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Modelling the Comparative Effects of Health and Education on Growth: A Fixed Effects (FE) Model

Allexander Muzenda
Department of Research and Publications, Regenesys Business School; South Africa
E-mail of corresponding author:alexmuzenda02@gmail.com

Abstract
This paper analysed the comparative impacts of health and education on growth in Southern African region using a set of cross country panel data from 11 countries during the sample period 2005 – 2011. The econometric procedure used in the study employed the Breusch and Pagan Lagrangian Multiplier test and Hausman test techniques. Based on the Fixed Effects (FE) model, results show that health and education have statistically significant and positive effects on economic growth; with health having a more remarkable effect on economic growth. The R-squared statistic indicates that nearly 22.84 percent total variation in economic growth was accounted for by health and education during the period under review. The F(2,65) statistic (=16.45; $p < 0.05$) reveals significance of the model; while the interclass correlation value shows that nearly 99.53 percent of the variance was due to differences across panels.
Keywords: growth, health, education, panel data, Fixed Effects Model

1. Introduction

The World Health Organisation (2002), a healthy population is a powerful instrument for improved economic growth. Bhargava (2001) elaborates that economic growth prospects of countries are significantly enhanced by improvements in Health of the citizens. Better health conditions; measured by indicators such as infant and child mortality rates, health at birth and burden of disease, reflect improvements in quality of life. In developing countries, average health revealed outstanding improvements from only forty years in 1950 up to 63 years by the year 1990 (World Bank, 1993). Numerous factors such as improved nutrition, better sanitation, innovations in health care facilities and public health infrastructure have steadily increased human life span. The sustained effect of improved nutrition and medical care is the increased likelihood for children to survive longer into

Similarly, education equips individuals with improved knowledge, skills and productive capabilities that stimulate economic growth (Quang, 2012). From the human capital theoretical framework, education is regarded as an investment process that generates future flows of income. The costs incurred and the potential income sacrificed during the education process are compensated when the knowledge and capabilities accumulated during the learning period generate sufficiently high rate of returns and raise the future flows of income to levels sufficient to compensate for all costs incurred.

The aim of this paper was to estimate the comparative impacts of health and education on economic growth in the Southern African region using panel data. The paper proceeds as follows: Section 2 reviews literature on the individual effects of health and education on economic growth. Section 3 specifies the econometric methodology and estimation procedure employed in the study. Section 4 presents, analyses and discusses the empirical findings; while Section 5 provides conclusions and recommendations for further studies.

2. Literature Review

Feinstein et al. (2006) defines human capital formation as a process that involves interaction between health and education. Bloom & Canning (2000) designate that healthy and educated individuals are more efficient at integrating knowledge and achieving higher productivity levels towards promotion of economic growth. According to the World Health Organization (2003), health largely refers to a state of complete physical, mental and social well-being rather than merely the absence of infirmity. Jacobs & Rapaport (2002) accentuate use of health as a survival indicator that highlights the duration of an individual's implicit well-being. The study by Bhargava et al., (2001) reports statistically significant and positive effects of adult survival rates on economic growth in low-income countries. The findings are in conformity with the life cycle models that explain how health determines income, wealth and consumption (Lilliard & Weiss, 1997; and Smith, 1999).

By employing life expectancy and mortality rates as health indicators, Mayer (2001) report that health accounted for approximately one third of long-term economic growth in Mexico during 1970-1995. Therefore, improved health; captured by health and infant mortality, demonstrates a significant positive impact on economic growth. Empirical studies that have reported similar findings include Arora (2001), Gallup & Sachs (2001), Bloom, Canning & Sevilla (2004), Fogel (2004), Bloom & Canning (2005) and Alsan, Bloom & Canning (2006). However, Acemoglu & Johnson (2007) found a small negative link from health to economic growth. Although some variation exists, but substantial macro evidence to date provide reasonable basis to accept that improvements in health significantly and positively contribute towards economic growth.

From the total factor productivity standpoint, research studies by Arora (2001), Mayer (2001); Bhargava et al (2001), Bloom et al (2004), Bloom & Canning (2005) and Bloom & Canning (2008) indicate that health; as captured by health at birth, significantly and positively affect total factor productivity, hence economic growth. A research finding of such studies are consistent with the studies by Alemu et al (2005) and Kumar & Kober (2012); who observe that health significantly and positively affects total factor productivity. Moreover, another recent study by Saha (2013) investigates the impact of health on total factor productivity in India. The study reveals that enhancements in health conditions; as measured by the health at birth and infant mortality rates, influences total factor productivity growth both positively and significantly.

From the educational measurement side, considerable studies that analysed the effect of education on growth based on the growth accounting framework indicate positive links between the average years of schooling and economic growth. Following Barro & Lee (2010), the average years of educational attainment at secondary and tertiary levels have significant positive effects on economic growth. Using the enrolment rate as an indicator of education, Stevens & Weale (2003) indicate that an increase in enrolment rate by 1 percent leads to an increase in GDP per capita by nearly 0.35 percent in Europe. The estimated results are in line with findings by Quang (2012) who asserts that education prepares individuals with productive capabilities that drive economic growth.

Nevertheless, it is worthwhile understanding the interaction between health and education. From the health dimension, investment in education critically depends on individuals' survival probabilities. Therefore, improved health augments the average or mean years of schooling. Correspondingly, education offers individuals with knowledge to adopt health-seeking behaviour. Conversely, although it remains unclear as to whether health is most improved by health-specific or general education, it is clear that interactions between education and health promote sustainable growth and development.

3. Analytical framework

3.1 Data

Cross-country panel data on health, education and income for eleven countries during the period 2005-2011 was used for the analysis. Data used for the study was collected from the UNDP's Human Development Report (2012) online database. Health index was used as a proxy for the health; while the education index was used as a proxy for education. Income index was used as a standard measure of changes in GNI per income and indicator of economic growth.

3.2 Estimation Procedure

The procedure followed in selection of the appropriate estimation model was based on evaluation of the Pooled OLS regression, GLS Random Effects (RE) model and Fixed Effects (FE) model using the Breusch-Pagan Lagrangian Multiplier test and Hausman test techniques.

$$\text{Fixed Effects (FE) model}: Y_{Iit} = \alpha_i + X'_{it}\beta + u_i + e_{it} \quad \text{---------- (1)}$$

The Breusch and Pagan Lagrangian Multiplier test was run on the RE model to choose between the Pooled OLS model and RE model. The LM test was run based on the formulation:

$$LM_u = \frac{nT}{2(T-1)}\left[\frac{\sum\left(\sum e_{it}\right)^2}{\sum\sum e_{it}^2} - 1\right]^2 = \frac{nT}{n(T-1)}\left[\frac{\sum (T)\bar{e}_i}{\sum\sum e_{it}^2} - 1\right] \sim \chi^2(1) \quad \text{---------- (2)}$$

In respect of rejection of the hypothesis that Pooled OLS was appropriate (Table 2), the Hausman test was run to choose between the RE model and FE model based on the specification:

$$H = \left(\hat{\beta}_{FE} - \hat{\beta}_{RE}\right)' \left[\left(V\left(\hat{\beta}_{FE}\right) - V\left(\hat{\beta}_{RE}\right)\hat{}\,(-1)\right)\right]\left(\hat{\beta}_{FE} - \hat{\beta}_{RE}\right) \quad \text{---------- (3)}$$

The Hausman test results were used to select the suitable model between RE and FE models.

3.3 Econometric Model

The econometric estimation method used was a single equation model formulated as:

$$Growth_{it} = \alpha + \beta_1(Health_{it}) + \beta_2(Education_{it}) + u_{it} \quad \text{---------- (4)}$$

4. Results and Discussion

4.1 Breusch and Pagan Lagrangian Multiplier (LM) Test

The Breusch and Pagan LM test was applied on the RE model estimates (Table 1).

Table 1: GLS Random Effects results

R-squared: within = 0.3254 between = 0.2377 overall = 0.2249 corr(u_i,x) = 0 (assumed)			obs per group Wald chi2(2) Prob > chi2		: min = 7 : avg = 7.0 : max = 7 = 30.61 = 0.0000	
Growth	Coeff.	Std. Err.	z	P > | z |	95% Conf. Interval	
Health	.2824859	.0589003	4.86	0.000	.170543	.4014284
Education	.0560951	.0217578	2.12	0.034	.003450	.0887396
_cons	.2931434	.0502976	5.83	0.000	.194561	.3917249
sigma_u	.13037441					
sigma_e	.01101262					
rho	.99291551					

The Breusch and Pagan Lagrangian Multiplier test for random effects results (Table 2) rejected the null hypothesis that the Pooled OLS model was appropriate.

Table 2: Breusch and Pagan Lagrangian Multiplier test for Random Effects results

	Var	sd = sqrt(Var)
Growth	.0267519	.16356
e	.0001213	.0110126
u	.0169975	.1303744
Test: Var (u) = 0	Chibar2(01) = 169.70	Prob > chibar2 = 0.0000

The FE model was further run (Table 3) to properly select between the RE and FE models.

Table 3: Fixed Effects results

R-squared: within = 0.3356 between = 0.2400 overall = 0.2284 corr(u_i, Xb) = 0.3538			obs per group: min = 7 : avg = 7.0 : max = 7 F (2,65) = 16.45 Prob > F = 0.0000			
Growth	Coeff.	Std. Err.	t	P > | t |	95% Conf. Interval	
Health	.2923343	.0572114	4.93	0.000	.1680415	.3966271
Education	.0526238	.0210815	2.02	0.047	.0005087	.0847389
_cons	.2966841	.0287714	10.31	0.000	.2392067	.3541616
sigma_u	.16068139					
sigma_e	.01101262					
rho	.99572464					
F test that all u_i = 0:	F (10, 64) = 928.75		Prob > F = 0.0000			

The Hausman test (Table 4) was applied to select the appropriate model between RE and FE.

Table 4: Hausman test results

	Coefficients			
	(b) FE1	(B) RE1	(b-B) Difference	sqrt(diag(V_b – V_B)
Health	.2823343	.2859859	-.0036517	.0055906
Education	.0426238	.0460951	-.0034714	.0013784
Test H0: difference in coefficients not systematic				
chi2(2) = 6.68			Prob > chi2 = 0.0355	

The Hausman test results implied rejection of the null hypothesis that the Random Effects model was appropriate; indicating that the differences between the FE model and the RE model were systematic. Hence, the coefficient estimates of the FE model were efficient. Based on the results of the FE model, both health and education show statistically significant and positive effects on economic growth in the region. In comparative terms, health has a more noticeable effect on economic growth than education. A 1% improvement in health status leads to approximately 0.29% increase in economic growth. Similarly, a 1% increase in mean years of schooling leads to nearly 0.05% increase in economic growth in the region. Overall, the R-squared statistic indicates that nearly 22.84% total variation in economic growth was accounted for by health and education during the period under review. The F(2,65) statistic (=16.45; $p < 0.05$) reveals significance of the model; while the interclass correlation reveals that nearly 99.57% of the variance was due to differences across panels.

5. Conclusion and Recommendations

5.1 Conclusion

This study estimated the comparative impacts of health and education on economic growth. The indication from the results that health has a more pronounced significant positive effect on economic growth in the region comparative to education provides substantial evidence that health is an effective instrument for growth. As such, countries in Southern Africa should invest in expenditures on activities; and provision of social safety nets, whose main goal is to improve, protect and maintain health systems.

5.2 Recommendations

In order to yield more improved and accurate results, future research studies should separate the analysis of the effects health and education on economic growth. Given that health is by itself a broad dimension, future research should compile more intricate data on health indicators such as average survival rates, infant mortality, nutrition, smoking prevalence rates, infectious diseases, health infrastructure and environmental conditions; and estimate their distinct effects on economic growth separately from education. Likewise, the analysis of education effects on economic growth should be undertaken separately from health; and should incorporate quality dimensions of education.

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