

Impact of Human Capital on Economic Growth in D-8 Countries: GMM Estimation of Panel Models

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Abstract

This study has been conducted to explore the role of health capital and education capital as compared to physical capital in economic growth of eight developing countries (D-8). The model is specified on the basis of Solow Growth extended model for economic growth. Data is covering twenty-one years from 1995 to 2015. GMM is used to estimate panel data models as causality test proves endogeneity problem in the specified model. This study provides empirical evidence that human capital (i.e. education capital and health capital) and physical capital positively affect economic growth of D-8 economies. However, human capital as compared to physical capital seems to be the engine of economic growth in these developing countries. Policy makers should consider investing in initiatives that improve human capital, such as providing better education opportunities, improving public health initiatives, and providing better access to healthcare. They should also seek to ensure that initiatives to increase physical capital, such as infrastructure and technological advancements, are implemented in a way that benefits communities with the greatest need. Additionally, policy makers should consider initiatives that incentivize businesses to invest in their employees, such as providing tax credits for businesses that invest in employee training and development. Finally, policy makers should make sure that any initiatives to increase human and physical capital are equitable and accessible to all citizens, regardless of their social, economic, or racial backgrounds.

Keywords: Economic Growth, Human Capital, Developing Countries, Panel Data, GMM

JEL Classification: C23, F6, I1, I2, O5

Introduction

Literature of economic growth (Barro, 1991; Benhabib & Spiegel, 1994; Fuente & Doménech, 2000, 2006; Horwitz, 2005; Lucas, 1988; Mankiw et al., 1992; Penghui et al., 2022; Pistorius, 2004; Romer, 1990; Siggel, 2001; van Zon & Muysken, 2001) reveals that human capital is the driver of economic growth. Importance of human capital is empirically supported by cross-country analyses with differences in economic growth (Barro, 1991; Barro & Lee, 1996; Benhabib & Spiegel, 1994; Mohd & Malaysia, 2020; Mankiw et al., 1992; Sachs & Warner, 1997). Different growth theories including Mankiw et al. (1992); Lucas (1988); and Romer (1986) explain important role of human capital for growth of economies. Health, education, training and any other investments that increases the individual's productivity are defined as human capital. However, the economists that include human capital in their studies paid more attention for analyzing the influence of health and education on development. The reason might be that education increases efficiency of labor. Increase in education leads to improvement in human capital and physical capital that ultimately result into higher economic growth (Barro, 2001; Dickens et al., 2006; Widarni & Wilantari, 2021). Health capital also increases efficiency of labor. It incorporates health services, nutrition activities, family planning and emergency for health but it does not cover sanitation and water provision. There are a number of studies based upon panel data, which reveal significance of health capital and education capital for economic growth. However, to the best of authors' knowledge, no such study is available in the case of D-8 economies.

The D-8 (Developing-8) Organization is a group of eight countries from the Organization of Islamic Cooperation (OIC). The D8 countries are Bangladesh, Egypt, Indonesia, Iran, Malaysia, Nigeria, Pakistan, and Turkey having about 13% of the world population. It was established in 1997 with the aim of promoting cooperation among the countries and improving their economic and social development. Co-operation in all these areas depends upon economic growth of the countries which is further linked up with human capital. The selection of these countries was based on their size of population, geographical coverage, and level of economic development. These countries also have similar challenges and opportunities in terms of human capital and human development. Since all the eight countries are developing countries which are deficient of physical as well as human capital. It makes them a relevant group for analysis. The goal of the D-8 is to promote economic cooperation and development among its member countries, and the focus on human capital and development might be consider as a way to achieve this goal. Some peculiarities of the D-8 countries as compared to other countries are Geographical and Cultural Diversity, Growing Economies, Emerging Markets, Young and Growing Population, Strategic Location, and Demographic Characteristics. These peculiarities make the D-8 countries an interesting and important group to study, and they make them distinct from other countries in terms of human capital and human development. Additionally, the D8 countries are located in different regions of

the world, which provides a wider geographical coverage. Hence, this paper uses neoclassical growth extended model to achieve the following objectives.

Objectives of the Study

- To investigate the role of education capital, health capital, and physical capital in economic growth of D-8 economies.
- To compare the impact of human capital versus physical capital for economic growth of the countries.

Literature Review

Literature contains a large number of researches exploring the impact of human capital for growth of economies individually as well as for panels of countries. Babatunde and Adefabi (2005) explains co-integration between human capital and economic growth in Nigeria. Xiaoqing (2005) and Yang (2020) investigate positive impact of health investment and physical capital on economic growth in china. Abbas and foreman (2007) concludes direct relationship of human capital and economic growth in Pakistan. Aka and Dumant (2008) empirically analyzes long-run positive impact of health expenditures on economic growth in USA. According to Akram et al., (2008), there is long run positive effect of health capital on economic growth in Pakistan. Aghion et al., (2009) establishes causal impact of economic growth and education in USA. Gungor (2010) finds that education inequality and human capital both have negative and significant impact on economic growth of Turkey. Ali et al., (2012); Imran et al., (2012); Khattak and Khan (2012); and Munir and Arshad (2018) shows significant positive role of human capital in Pakistan.

Some of the panel data studies relevant to economic growth and human capital are also available in the literature. According to Barro (2001), education seems to have positive impact on economic growth while considering a panel of 100 countries. Beraldo et al., (2009) and Gyimah et al., (2006) and point out positive role of education in growth of panels of African OECD countries. The results are consistent that education and health expenditure have positive and significant role in economic growth. Baltagi and Mascone (2010) shows significant positive estimates of health expenditure for economic growth in 20 OECD countries. Mehrara and Musal (2011) show causal relationship between health and economic growth in oil exporting countries. Peykarjou et al. (2011) empirically analyzes the relationship between health expenditure and economic growth by taking annual data (2001-2009) of OIC member states. Health capital is found to have positive impact on economic growth. Hosoya (2012) shows positive role of human capital, health, and education in economic growth of OECD countries while Mohammadi et al. (2012) shows negative impact of health expenditure and education expenditure on economic growth in ECO countries. Maitra and

Mukhopadhyay (2012) empirically analyze government expenditure, health care and GDP in selected countries of Pacific and Asia by taking an annual data from 1981-2011. The study concludes that education expenditure as well as health expenditure are positively associated with economic growth. Ozturk and Topcu (2014) studies the positive role of health expenditure in economic growth of eight developed countries (G8). Table-1 summarizes the literatures.

Table 1. Summary of the studies

Variables' relationship	Studies
Education expenditures shows positive impact on economic growth	Aghion et al. (2009); Barro (2001); Babatunde & Adefabi (2005); Claude & Ralph (2019); Hosoya (2012); Islam (2014); Khattak & Khan (2012); Kotásková et al. (2018); León-Gonzalez & Montolio (2015); Ohwofasa et al., (2012); Rahman (2011).
Education expenditures shows negative impact on economic growth	Bexheti and Mustafi (2015); Goczek et al. (2021); Gungor (2010); Mohammadi et al. (2012); Nurudeen & Usman (2010).
Health expenditures shows positive impact on economic growth	Akram et al. (2008); Baltagi & Moscone (2010); Beraldo et al. (2009); Maitra and Mukhopadhyay (2012); Ozturk & Topcu (2014); Penghui et al. (2022); Peykarjou et al. (2011); Wang et al. (2018).
Health expenditures shows negative impact on economic growth	Abbas et al. (2022); Aka & Dumant (2008); Behera & Dash (2019); Mehrara & Musal (2011); Oladosu et al. (2022); Yang (2020).
Physical capital shows positive impact on economic growth	Abdouli & Omri (2021); Mohd & Malaysia (2020); Widarni & Wilantari (2021).
Physical capital shows negative impact on economic growth	Abbas & Foreman (2007); Ibrahim (2018); León-Gonzalez & Montolio (2015); Limam et al. (2017); Munir & Arshad (2018).

Review of literature shows that most of the studies found positive role of Education, Physical and Health capital in economic growth. But some studies found negative impact also. Hence, this study will help us to determine the impact of human capital on economic growth and to compare importance of human capital versus physical capital in D8 economies

Model Specification

According to Solow growth model, higher savings lead to higher capital stock which result into higher level of output. Solow growth model is further extended by introducing human capital in the model. The model is specified on the basis of extended Solow growth model where final form of the model is derived as follows. Assuming Cobb-Douglass production function. i.e.

$$Y(t) = A(t) K(t)^\alpha L(t)^{1-\alpha} \text{-----}$$

---- (3.1)

Dividing both sides by L(t) and simplification gives us

$$y(t) = k(t)^\alpha . A(t) \text{-----}$$

---- (3.2)

Where y(t) represents level of output per unit of labor and k(t) represents stock of capital per unit of labor. Capital Stock Development is administrated by

$$k^o(t) = s(k) y(t) - (n + g + \delta)k(t) \text{-----}$$

----(3.3)

Where s(k) is output fraction devoted in physical capital in time t. ‘g’ is the growth rate of technology and ‘n’ is the growth rate of labor, while depreciation rate is represented by ‘δ’. Capital stock k(t) converges to the capital value (k⁰) when actual investment is equal to break even investment, so (k⁰) becomes zero. i.e.

$$0 = s(k) k(t)^\alpha - (n + g + \delta)k(t)$$

$$k(t) = \left[\frac{s(k)}{(n+g+\delta)} \right]^{1/(1-\alpha)} \text{-----}$$

---- (3.4)

Put k(t) in equation (3.2) and taking long on both sides, we get

$$\ln(t) = \ln\left\{ \left[\frac{s(k)}{(n+g+\delta)} \right]^{\frac{1}{1-\alpha}} \right\}^\alpha A(t)$$

$$\ln y(t) = \beta_0 + \frac{\alpha}{1-\alpha} \ln s(k) - \frac{\alpha}{1-\alpha} \ln(n + g + \delta) + \epsilon(t) \text{-----}$$

---- (3.5)

Where $\ln A(t) = \beta_0$

Now we introduce education capital and health capital in the production function, i.e.

$$y(t) = k(t)^\alpha E(t)^\beta h(t)^\gamma . A(t) \text{-----}$$

---- (3.6)

The evolution of education capital implies that

$$E^o(t) = s(e)E(t)^\beta - (n + g + \delta)E(t)$$

Where $s(e)$ is output fraction that capitalized in education capital at time t .

Put $E^o(t) = 0$

$$0 = s(e) E(t)^\beta - (n + g + \delta)E(t)$$

$$s(e) E(t)^\beta = (n + g + \delta)E(t)$$

$$E(t) = \left[\frac{s(e)}{(n+g+\delta)} \right]^{1/(1-\beta)} \text{-----}$$

---- (3.7)

Similarly, the evolution of health capital can also be governed as follows

$$h^o(t) = s(h)h(t)^\gamma - (n + g + \delta)h(t)$$

Put $h^o(t) = 0$

$$0 = s(h) h(t)^\gamma - (n + g + \delta)h(t)$$

$$h(t) = \left[\frac{s(h)}{(n+g+\delta)} \right]^{1/(1-\gamma)} \text{-----}$$

---- (3.8)

$s(h)$ is a stock of capital invested in health capital. Put the values of $k(t)$, $E(t)$ and $h(t)$ in equation (3.6), we get

$$y(t) = \left(\left[\frac{s(k)}{(n+g+\delta)} \right]^{1-\alpha} \right)^\alpha \left(\left[\frac{s(e)}{(n+g+\delta)} \right]^{1-\beta} \right)^\beta \left(\left[\frac{s(h)}{(n+g+\delta)} \right]^{1-\gamma} \right)^\gamma \cdot A(t)$$

$$\ln y(t) = \frac{\alpha}{1-\alpha} \ln s(k) - \frac{\alpha}{1-\alpha} \ln(n + g + \delta) + \frac{\beta}{1-\beta} \ln s(e) - \frac{\beta}{1-\beta} \ln(n + g + \delta) + \frac{1}{1-\gamma} \ln(h) - \ln(n + g + \delta) + \ln A(t)$$

$$\ln y(t) = \beta_0 + \frac{\alpha}{1-\alpha-\beta-\gamma} \ln(k) + \frac{\beta}{1-\alpha-\beta-\gamma} \ln(e) + \frac{\gamma}{1-\alpha-\beta-\gamma} \ln(h) - \left(\frac{\alpha + \beta + \gamma}{1-\alpha-\beta-\gamma} \right) \ln(n + g + \delta) + \epsilon(t)$$

$$y(t) = \beta_0 + \beta_1 PHY + \beta_2 EDU + \beta_3 HE + \beta_4 TRA + \epsilon \text{-----}$$

---- (3.9)

The new endogenous growth theory argues that degree of technological advances increases with the openness of the economy. The trade openness is introduced to include foreign sector. Hence the following model is specified on the basis of above theoretical framework.

$$y(t) = \beta_0 + \beta_1 k(t) + \beta_2 E(t) + \beta_3 h(t) + \beta_4 Q(t) + \epsilon \text{-----}$$

-- (3.10)

Where $k(t)$ is physical capital, $h(t)$ is health capital, $E(t)$ is education capital and $Q(t)$ is trade openness and Dependent variable is $y(t)$ is Real Gross Domestic Product per capita.

Data and Methodology

Annual data of all the variables in Eq. (3.10) are taken from World Development Indicators for the period from 1995 to 2015. Base year of the data is 2005 and unit is US dollar. We use real Gross Domestic Product per capita in US dollars. Real education expenditure as a proxy of education Capital and real health expenditure per capita as proxy for Health Capital. Real Gross Fixed Capital in US dollars while trade-GDP ratio as proxy for trade openness are considered in this study. Table 2 gives Descriptive statistics of the variables and correlation between the variables.

Next step is estimation of the model. A number of studies show that there is bi-directional relationship between economic growth and capital stock. Panel causality test presented by Dumitrescu & Hurlin (2012) is performed to detect the problem of endogeneity. Standard Granger Causality regressions are performed for each cross section individually and then average of the test statistics (i.e. \bar{W}) is computed. Standardized version of \bar{W} follows standard normal distribution which is termed as \bar{Z} statistic. The results of panel causality test are presented in Table-3. Bi-directional causality of education capital and health capital with GDP per capita is shown by the results. It implies that there is the problem of endogeneity and therefore, Generalized Method of Moments (GMM) introduced by Hansen (1982) is appropriate estimation technique.

Table 2. Descriptive Statistics and Correlation Matrix of the Variables

	GDP per Capita	Health Expenditure per capita	Total Education Expenditure	Trade as % of GDP	Physical Capital Stock
No. of Obs.	168	168	168	168	168
Mean	4889.394	240.3267	1.01E+09	61.65622	4.08E+10
Median	1435.568	139.6728	24113973	50.53302	2.81E+10
SD	15072.2	273.3486	3.29E+09	48.94121	3.51E+10
Minimum	455.487	12.49831	5323095	0.976049	1.48E+08
Maximum	161184.8	1562.236	2E+10	207.2546	1.49E+11
Correlation	GDP per Capita	Health Expenditure per capita	Total Education Expenditure	Trade as % of GDP	Physical Capital Stock
GDP per Capita	1	0.064926	-0.00963	0.003483	0.193421
Health Expenditure per capita		1	-0.04129	0.263623	0.525488
Total Education Expenditure			1	0.037528	0.429401
Trade as % of GDP				1	0.133239
Physical Capital Stock					1

Table 3. Pair wise Dumitrescu Hurlin Panel Causality Tests

Null Hypothesis	\bar{W} -Stat	\bar{Z} -State	P-Value
Education expenditures does not homogeneously cause RGDP per worker	3.2313	3.1042	0.0019
RGDP per worker does not homogeneously cause education expenditures	2.6865	2.2851	0.0223
Health expenditures does not homogeneously cause RGDP per worker	3.9097	4.1243	0.0000
RGDP per worker does not homogeneously cause health expenditures	3.9156	4.1331	0.0000
Physical capital does not homogeneously cause RGDP per worker	1.4009	0.3522	0.7247
RGDP per worker does not homogeneously cause Physical capital	2.2267	1.5938	0.1110
Trade openness does not homogeneously cause RGDP per worker	2.7025	2.3091	0.0209
RGDP per worker does not homogeneously cause Trade openness	2.02416	1.2892	0.1973

For GMM technique, population moment conditions are specified on the regression errors and equate it to zero. Finally, In order to derive parameter estimates, the sample moments are used. Let L moment conditions (i.e. $m_1, m_2, m_3, \dots, m_L$) of the column vector are denoted by A, then we define the criterion function as following.

$$\text{Min}(m_1^2 + m_2^2 + m_3^2 + \dots + m_L^2) = \text{Min}(A'A) = M$$

GMM parameter estimates are obtained by minimizing this criterion function with variance-covariance weighting matrix is $\hat{\Omega}$. The weighting matrix is introduced, in order to account for heteroscedasticity and autocorrelation, then the criterion function is as following.

$$\text{Min}_\theta (A' \hat{\Omega}^{-1} A) = M$$

Application of GMM requires over-identification of the equation. In order to fulfill the condition of over-identification, the number of parameters to be estimated should be less than the number of 'valid' moment conditions. Hence, the number of parameters to be estimated must be less than the number of instruments. In order to test the over-identifying restriction and hence, exogeneity of the instruments with respect to the error term, we also apply J-statistic of Hansen (1982). Hence, panel data models are estimated by employing GMM and then diagnostic tests are applied to select the most suitable among common effect model (CEM), fixed effect model (FEM) and random effect model (REM). Diagnostic tests include F statistic that is helpful to select between CEM and FEM while Hausman test statistic is applied to select the most suitable model between FEM and REM.

Results and Discussion

The model specified as equation (3.10) is estimated by employing GMM estimation technique due to endogeneity issue as shown by Table 3. Three panel data models, i.e. Common effect model, Fixed effect model and Random effect model, are estimated and then the best model is selected on the basis of F-test and Hausmann test. The value of F statistics is 212181 and the null hypothesis of equality of parameters in the fixed effect model is rejected. It implies that the fixed effect model is more appropriate than the common effect model. The value of Hausmann test statistic is 5.9291 that lies in acceptance region and, hence, the null hypothesis of Random effect model is accepted. Hence, REM is selected as the most suitable model to explain the phenomenon. Moreover, insignificance of J-test statistic in all the three models indicate fulfilment of over identifying condition for GMM estimation technique. Results are presented in Table 4.

Coefficient estimates of the REM are used to explain the phenomenon under consideration. Results indicate significant positive impact of education capital on economic growth. The coefficient estimate shows that 1% increase in education capital causes 0.17% increase in real GDP per capita. Improvement in education level makes people more efficient to allocate resources which leads to a rise in economic growth. Educated labor force is more adaptive and easy to mobile. They easily adopt new technologies in production, (Dickens et al., 2006). Literature also supports these findings (Aghion et al., 2009; Barro, 2001; Babatunde & Adefabi, 2005; Podrecca & Carmeci, 2002).

Table 4. GMM Estimation Results Panel Data Models

Variable	Common Effect Estimates (t statistic)	Fixed Effect Estimates (t statistic)	Random Effect Estimates (t statistic)
Constant	-1669 (-2.0561)***	4.6661 (14.9456)***	0.3476 (4.6166)***
Education Capital	0.2602 (5.2864)***	0.0291 (2.0821)	0.1716 (40.1617)***
Health capital	0.5426 (10.9602)***	0.2493 (11.1906)***	0.4398 (68.4119)***
Physical Capital	0.3737 (6.7896)***	0.2706 (5.7751)***	0.4735 (39.3980)***
Trade Openness	-0.4473 (- 5.5793)***	-0.1545 (- 6.3725)***	-0.4627 (- 96.2586)***
R-squared	0.8040	0.9952	0.8342
Adj R-square	0.7972	0.9947	0.8291
J-statistics (p- Value)	6.3867 (0.1023)	12.7809 (0.1196)	9.0923 (0.1054)

*Here *, **, *** indicate significance of parameters at 10%, 5% and 1% respectively. t-statistics are presented in brackets.*

Estimate of health capital also shows positive and significant impact on economic growth of D8 countries. It means that there is positive association of health capital and economic growth. The coefficient estimate indicates that 1% increase in health capital causes an increase of 0.43% in economic growth. If people are healthy, they are more efficient in their productivity which leads to higher economic growth. Healthy labor is mentally and physically more robust and energetic. Healthy workers earn high wages and more productive. Better health contributes in economic growth as it decreases the loss of productivity due to illness. Moreover, better health increases the uses of natural resources that are inaccessible due to diseases. Health capital also increases school enrollment of children and makes them better for learning. Some studies in the published literature also support these findings (Aka & Dumant, 2008; Akram et al., 2008; Beraldo et al., 2009). Significant and positive impact of physical capital on economic growth is estimated in the model. The results show that 1% increase of physical capital stock causes 0.47% rise in economic growth. If there is improvement in infrastructure like roads, railways, including offices, commercial buildings, industrial equipment, and machinery, it results in improvement of economic growth. Aghion and Howitt's (1998) says that investment in physical capital increases the capacity of production. It all leads to higher economic growth. Some previous studies like Xiaoqing (2005) and Becker et al., (1994) also support the findings. Coefficient estimate of trade openness indicates adverse impact on the developing economies. It is because of rise in exports of raw material instead of final goods as barriers of trade reduction in developing countries. Gries and Redlin (2012) and Wigeborn (2010) also support these findings of the study.

If we compare the coefficient estimates of education capital, health capital and physical capital, it is obvious that physical capital indicates larger impact as compared to education capital and health capital. However, adding both the coefficient estimates of education and health capital representing human capital shows larger impact of human capital as compared to the impact of physical capital on economic growth in D-8 economies. It implies that investment in both physical as well as human capital is imperative for D-8 countries in order to achieve high economic growth. If there is improvement in infrastructure, it results in improvement of economic growth. Policy makers of these economies should raise the level of human capital along with physical capital. It is because investments in human resources leads to higher output per worker due to increase in efficiency of labor and their capabilities. It also improves the quality of products. Developing countries should make more investment in health sector by creating maximum services of health that are in easy access to all people in the country. It also try to increase the coverage of insurance to all people and increase the efficiency of covering insurance for the provision of healthcare costs. According to the results of this study, developing countries should increase their attention to education sector as well as in health sector that can resultantly increase the process of economic growth in any country.

Conclusion and Policy Implications

This study has been conducted to explore the role of physical capital and human capital in economic growth of eight developing economies named D-8 countries. Literature review is concluded that growth theories considered human capital as vital input for economic growth. Most of the empirical studies show positive impact of human capital but some empirical studies mention adverse impact of human capital on economic growth in some economies. Hence, major objective of this study is to evaluate the impact of physical capital and human capital on economic growth in D-8 economies. Moreover, comparison of the role of both types of capital in economic growth of developing economies may provide useful information about policy steps in these countries. Model is specified on the basis of neoclassical growth theory by incorporating education and health capital. Annual data ranging from 1995 to 2015 are taken from WDI. GMM is employed to estimate the three panel data models and Random effect model is selected as an appropriate model to analyze the phenomenon. Results conclude that the impact of Education capital, Health capital and physical capital on real GDP per capita is significant and positive in D-8 countries. However, impact of human capital (health capital and education) on economic growth is larger than physical capital. Hence, human capital can be considered as the main driver of economic growth in spite of significance of physical capital in D-8 economies. Human capital is an important factor for economic growth, and should be improved in parallel with physical capital. To do this, policy makers should focus on strengthening education and training systems, which can help individuals develop skills and knowledge necessary for success in the job market. Additionally, policy makers should ensure that labor markets are fair and efficient, and that wages are commensurate with productivity and cost of living (Awais, Zulfiqar, Saghir, Sohail, & Rana, 2022). They should also programs, and support entrepreneurship. Therefore, more investment in human capital than work to create jobs, provide job-training physical capital is suggested to raise the level of economic growth. However, trade openness adversely affects economic growth in these countries which implies that D-8 countries should revise their trade policies and should restrict non-productive imports. This could help protect domestic industries and encourage local job creation. To do this, they should establish clear and consistent regulations and tariffs, and provide incentives for local businesses to produce goods and services. This could help create a more robust economy and increase the number of available jobs.

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