

The relationship between Economic Growth and Human Capital in Developing Countries

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ABSTRACT

This paper investigates the causal relationship between education and GDP in developing countries by using panel unit root tests and panel cointegration analysis for the period 1970-2010. A three-variable model is formulated with capital formation as the third variable. The results show a strong causality from investment and economic growth to education in these countries. Yet, education does not have any significant effects on GDP and investment in short- and long-run. It means that it is the capital formation and GDP that drives education in mentioned countries, not vice versa. So the findings of this paper support the point of view that it is higher economic growth that leads to higher education proxy. It seems that as the number of enrollments raise, the quality of the education declines. Moreover, the formal education systems are not market oriented in these countries. This may be the reason why huge educational investments in these developing countries fail to generate higher growth. By promoting practice-oriented training for students particularly in technical disciplines and matching education system to the needs of the labor market, it will help create long-term jobs and improve the country's future prospects.

Keywords: Panel Unit Root; Panel Cointegration; Granger Causality; Human Capital; Developing Countries

JEL classifications: O40, O15, I20, C33, C10

1. INTRODUCTION

Generally, it is argued that higher formal education cause more economic growth. Lucas (1988) argues the accumulation of human capital is responsible for sustained growth, and education is the main channel through which the human capital accumulates. Romer (1986, 1990) show that human capital, which generates innovations, stimulate growth. As it is well documented in the literature, education also constructs spillover affects, improves the adaptation speed of entrepreneurs to disequilibrium, and boosts research productivity. Furthermore, there is the possibly feedback effects from economic growth to human capital. It is argued that economic growth could lead to human capital accumulation (Mincer, 1996). So, the causal chain between economic growth and education implied by the existing macroeconomic paradigms seems relatively ambiguous.

The subject, therefore, as to the dynamic causal relationships in the Granger sense remains uncertain and is a practical one. There is mixed evidence in the empirical literature regarding the relation between education and economic growth. Benhabib and Pritchett (1997) report fragile correlation between growth and education. Levine and Renelt (1992) show that education does not have significant impact in many of the growth regressions they have estimated. Bils and Klenow (2000) finds the weak causality from education to growth; so that the statistical significance of education in growth regressions may arise from just omitted variables. therefore, the cross-sectional studies seem to yield mixed results. Dessus (1999) argues that the findings of Pritchett (1997) may be due to specification bias. Dessus' (1999) panel data results suggest that as the education quantity increase, the quality of the education decrease. This may be the reason why enormous educational investments in developing countries fail to generate higher growth.

The focus of the paper is, therefore, to examine the relationship between education and economic growth using panel data for 101 developing countries during the period 1970-2010. The direction of causality between these two variables is examined by utilizing a cointegration and error correction modeling framework. The paper is organized in four sections. Section 2 discusses the methodology, data and empirical results of the study. Section 3 concludes.

2. DATA AND EMPIRICAL RESULTS

We apply a three variable model to examine the causal relationship between human capital GDP with gross investment included in model as conditioning variable along with these two variables. Human capital is proxied by enrolment ratio in all levels of education (including tertiary, secondary and primary education measured as the percentage of the working age population) as well as public expenditures on education relative to total public expenditures. We apply the principle component approach to merge the proxies into one measurement (HUM).

The data were obtained from the Barro and Lee dataset and world development indicators. Data used in the analysis are annual time series during the period 1970-2010 on the proxy of human capital, (logarithm of) real GDP per capita (GDP) and real investment (INV) in constant 2000 prices in local currency units using panel data for 101 developing countries. The choice of the starting period was constrained by the availability of data (For the names of countries, see the appendix).

To test the nature of association between the variables while avoiding any spurious correlation, the empirical investigation in this paper follows the three steps: We begin by testing for non-stationarity in the three variables of HUM, GDP and INV. Prompted by the existence of unit roots in the time series, we test for long run cointegrating relation between three variables at the second step of estimation using the panel cointegration technique developed by Pedroni (1995, 1999). Granted the long run relationship, we explore the causal link between the variables by testing for granger causality at the final step.

2. 1. Panel Unit Roots Results

The panel data technique referred above has appealed to the researchers because of its weak restrictions. It captures country specific effects and allows for heterogeneity in the direction and magnitude of the parameters across the panel. In addition, it provides a great degree of flexibility in model selection. Following the methodology used in earlier works in the literature we test for trend stationarity of the three variables of HUM, GDP and INV. With

a null of non-stationary, the test is a residual based test that explores the performance of four different statistics. Together, these four statistics reflect a combination of the tests used by Levin-Lin (1993) and Im, Pesaran and Shin (1997). While the first two statistics are non-parametric rho-statistics, the last two are parametric ADF t-statistics. Sets of these four statistics have been reported in Table 1.

The first three rows report the panel unit root statistics for HUM, GDP and INV at the levels. As we can see in the table, we cannot reject the unit-root hypothesis when the variables are taken in levels and thus any causal inferences from the three series in levels are invalid. The last three rows report the panel unit root statistics for first differences of HUM, GDP and INV. The large negative values for the statistics indicate rejection of the null of non-stationary at 1 % level for all variables. It may, therefore be concluded that the three variables of HUM, GDP and INV are unit root variables of order one, or, I (1) for short.

Table 1. Test of Unit Roots for HUM, GDP and INV.

Variables	Levin-Lin Rho-stat	Levin-Lin t-Rho-stat	Levin-Lin ADF stat	IPS ADF stat
<i>HUM</i>	0.80	-0.91	-0.76	-1.10
<i>GDP</i>	-1.74	-1.38	-1.39	-0.49
<i>INV</i>	0.42	-0.62	-0.83	-1.89
ΔHUM	-14.63***	-7.61***	-7.29***	-12.01***
ΔGDP	-10.75***	-8.95***	-9.40***	-18.11***
ΔINV	-14.10***	-8.41***	-7.62***	-16.74***

***significant at 1 %

2. 2. Panel Cointegration Results

At the second step of our estimation, we look for a long run relationship among HUM, GDP and INV using the panel cointegration technique developed by Pedroni (1995, 1999). This technique is a significant improvement over conventional cointegration tests applied on a single country series. While pooling data to determine the common long run relationship, it allows the cointegrating vectors to vary across the members of the panel. After including INV as an additional variable, the cointegration relationship we estimate is specified as follows:

$$GDP_{it} = \alpha_i + \delta_t + \beta_i HUM_{it} + \gamma_i INV_{it} + \varepsilon_{it} \quad (1)$$

where α_i refers to country effects and δ_t refers to trend effects. ε_{it} is the estimated residual indicating deviations from the long run relationship. With a null of no cointegration, the panel cointegration test is essentially a test of unit roots in the estimated residuals of the panel. Pedroni (1999) refers to seven different statistics for this test. Of these seven statistics, the first four are known as panel cointegration statistics; the last three are group mean panel cointegration statistics. In the presence of a cointegrating relation, the residuals are expected to be stationary. These tests reject the null of no cointegration when they have large negative values except for the panel-v test which reject the null of cointegration when it has a large positive value. All of these seven statistics under different model specifications are reported in Table 2. The statistics for all different model specifications suggest rejection of the null of no

cointegration for all tests except the panel and group ρ -tests. However, according to Perdroni (2004), ρ and PP tests tend to under-reject the null in the case of small samples. We, therefore, conclude that the three unit root variables HUM, GDP and INV are cointegrated in the long run.

Table 2. Results of Panel Cointegration test.

Statistics	
Panel v-stat	8.03***
Panel Rho-stat	-6.61***
Panel PP-stat	-6.81***
Panel ADF-stat	-5.71***
Group Rho-stat	-2.91**
Group PP-stat	-9.71***
Group ADF-stat	-6.81***

***significant at 1 %

** significant at 5 %

2. 3. Panel Causality Results

Cointegration implies that causality exists between the series but it does not indicate the direction of the causal relationship. With an affirmation of a long run relationship among HUM, GDP and INV, we test for Granger causality in the long run relationship at the third and final step of estimation. Granger causality itself is a two-step procedure. The first step relates to the estimation of the residual from the long run relationship. Incorporating the residual as a right hand side variable, the short run error correction model is estimated at the second step. Defining the error term from equation (1) to be ECT_{it} , the dynamic error correction model of our interest by focusing on Human capital (HUM) and GDP is specified as follows:

$$\Delta GDP_{it} = \alpha_{yt} + \beta_{yt} ECT_{i,t-1} + \gamma_{y1i} \Delta HUM_{i,t-1} + \gamma_{y2i} \Delta HUM_{i,t-2} + \delta_{y1i} \Delta GDP_{i,t-1} + \delta_{y2i} \Delta GDP_{i,t-2} + \lambda_{y1i} \Delta INV_{i,t-1} + \lambda_{y2i} \Delta INV_{i,t-2} + \varepsilon_{yit} \quad (2)$$

$$\Delta HUM_{it} = \alpha_{hi} + \beta_{hi} ECT_{i,t-1} + \gamma_{h1i} \Delta INV_{i,t-1} + \gamma_{h2i} \Delta HUM_{i,t-2} + \delta_{h1i} \Delta GDP_{i,t-1} + \delta_{h2i} \Delta GDP_{i,t-2} + \lambda_{h1i} \Delta INV_{i,t-1} + \lambda_{h2i} \Delta INV_{i,t-2} + \varepsilon_{hit} \quad (3)$$

where Δ is a difference operator; ECT is the lagged error-correction term derived from the long-run cointegrating relationship; the β_y and β_h are adjustment coefficients and the ε_{yit} and ε_{hit} are disturbance terms assumed to be uncorrelated with mean zero. Sources of causation can be identified by testing for significance of the coefficients on the lagged variables in Eqs (2) and (3). First, by testing $H_0 : \gamma_{y1i} = \gamma_{y2i} = 0$ for all i in Eq. (2) or $H_0 : \delta_{h1i} = \delta_{h2i} = 0$ for all i in Eq. (3), we evaluate Granger weak causality. Masih and Masih (1996) and Asafu-Adjaye (2000) interpreted the weak Granger causality as 'short run' causality in the sense that the dependent variable responds only to short-term shocks to the stochastic environment.

Another possible source of causation is the ECT in Eqs. (2) and (3). In other words, through the ECT, an error correction model offers an alternative test of causality (or weak exogeneity of the dependent variable). The coefficients on the ECTs represent how fast deviations from the long run equilibrium are eliminated following changes in each variable. If, for example, β_{yi} is zero, then GDP does not respond to a deviation from the long run equilibrium in the previous period. Indeed $\beta_{yi} = 0$ or $\beta_{hi} = 0$ for all i is equivalent to both the Granger non-causality in the long run and the weak exogeneity (Hatanaka, 1996).

It is also desirable to check whether the two sources of causation are jointly significant, in order to test Granger causality. This can be done by testing the joint hypotheses $H_0 : \beta_{yi} = 0$ and $\gamma_{y1i} = \gamma_{y2i} = 0$ for all i in Eq. (2) or $H_0 : \beta_{hi} = 0$ and $\delta_{h1i} = \delta_{h2i} = 0$ for all i in Eq. (3). This is referred to as a strong Granger causality test. The joint test indicates which variable(s) bear the burden of short run adjustment to re-establish long run equilibrium, following a shock to the system (Asafu-Adjaye, 2000). The results of the F test for both long run and short run causality are reported in Table 3. As is apparent from the Table, the coefficients of the ECT, GDP and INV are significant in the HUM equation which indicates that long-run and short-run causality run from GDP and INV to human capital. So, GDP and INV strongly Granger-causes human capital. INV does Granger cause GDP at short run at 5% level, without any significant effect on output in long run. Weak exogeneity of GDP indicate that this variable does not adjust towards long-run equilibrium. Moreover, the interaction terms in the HUM equation are significant at 1% level. These results imply that, there is Granger causality running from GDP and INV to human capital in the long-run and short run, while human capital have a neutral effect on GDP in both the short- and long-run. In other words, GDP is weakly exogenous and whenever a shock occurs in the system, human capital would make short-run adjustments to restore long-run equilibrium.

Table 3. Result of Panel causality tests.

Dependent Variable	Source of causation (independent variable)						
	Short-run			Long-run	Joint (short-run/long-run)		
	Δ GDP	Δ HUM	Δ INV	ECT(-1)	Δ GDP, ECT(-1)	Δ HUM, ECT(-1)	Δ INV, ECT(-1)
Δ GDP	-	F=0.81	F=9.09***	F=0.61	-	F=0.99	F=4.01**
Δ HUM	F=4.61**	-	F=5.91***	F=7.81***	F=7.91***	-	F=883***

***significant at 1 %

** significant at 5 %

3. CONCLUSION

The objective of this study is to examine Granger causality between human capital and income for 101 developing countries over the period 1970-2010. Real capital formation is also included in the model along with these two variables. The panel integration and cointegration techniques are employed to investigate the relationship between the three variables: human capital proxy, GDP, and investment. The empirical results indicate that we cannot find enough evidence against the null hypothesis of unit root. However, for the first difference of the variables, we rejected the null hypothesis of unit root. It means that the variables are I(1). The

results show that there is a long-run relationship between human capital and GDP. Utilizing Granger Causality within the framework of a panel cointegration model, the results suggest that there is strong causality running from GDP and investment to human capital with no feedback effects from human capital to GDP for developing countries.

It means that it is the investment and GDP that drives the human capital in mentioned countries, not vice versa. So the findings of this paper support the point of view that it is higher economic growth that leads to higher human capital. According to the results, it seems that, to some extent, investments have contributed to human capital and economic growth during the sample period. It seems that as the number of enrollments increase, the quality of the education declines. This may be the reason why huge educational investments in these developing countries fail to generate higher growth. In order to match education opportunities with the demands of the labour market, support should be provided for integrating labour market data into educational planning and establishing technical and start-up centres at universities

Appendix: Sample Countries

Algeria	Korea, rep
Argentina	Lesotho
Azerbaijan	Liberia
Bangladesh	Lithuania
Barbados	Madagascar
Belize	Malawi
Benin	Malaysia
Bolivia	Mali
brazil	Mauritania
Bulgaria	Mauritius
Burundi	Mexico
Cambodia	morocco
Cameroon	Mozambique
cape Verde	Namibia
central African rep	Nepal
Chad	Nicaragua
Chile	Niger
China	Nigeria
Colombia	Pakistan
Comoros	Panama
Congo, Dem. Rep.	Papua new guinea
Congo, Rep.	Paraguay
Costa Rica	Peru
cote d'Ivoire	Philippines
Cyprus	Poland
Dominica	Portugal
Dominican republic	Romania
Ecuador	Rwanda
Egypt	Sao tome
Elsalvador	Senegal
equatorial guinea	Seychelles
Estonia	sierra Leone
Ethiopia	Solomon islands
Gabon	South Africa
Gambia	Sri lanka

Ghana	St. Lucia
Grenada	St. Vincent and the Grenadines
Guatemala	Sudan
Guinea	Tanzania
guinea-Bissau	Thailand
Guyana	Togo
Haiti	Trinidad
Honduras	Tunisia
Hungary	Turkey
India	Uganda
Indonesia	Uruguay
Iran	Uzbekistan
Jamaica	Venezuela
Jordan	Zambia
Kazakhstan	Zimbabwe

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References

- [1] Aghion P., Howitt P., *Endogenous growth theory*, MIT Press, 1998.
- [2] Alderman H., Behrman J. R., Ross D. R., Sabot R., *Oxford Bulletin of Economics and Statistics* 58 (1996) 29-55.
- [3] Anderson T. W., Hsiao C., *Journal of the American Statistical Association* 76 (1981) 598-606.
- [4] Arellano M., Bond S. R., *Review of Economic Studies* 58 (1991) 277-297.
- [5] Arellano M., Bover O., *Journal of Econometrics* 68 (1995) 29-51.
- [6] Barro R. J., *Quarterly Journal of Economics* 106 (1991) 407-443.
- [7] Barro R. J., *Swedish Economic Policy Review* 6 (1999) 237-277.
- [8] Barro R. J., Lee J. W., *American Economic Review* 86 (1996) 218-223.
- [9] Barro R. J., Sala-i-Martin X., *Economic Growth*, Mc-Graw Hill, New York, 1995.
- [10] Benhabib J., Spiegel M. M., *Journal of Monetary Economics* 34 (1994) 143-173.
- [11] Bils M., Klenow P., *Does schooling cause growth or the other way around?* NBER Working, 1998, Paper 6393.
- [12] Granger C. W. J., *Econometrica* 37(3) (1969) 424-438.
- [13] Granger C. W. J., *Journal of Econometrics* 39 (1988) 199-211.
- [14] Harrod R. F., *Economic Journal* 49 (1939) 14-33.
- [15] Hatanaka M., *Time-Series-Based Econometrics: Unit Roots and Co-integration*. Oxford University Press, Oxford, 1996.
- [16] Im K. S., Pesaran M. H., Shin Y., *Testing for Unit Roots in Heterogeneous Panels*, University of Cambridge, 1997, Department of Applied Economics.

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- [17] Im K. S., Pesaran M. H., Shin Y., *Journal of Econometrics* 115 (2003) 53-74.
- [18] Levin A., Lin C. F., *Unit Root Tests in Panel Data: Asymptotic and Finite Sample Properties*. Department of Economics, University of California at San Diego, Working Paper 1992, 92-23.
- [19] Levin A., Lin C. F., *Unit Root Test in Panel Data: New Results*. Department of Economics, University of California, San Diego, Working paper 2003, 93-56.
- [20] Levin A., Lin C. F., Chu C. S. J., *Journal of Econometrics* 108 (2002) 1-24.
- [21] Masih A. M. M., Masih R., *Energy Economics* 18 (1996) 165-183.
- [22] Pedroni P., *Panel Cointegration: Asymptotic and Finite Sample Properties of Pooled Time Series Tests, with an Application to the PPP Hypothesis*. Indiana University, Working Papers in Economics 1995, No. 95-013.
- [23] Pedroni P., *Panel Cointegration: Asymptotic and Finite Sample Properties of Pooled Time Series Tests, with an Application to the PPP Hypothesis: New results*, India University, Working Papers in Economics, 1997.
- [24] Pedroni P., *Oxford Bulletin of Economics and Statistics* 61 (4) (1999) 5-49.
- [25] Pedroni P., *Econometric Theory* 20(3) (2004) 597-627.
- [26] Pesaran M. H., Shin Y., *An Autogressive Distributed Lag Modelling Approach to Cointegration Analysis*, Working Paper Trinity College, Cambridge, 1997.
- [27] Solow R. M., *Quarterly Journal of Economics* 70 (1956) 65-94.

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