.archives-ouvertes.fr/docs/00/22/44/34/PDF/Causality_WP.pdf.

Kar, M. & Ağır, H. (2003). Türkiye'de beşeri sermaye ve ekonomik büyüme: Nedensellik testi. *II. Ulusal Bilgi, Ekonomi ve Yönetim Kongresi Bildiriler Kitabı,* (Derbent- Izmir), 181-190.

Kelly, T. (1997). Public expenditures and growth. *Journal of Development Studies*, 34:1, 60-84.

Keskin, A. (2011). Ekonomik kalkınmada beşeri sermayenin rolü ve Türkiye. *Atatürk Üniversitesi İktisadi ve İdari Bilimler Dergisi,* 25, 3-4, 125-153.

Konya, L. (2006). Exports and growth: Granger causality analysis on OECD countries with a panel data approach. *Economic Modelling*, 23, 6, 978–992.

Mulligan C. B. & Sala-i-Martin, X. (1992). Transitional dynamics in two-sector models of endogenous growth. *NBER Working Paper Series*, WP No:3986.

Rivera, B. & Currais, L. (1999). Economic growth and health: direct impact or reverse causation?. *Applied Economics Letters*, 6:11, 761-764.

Romer, P.M. (1989). Human capital and growth: theory and evidence. *NBER Working Paper Series*, WP No:3173.

Roodman, D. (2006). How to do xtabond2: An introduction to "difference" and "system" GMM in stata. *The Center for Global Development Working Paper Series*, No. 103.

Serel, H. & Masatçı K. (2005). Türkiye'de beşeri sermaye ve iktisadi büyüme ilişkisi: Ko-entegrasyon analizi. *Atatürk Üniversitesi İktisadi ve İdari Bilimler Dergisi,* 19, 2, 49-58.

Şimşek M. & Kadılar, C. (2010). Türkiye'de beşeri sermaye, ihracat ve ekonomik büyüme arasındaki ilişkinin nedensellik analizi. *C.Ü. İktisadi ve İdari Bilimler Dergisi,* 11, 1,115-140.

Taban, S. & Kar, M. (2006). Beşeri sermaye ve ekonomik büyüme: nedensellik analizi: 1969-2001. *Anadolu Üniversitesi Soyal Bilimler Dergisi*, 6, 1, 159-181.

Taban, S. (2006). Türkiye'de sağlık ve ekonomik büyüme arasındaki nedensellik ilişkisi. *Sosyoekonomi,* Temmuz-Aralık 2006-2, 31-46.

Windmeijer, F. (2005). A finite sample correction for the variance of linear efficient two-step GMM estimators. *Journal of Econometrics*, 126, 25-51.

Yaylalı, M. & Lebe, F. (2011). Beşeri sermaye ile iktisadi büyüme arasındaki ilişkinin ampirik analizi, *Marmara Üniversitesi İİBF Dergisi*, XXX, I, 23-51.