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How Does Human Capital Affect on Growth in Different Economies?

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Abstract: Problem statement: The main objective of this study was to investigate how human capital can affect growth in different economies. **Approach:** For this purpose, we investigated the model, which the growth rate of total factor productivity depends on human capital stock level using a cross-country panel approach for 104 countries in five-year intervals during the 1980-2005. **Results:** The finding of this study showed that human capital through its effect on the speed of technology adoption from abroad has positive effect and significantly on growth in total samples of countries while human capital directly in developed countries enter negatively inverse developing countries. **Conclusion:** Moreover human capital affects growth in different ways it has more effects on per capital growth through technology/catch-up component than domestic innovation component. Moreover human capital of different ways has different effects on growth but in total it has positive effect on economic growth.

Key words: Human capital, growth, panel approach

INTRODUCTION

The importance of human capital in economic growth has been emphasized by many theoretical models of economic growth, such as Nelson and Phelps (1966); Lucas (1988); Rebelo (1991) and Mulligan and Sala-I-Martin (1997) and also many empirical studies of growth for a broad cross-section of countries such as Romer (1990a); Barro (1991); Kyriacou (1991) and Benhabib and Spiegel (1992) have used proxies for human capital.

Although empirical researches have established the positive influence of human capital to economic growth, but many studies cast doubt on the traditional role given to human capital, merely as a factor of production and there is disagreement about the mechanisms through which this happens. Romer (1990a) suggests that human capital may directly affect on productivity by enhancing the capacity of countries to create new technologies. Aghion and Howitt (1997, chapter 10) distinguish two major frameworks within the endogenous growth literature, i.e., the Lucas approach and the Nelson-Phelps approach. The former, based on Lucas (1988) and shared by neo-classical growth theory, assumes that growth is driven by the accumulation of human capital. It treats human capital like an ordinary input in the production function. In particular, differences in growth rates across countries are assumed to be primarily due to differences in the rates of human capital accumulation. The second approach, based on Nelson and Phelps (1966), relates growth to the stock of human capital which affects a country's ability to innovate and catch-up with more advanced countries (Aghion and Howitt, 1997).

Benhabib and Spiegel (1994), with adopting from Nelson and Phelps (1966) framework, introduce an alternative model. Their model allows human capital to influence growth through two channels: First, human capital levels directly influence the rate of domestically produced technological innovation (Romer, 1990a). Second, the human capital stock affects the speed of adoption of technology from abroad (Nelson and Phelps, 1966). In their model, at any time, there exists some country which is the world leader in technology. The speed, on which nations catch up to this leader country, is then a function of their human capital stocks (Benhabib and Spiegel, 1994). They make a very good attempt in this direction, by introducing a cross-country approach during a twenty-year interval of 1965-1985. Their empirical findings show that human capital stock in levels plays a role in determining the growth of per capital income whether negatively or insignificantly. They also obtain positive results that human capital could be effective in economic growth as an engine of attracting physical capital and as a determinant of the magnitude of a country's Solow residual.

This study extends the study of Benhabib and Spiegel (1994) in several important ways, while Benhabib's research was based on a cross-country data using ordinary least square for 78 countries in a twenty-year interval of 1965-1985, this study utilizes a panel data for 104 countries in five-year intervals of 1980-

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2005, we also have used a greater sample for estimation including 25 developed countries (OECD) and 79 developing countries instead of third of poorest and richest countries. We also use average years of schooling of updated data set by Barro and Lee (2010) data as a proxy for human capital instead of Kyriacou human capital measure.

Then we compared the effect of human capital stock in economic growth in developing countries with developed countries. We also estimated the physical stock by perpetual inventory method, following Bernanke and Gurkaynak (2001) approach. The rest of the study is outlined as follows: At first provides a brief of information description about related literature are presented. In continue, describes the data and methodology, in addition discussion and empirical results. The study finishes with a conclusion.

Literature review: The importance of human capital in economic growth has been emphasized by many researchers. In fact, after failure of the Solow model in explaining income difference across countries, many approaches have been implemented to augment the standard of Solow growth model. More evidences gradually suggested the importance of human capital in economic growth. Kendrick (1976) estimated that over half of the total US capital stock in 1969 was human capital. Azariadis and Drazen (1990) found that without a highly literate labor force, no country was able to experience fast growth during the postwar period.

The next question is how human capital affects economic growth. Nelson and Phelps (1966) suggested that the ability of a country to import and use new technologies from abroad is also a function of the country`s human capital stock. Romer (1990a) suggested that human capital might directly affect productivity by enhancing the capacity of a country to create new technologies. Lucas (1990) said that physical capital failed to flow to poor countries because of their relatively poor endowments of complementary human capital. Kyriacou (1991) examined the role of human capital in explaining the inability of some developing countries to catch-up with more advanced countries, using a cross-country Cobb-Douglas production for large number of countries during 1970-1985 periods. He found that coefficient of human capital (years of schooling in the labor force) is negative and insignificant (Kyriacou, 1991).

Mankiw *et al*. (1992) examined whether the Solow growth model was consistent with the international variation in the standard of living or not. It showed that an augmented Solow model that included accumulation of human capital as well as physical capital provided an excellent description of the cross-country data and found that the human capital variable as an ordinary input in the production function entered significantly in explaining income differences (Mankiw *et al*., 1992). Islam (1995) extended Mankiw *et al*. (1992) study by introducing a panel data approach. He selected the same country sets and analyzed the data in the period 1960-1985. He found a better evidence of convergence in a panel data scenario, but failed in showing the significance of human capital in the method (Islam, 1995). Benhabib and Spiegel (1994) adapted the Nelson and Phelps (1966) framework to analyze the effect of human capital on the speed of technological catch-up and diffusion and examined how these changes influence the growth. The alternative model indicated a more positive role of human capital in determining per capita income (Benhabib and Spiegel, 1994). Deepak *et al*. (2003) empirically analyzed the determinants of income-level convergence. Specifically, the effect of human capital on per capita income was estimated for 22 countries of OECD over the 1955-1990 periods using pooled data. Human capital was modeled as a latent variable and results indicated that it was a significant factor in explaining the variation of per capita income levels among the OECD countries (Deepak *et al*., 2003).

MATERIALS AND METHODS

The theoretical framework: With the emergence of the endogenous growth theories in 1980s, the relationship between economic policy and growth became a highly debated issue. In the theoretical literature, discussions are focused on different channels through which economic policy affects economic growth. The endogenous growth theory is a reaction to the traditional Neo-classical growth models, represented by (Solow, 1956; Levine and Renelt, 1992; Levine, 1997; Easterly and Levine, 2001).

In fact the main distinction between old and new growth theories is that the former utilizes the assumption that returns to the capital stock is diminishing, while the latter argues that returns to capital itself or, in a wider sense, to the stock of physical and human capital formation is constant or increasing (Sala-I-Martin, 1990). This then implies that those variables that lead to non-decreasing returns drive the growth rate. Many candidates have been recommended as the source of non-decreasing returns: particularly, the stock of human capital Lucas (1988); accumulated capital, Rebelo (1991); research and development, Romer (1986; 1990a); or public infrastructure investment (Barro, 1991). Thus, endogenous growth models highlight sectors of the economy that influence the growth path of an economy. This can be simply shown in a Cobb-Douglas production function in which per capita income, Y_t, is dependent upon three input factors, Labor, L_t, physical capital, K_t and human capital, H_t.

Assuming a Cobb-Douglas technology, $Y_t = A_t(H_t) K_t^{\alpha} L_t^{B} \varepsilon_t$ and taking log differences, the relationship for long-term growth can be expressed as (Benhabib and Spiegel, 1994):

$$\begin{aligned}(\log Y_T - \log Y_0) = & \left[\log A_T(H_t) - \log A_0(H_t)\right] \\ & + \alpha(\log K_T - \log K_0) \\ & + \beta(\log L_T - \log L_0) \\ & + (\text{Log}\varepsilon_T - \log\varepsilon_0)\end{aligned} \quad (1)$$

According to two models (their first model state that time lag between the creation of a new technique and its adoption is a decreasing function of some index of average educational attainment, h. w, denote the lag, thus: A(t) = T(t-w(h)), $w'(h)<0$) of technological diffusion presented by Nelson and Phelps (1966). Their second model states that the rate at which the latest, theoretical technology is realized in improved technological practice depends upon educational attainment and upon the gap between the theoretical level of technology (is defined as the best-practice level of technology that would prevail if technological diffusion were completely instantaneous and advances exogenously at a constant exponential rate λ: $T(t) = T_0e^{\lambda t}$, $\lambda>0$) and the level of technology in practice (The level of technology in practice equals the theoretical level of technology w years ago, w a decreasing function of h):

$$A(t) = c(h)[\, T(t) - A(t)] \quad (2)$$

Equivalently:

$$\frac{\dot{A}}{A} = c(H)\left[\frac{T(t) - A(t)}{A(t)}\right] \quad \dot{c}(h) > 0 \;\; c(0) = 0 \quad (3)$$

Thus the rate of increase of the technology in practice (not the level) is an increasing function of education attainment and proportional to the gap, (T (t)-A (t))/A (t) (Nelson and Phelps, 1966).

In other hand many theories (for example Lucas 1988) emphasizing the endogenous model of growth and technical progress have modeled the growth of A, directly as a function of the educational level Romer (1990b) has also argued that the level of human capital may have an influence on growth of A, both directly and through its effect on the speed of the catching-up process (Benhabib and Spiegel, 1994).

Benhabib and Spiegel (1994) with adoption this two hypothesis introduce an alternative model that human capital to influence the technological progress through two channels: By directly affecting the ability of countries to innovate new technologies (Romer, 1990a) and by technological catch-up and diffusion between countries (Nelson and Phelps, 1966).

Thus, for a country i, the growth of total factor productivity, depending on two factors. The first is the level of human capital, reflecting the effect of domestic endogenous innovation. The second is an interactive term that involves the level of human capital and the technological lag of a country behind the leader (Country with the highest initial technology level, A (0)), to catch-up effects as following:

$$\begin{aligned}&\left[\log A_T(H_t) - \log A_0(H_t)\right]_i = \\ &c + gH_i + mH_i\left[(Y_{max} - Y_i)/Y_i\right]\end{aligned} \quad (4)$$

where, c represents exogenous technological progress, gH_i indicates endogenous technological progress associate with the ability of a country to innovate new technologies domestically, which is a function of human capital and $mH_i[(Y_{max}-Y_i)/Y_i]$ (Y_{max} is the initial income per worker for the leading country, that Luxembourg had highest Y_i in 1980) 0 represents the diffusion of technology from abroad, which is also a function of human capital. The term “domestic innovation” shows that human capital stocks enhance technological progress independently, while the term “catch-up” indicates that with keeping human capital levels constant, countries with low level of productivity will experience faster rates of growth of technology (Benhabib and Spiegel, 1994).

Equation 4 can be written:

$$\begin{aligned}&[\log A_T(H_t) - \log A_0(H_t)]_i = \\ &c + (g - m)\, H_i + mH_i\,(Y_{max}/Y_i)\end{aligned} \quad (5)$$

$$\begin{aligned}&(\log Y_T - \log Y_0) = c + (g - m)\, H_i + mH_i\,(Y_{max}/Y_i) \\ &+ \alpha\,(\log K_T - \log K_0) + \beta(\log L_T - \log L_0) \\ &+ (\log\varepsilon_T - \log\varepsilon_0)\end{aligned} \quad (6)$$

This equation is used to test that how human capital impacts on productivity growth.

Summary statistics: The research period is determined by the data availability. The five-year interval data is employed for some economies including developing economies and developed economies during the 1980-2005. The per capita GDP in constant prices and income per worker derived from Penn World Table (PWT version 6.3) and labor force is available from the World Bank data. The Average of the schooling years in total population over age 15 is constructed by Barro and Lee (2010) and is used in this study as human capital proxy. We construct the physical capital stock series by the perpetual inventory method (the Perpetual inventory method: $K_t = K_0(1\text{-}S)^t + \Sigma I_i\,(1\text{-}S)^{t-1}$ i = 1,…, t-1) following Bernanke and Gurkaynak (2001) approach Based on Bernanke and Gurkaynak (2001) approach, an initial value of the capital stock series for each country, i is generated by: $K_0 = I_1/(g_1+\delta)$ where K_0 is the capital stock, I_1 is the capital flow at year 1 or the year after the initial year, g_1 is the 5-year average annual growth rate around year 1 and δ is the depreciation which is assumed to be the same countries (0.06). The data on investment-to-GDP ratio, real GDP growth are from the Penn World Table (PWT version 6.3).

RESULTS

Unit-root tests: Recent literature in econometrics suggests that before undertaking an empirical analysis, unit root tests should be investigated for data series, because regression analysis carried out with non-stationary variables may invalidate many of the assumptions of regression analysis. If a time series has a unit root, a widespread and convenient way to remove non-stationary would be by taking first differences of the relevant variable. A non-stationary series, which transfers to a non stationary one by difference d times, is called an integration of order d and denoted as I (d) (Charemza and Deadman, 1997). Five types of panel unit root tests in Eviews are computable as following: Levin *et al*. (2002); Breitung (2000) and Im *et al*. (2003), Fisher-type tests using ADF and PP tests (Maddala and Wu (1999) and Hadri (2000). The results of the some unit root tests for the variables are presented in Table 1.

Cointegration tests: In next step, the tests of cointegration in a panel setting have been focused in recent literature. The purpose of the cointegration test is to determine whether a group of non-stationary series is cointegrated or not. If such stationary linear combination exists, it may be interpreted as a long-run equilibrium relationship among the variables.

Pedroni (1999) and Kao (1999) and Fisher-type test using an underlying Johansen methodology (Maddala and Wu (1999) are types of panel co integration tests.

The results of Kao (1999) cointegration test are presented in the Table 2.

The results indicate that cointegration or long-run equilibrium relationship exists between variables.

According to the previous economic discussions, we estimated equation 6, using the cross-country panel approach in three groups of countries.

The results are presented in Table 3.

As was expected, coefficients for physical capital accumulation and labor force enter in all models positively and significantly.

The obtained results of model 1 that were investigated on 104 country-samples showed that human capital accumulation affected productivity growth positively, however human capital, through technology adoption from abroad is more effective on growth than domestic technology.

In fact Coefficient for human capital in levels had positive effect and insignificantly on per capita growth.

The results of model 2, with the samples, containing 79 developing countries, were almost similar to the results found for the full sample. While Catch-up component entered positively and significantly, domestic innovation was positive but insignificant.

In model 3 we investigated the samples, including 25 developed countries; the results showed that although catch-up component had positive effect and significant, domestic innovation appeared with negative sign.

Table 1: Unit root test results

	Levin, Lin and Chu t*		Im, Pesaran and Shin w-stat		ADF-Fisher chi-square		pp-fisher chi square	
Variable	F	T	F	T	F	T	F	T
LRGDP	-3.737	-49.968	4.909	-1.502	121.025	241.735	159.383	412.825
H	-11.894*	-11.628*	0.943	1.049	146.122	55.990	233.967*	106.45
H (Y_{max}/ Y)	7.411	-20.710*	4.401	-0.939	144.548	172.468	236.732	279.244*
LL	-5.913*	-8.772*	3.994	3.134	187.277	113.900	384.317*	196.373
LK	-6.563*	-56.492*	1.557	-1.519	262.305*	261.413*	459.002*	471.980*
D (LRGDP)	-43.357*	-522.890*	-14.350*	-43.134*	389.308*	351.545*	441.856*	496.533*
D (LL)	-12.471*	-54.850*	-2.243*	-9.266*	222.318	283.131*	262.310*	425.097*
D (LK)	-53.093*	-22.435*	-11.157*	-47.018*	358.518*	316.395*	432.432*	455.821*

Note: F and T indicate the models that allow for an intercept and intercept and trend, respectively. Asterisk * shows significance at 1% level. Maximum lag is used as lag length

Table 2: Kao (1999) cointegration tests results

Null		Rho	Prob.	t-statistic	Prob.
No	DF	-7.617328	0.0000	-12.44178	0.0000
Cointegration	DF*	-4.839625	0.0000	-11.19954	0.0000

Table 3: Panel estimation-depended variable: $\Delta \log Y^a$ 1980-2005

Variable	Coefficient	Std. error	t-statistic	Prob model 1[b]
C	-0.2010	0.0587	-3.4381	0.0006
H	0.0084	0.0086	0.9798	0.3327
H (Y_{max}/Y)	0.0022	0.0001	11.1857	0.0000
Δ logL	0.5612	0.1225	5.5783	0.0000
Δ logk	0.2051	0.0586	3.4998	0.0005
F	4.3492			
R^2	0.5300			
Model 2[c]	-0.2449	0.0648	-3.7758	0.0002
H	0.0096	0.0111	0.8632	0.3887
H (Y_{max}/Y)	0.0022	0.0002	9.9323	0.0000
Δ logL	0.5337	0.1434	3.7199	0.0002
Δ logk	0.1992	0.0664	2.9969	0.0029
F	4.1881			
R^2	0.5200			
Model 3[d]				
C	0.1332	0.0374	3.5590	0.0007
H	-0.0321	0.0042	-7.5783	0.0000
H (Y_{max}/Y)	0.0115	0.0013	8.6087	0.0000
Δ logL	0.6007	0.1400	4.2891	0.0001
Δ logk	0.4188	0.0871	4.8046	0.0000
F	10.7067			
R^2	0.8100			

[a]: Δ logX, refers to the log difference of end and initial period in variable X. [b]: Including all countries in the sample. [c]: Including 79 developing countries. [d]: Including 25 of OECD countries

DISCUSSION

Although there exists wide spread evidence that indicates human capital have positive effects on growth in the empirical literature, the findings in Table 4 show that it is not always and it depends on the path that human capital influence growth. So that human capital has positive effect and significant on growth through its effect on the speed of technology adoption from abroad in all countries, but directly and through domestic innovation only in developing countries enter positively.

In comparison to obtained results of Benhabib and Spiegel (1994) estimation, the results of our estimation are somewhat different. While in Benhabib, human capital in levels entered negatively in developing countries, in our estimation it enters as a positive, however insignificantly. It also entered positively and significantly in Benhabib estimation on three of richest countries, while the obtained results of model 3 on 25 OECD countries show domestic innovation appears with negative sign.

Table 4: Capital stock used in this study [a]

	Advanced OECD (25)					
Country	K1980	K1985	K1990	K1995	K2000	K2005
Australia	8E+11	9.59E+11	1.17E+12	1.33E+12	1.64E+12	2.07E+12
Austria	2.63E+11	3.22E+11	3.81E+11	4.55E+11	5.32E+11	6.01E+11
Belgium	2.96E+11	3.45E+11	4E+11	4.83E+11	5.71E+11	6.57E+11
Canada	8.2E+11	1.06E+12	1.4E+12	1.66E+12	2E+12	2.47E+12
Denmark	1.64E+12	1.73E+12	2.05E+12	2.25E+12	2.68E+12	3.16E+12
Finland	1.65E+11	2.08E+11	2.25E+11	2.68E+11	2.88E+11	3.28E+11
France	1.82E+12	2.15E+12	2.5E+12	2.85E+12	3.18E+12	3.67E+12
Germany	2.89E+12	3.25E+12	3.67E+12	4.34E+12	4.9E+12	5.23E+12
Greece	2.39E+11	2.68E+11	2.88E+11	3.07E+11	3.4E+11	4.16E+11
Hungary	2.39E+13	2.96E+13	3.34E+13	3.41E+13	4.07E+13	5.12E+13
Iceland	7.08E+11	9.56E+11	1.17E12	1.29E+12	1.52E+12	1.86E+12
Ireland	9.97E+10	1.29E+11	1.43E+11	1.63E+11	2.22E+11	3.09E+11
Italy	1.55E+12	1.84E+12	2.18E+12	2.52E+12	2.87E+12	3.31E+12
Japan	6.48E+14	8.06E+14	1.02E+15	1.27E+15	1.45E+15	1.55E+15
Korea, rep	2.21E+14	3.69E+14	6.33E+14	1.14E+15	1.67E+15	2.15E+15
Luxembourg	1.77E+10	2.02E+10	2.52E+10	3.3E+10	4.18E+10	5.46E+10
Netherland	5.68E+11	6.26E+11	7.15E+11	8.18E+11	9.71E+11	1.12E+12
New Zealand	1.44E+11	1.72E+11	2.02E+11	2.23E+11	2.68E+11	3.3E+11
Norway	1.83E+12	2.3E+12	2.78E+12	2.96E+12	3.47E+12	3.92E+12
Portugal	1.23E+11	1.55E+11	1.84E+11	2.33E+11	3.03E+11	3.74E+11
Spain	8.36E+11	9.83E+11	1.21E+12	1.5E+12	1.81E+12	2.29E+12
Sweden	2.91E+12	3.24E+12	3.81E+12	4.15E+12	4.54E+12	5.09E+12
Switzerland	1.12E+12	1.1E+12	1.16E+12	1.22E+12	1.29E+12	1.34E+12
United Kingdom	9.25E+11	1.04E+12	1.26E+12	1.44E+12	1.71E+12	2.07E+12
United state	7.54E+12	9.36E+12	1.17E+13	1.38E+13	1.78E+13	2.21E+13
Developing (79)						
Albania	1.71E+12	2.17E+12	2.53E+12	2.26E+12	2.14E+12	2.45E+12
Algeria	1.44E+13	1.89E+13	2.15E+13	2.19E+13	2.2E+13	2.38E+13
Argentina	8.79E+11	9.41E+11	9.31E+11	9.92E+11	1.17E+12	1.19E+12
Bangladesh	2.06E+12	3E+12	4.21E+12	5.62E+12	7.96E+12	1.15E+13
Belize	1.85E+09	2.01E+09	2.32E+09	3.01E+09	3.56E+09	4.61E+09
Benin	2.42E+12	2.81E+12	2.95E+12	3.13E+12	3.61E+12	4.43E+12
Bolivia	6.96E+10	7.5E+10	8.17E+10	8.95E+10	1.14E+11	1.26E+11
Botswana	1.22E+10	2.02E+10	2.81E+10	4.92E+10	6.99E+10	9.21E+10

Table 4: Continued

Brazil	1.92E+12	2.58E+12	3.11E+12	3.45E+12	4.06E+12	4.43E+12
Bulgaria	5.86E+10	8.86E+10	1.2E+11	1.08E+11	9.4E+10	1E+11
Burundi	8.98E+11	1.4E+12	1.39E+12	1.58E+12	1.43E+12	1.37E+12
Cameroon	6.74E+12	1.13E+13	1.54E+13	1.56E+13	1.58E+13	1.8E+13
Central Africa	1.01E+12	9.67E+11	1.05E+12	1.09E+12	1.09E+12	1.04E+12
Chile	2.45E+13	3.03E+13	3.56E+13	5.04E+13	7.82E+13	1.02E+14
Chile	4.03E+12	6.11E+12	1.03E+13	1.66E+13	2.8E+13	4.46E+13
Colombia	1.82E+14	2.57E+14	3.11E+14	4E+14	4.93E+14	5.3E+14
Congo Dem rep	4.71E+12	5.41E+12	5.92E+12	6.34E+12	5.75E+12	6.16E+12
Congo rep	2E+12	4.56E+12	4.76E+12	5E+12	5.45E+12	5.83E+12
Costa Rica	5.4E+12	6.52E+12	8.35E+12	1.07E+13	1.34E+13	1.76E+13
Cote d'Ivoire	1.02E+13	1.15E+13	1.06E+13	1.03E+13	1.15E+13	1.17E+13
Dominican rep	4.39E+11	5.92E+11	7.63E+11	9.4E+11	1.34E+12	1.75E+12
Ecuador	4.08E+10	5.66E+10	6.44E+10	7.13E+10	7.65E+10	8.58E+10
Egypt	2.49E+11	4.45E+11	5.04E+11	5.37E+11	6.56E+11	8.1E+11
El Salvador	1.33E+10	1.42E+10	1.55E+10	1.83E+10	2.29E+10	2.76E+10
Fiji	5.09E+09	6.81E+09	6.99E+09	8.91E+09	1.05E+10	1.14E+10
Gabon	6.43E+12	8.34E+12	9.29E+12	9.68E+12	1.09E+13	1.14E+13
Gambia	5.19E+09	6.46E+09	8.76E+09	1.41E+10	1.93E+10	2.53E+10
Ghana	5.09E+10	4.11E+10	3.47E+10	3.16E+10	3.08E+10	3.07E+10
Guatemala	1.54E+11	1.86E+11	2E+11	2.41E+11	2.94E+11	3.79E+11
Guyana	7.86E+11	8.68E+11	8.18E+11	9.2E+11	1.02E+12	1.01E+12
Haiti	1.22E+11	1.76E+11	2.2E+11	2.18E+11	2.36E+11	2.59E+11
Honduras	1.33E+11	1.6E+11	1.91E+11	2.68E+11	3.69E+11	4.54E+11
India	1.91E+13	2.33E+13	2.99E+13	3.83E+13	5.17E+13	7.02E+13
Indonesia	1.26E+15	2.36E+15	3.61E+15	5.28E+15	6.97E+15	7.44E+15
Iran	2.44E+15	2.91E+15	3.11E+15	3.71E+15	4.23E+15	5.05E+15
Jamaica	1.82E+12	1.68E+12	1.66E+12	1.87E+12	2.01E+12	2.2E+12
Jordan	6.96E+09	1.35E+10	1.65E+10	2.09E+10	2.45E+10	2.74E+10
Kenya	1.36E+12	1.49E+12	1.63E+12	1.7E+12	1.95E+12	2.27E+12
Lesotho	7.19E+09	1.04E+10	1.42E+10	2.47E+10	3.4E+10	3.92E+10
Liberia	2.23E+10	1.77E+10	1.36E+10	1.01E+10	1.57E+09	5.74E+09
Libya	4.66E+10	6.85E+10	7.02E+10	6.57E+10	6.05E+10	6.09E+10
Malawi	8.88E+11	9.91E+11	1E+12	1.05E+12	1.02E+12	1.01E+12
Malaysia	1.3E+11	2.56E+11	3.38E+11	5.77E+11	8.9E+11	1.08E+12
Mali	3.36E+12	3.42E+12	3.88E+12	4.44E+12	5.11E+12	5.75E+12
Mauritania	7.79E+11	9.72E+11	9.8E+11	8.81E+11	8.77E+11	1.16E+12
Mauritius	1.22E+11	1.45E+11	2E+11	2.84E+11	3.74E+11	4.75E+11
Mexico	6.7E+12	9.53E+12	1.07E+13	1.31E+13	1.54E+13	1.88E+13
Morocco	4.68E+11	6.19E+11	7.47E+11	8.82E+11	1.03E+12	1.27E+12
Mozambique	7.77E+10	8.95E+10	1E+11	1.21E+11	1.72E+11	2.36E+11
Namibia	6.95E+10	7.24E+10	6.67E+10	7.03E+10	7.71E+10	9.36E+10
Nepal	2.56E+11	3.55E+11	4.98E+11	6.81E+11	9.56E+11	1.27E+12
Nicaragua	1.65E+11	2.03E+11	2.21E+11	2.11E+11	2.45E+11	2.72E+11
Niger	1.66E+12	2.03E+12	2.53E+12	2.57E+12	2.69E+12	2.99E+12
Pakistan	4.84E+12	6.49E+12	8.54E+12	1.1E+13	1.31E+13	1.51E+13
Panama	1.12E+10	1.34E+10	1.3E+10	1.68E+10	2.45E+10	2.84E+10
Papua New Guinea	1.79E+10	2.02E+10	2.09E+10	2.18E+10	2.44E+10	2.9E+10
Paraguay	3.85E+13	6.73E+13	8.74E+13	1.13E+14	1.32E+14	1.34E+14
Peru	2.12E+11	2.87E+11	3.16E+11	3.5E+11	4.49E+11	4.99E+11
Philippine	3.59E+12	5.16E+12	5.53E+12	6.6E+12	8.01E+12	9.37E+12
Romania	5.38E+11	8.35E+11	1.03E+12	1E+12	9.05E+11	8.82E+11
Rwanda	5.25E+11	9.27E+11	1.36E+12	1.4E+12	1.42E+12	1.7E+12
Senegal	5.05E+12	4.36E+12	4.53E+12	4.66E+12	5.73E+12	7.86E+12
Sierra Leone	6.17E+12	6.52E+12	6.71E+12	6.64E+12	5.56E+12	4.07E+12
Singapore	7.22E+10	1.3E+11	1.75E+11	2.49E+11	3.63E+11	4.32E+11
Sought Africa	1.69E+12	2.07E+12	2.12E+12	2.15E+12	2.37E+12	2.68E+12
Sri Lanka	2.49E+12	3.08E+12	3.45E+12	3.89E+12	4.58E+12	5.43E+12
Sudan	1.95E+10	2.33E+10	2.39E+10	2.49E+10	3.2E+10	7.16E+10
Swaziland	8.89E+09	1.38E+10	1.76E+10	2.34E+10	2.85E+10	3.41E+10
Syrian Arab rep	5.3E+11	9.17E+11	1.08E+12	1.24E+12	1.47E+12	1.78E+12
Thailand	4.19E+12	6.04E+12	8.64E+12	1.54E+13	2E+13	2.16E+13
Togo	2.83E+12	3.21E+12	3.25E+12	3.06E+12	3E+12	2.98E+12
Trinidad and Tobago	1.01E+11	1.54E+11	1.51E+11	1.44E+11	1.55E+11	1.69E+11
Tunisia	4.02E+10	5.96E+10	6.52E+10	7.38E+10	8.42E+10	9.98E+10
Turkey	2.19E+11	2.68E+11	3.68E+11	5.2E+11	7.07E+11	8.64E+11
Uganda	1.98E+13	1.69E+13	1.63E+13	1.7E+13	2.1E+13	2.65E+13
Uruguay	3.88E+11	4.77E+11	4.7E+11	5.29E+11	6.54E+11	6.67E+11
Venezuela	6.06E+14	6.44E+14	6.54E+14	6.64E+14	7.1E+14	7.26E+14
Zambia	5.36E+13	4.81E+13	4.29E+13	3.72E+13	3.48E+13	4.32E+13
Zimbabwe	2.89E+10	3.59E+10	4.27E+10	5.51E+10	6.41E+10	6.33E+10

[a] K represent physical capital estimated by perpetual inventory method under 0.06 depreciation

CONCLUSION

Human capital has been considered as an important factor in economic growth for a long time and empirical evidences for a broad group of countries confirm this linkage, but there are differences on how they impact human capital on economic growth. This study studied how the impact of human capital on per capital growth applies the introduced model by Benhabib and Spiegel (1994). We used cross-country panel data for 104 countries in five year-intervals from 1980-2005. In this model human capital affects on growth in two ways. First, human capital levels directly influence the rate of domestically produced technological innovation (Romer, 1990a). Second, the human capital stock affects on the speed of adoption of technology from abroad (Nelson and Phelps, 1966).

The obtained results are somewhat different from presented results by Benhabib at least for OECD countries, by emphasizing on the technology diffusion/catch-up component over the domestic innovation component.

The results showed that however, human capital had negative effect on growth in OECD countries in levels directly; it affected the growth positively and significantly by its influence on the speed of adoption technology from abroad. Considering the results, much of the effects of human capital on growth are through catch-up component. In developing countries, however, human capital had positive effect on growth through domestic innovation component, but it was insignificant. Such physical capital stock and labor force entered positively and significantly in growth equation.

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