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ECONOMIC GROWTH, CONVERGENCE AND QUALITY OF HUMAN CAPITAL FORMATION SYSTEM

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ECONOMIC GROWTH, CONVERGENCE AND QUALITY OF HUMAN CAPITAL FORMATION SYSTEM

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SUMÁRIO

ABSTRACT

This paper's goal is to make use of a human capital proxy that takes into account quantitative and qualitative aspects of this factor to measure with a higher level of accuracy the impact of human capital on countries' income level and rate of growth. The empirical study will take place by means of a comparative analysis of Mankiw, Romer and Weil's 1992 paper.

Key words: Human capital proxy; Mankiw, Romer and Weil´s 1992 paper; qualitative aspects of human capital.

JEL classification: C21, E13, I20, O11, O41

RESUMO

O objetivo do presente estudo é utilizar uma proxy para capital humano que leve em consideração aspectos quantitativos e qualitativos desse fator para se analisar o seu impacto sobre o nível e a taxa de crescimento da renda. O estudo de Mankiw, Romer e Weil (1992) é utilizado como base na comparação dos resultados encontrados.

Palavras chaves: Proxy para capital humano; artigo de Mankiw, Romer e Weil de 1992; aspectos qualitativos do capital humano.

1. INTRODUCTION

This paper's goal is to make use of a human capital proxy that takes into account quantitative and qualitative aspects of this factor to measure with a higher level of accuracy the impact of human capital on countries' income level and rate of growth. The empirical study will take place by means of a comparative analysis of Mankiw, Romer and Weil's[1] 1992 paper.

2. EQUATIONS

The equations on regression analysis used are the same ones as in MRW. When economies are on steady state, the equation is:

$$\ln y^* = a + xt + \left(\frac{\beta}{1-\alpha-\beta}\right)\ln(s_k) + \left(\frac{\alpha}{1-\alpha-\beta}\right)\ln(s_h) - \left(\frac{\alpha+\beta}{1-\alpha-\beta}\right)\ln(\delta + n + x) + \varepsilon \qquad (1)$$

where y * is the per capita income in the steady state, s_k and s_h are the average share of real investment on physical and human capital in real GDP, respectively; α, β e 1 – α – β are the shares of human capital, physical capital and of labor on real GDP, respectively. The rate of growth of working age population is measured by n, while x represents technological progress rate. Physical capital depreciation rate is δ, a is a constant, and ε represents each country's specificity. If the steady state constraint is relaxed, we have the following equation:

$$\ln\left(\hat{y}_t\right) - \ln\left(\hat{y}_0\right) = \left(1-e^{-\lambda t}\right)\left(\frac{\beta}{1-\alpha-\beta}\right)\ln(s_k) + \left(1-e^{-\lambda t}\right)\left(\frac{\alpha}{1-\alpha-\beta}\right)\ln(s_h)$$
$$-\left(1-e^{-\lambda t}\right)\left(\frac{\alpha+\beta}{1-\alpha-\beta}\right)\ln(n+x+\delta) - \left(1-e^{-\lambda t}\right)\ln\left(\hat{y}_0\right) + \left(1-e^{-\lambda t}\right)\varepsilon \qquad (2)$$

where λ = (n + x + δ)(1 − α − β) is the speed of convergence and $\hat{y}$ is income in effective units of labor. The coefficient of $\ln(\hat{y}_0)$, in Equation (2), tests the hypothesis that countries are out of their steady state.

3. DATA

The analysis comprises the same period of the study as MRW (1960-1985). Data on physical and human capital, GDP per worker in 1960-1985, and rate of growth of working age population are from MRW's appendix. HDI is the United Nations' Human Development Index (Human Development Report 2003). It is available for the 1975 – 1985 period, in five year intervals. MRW data are divided

[1] MRW henceforth.

into three samples: all non-producing oil countries (n = 98); first sample less countries where data had received D grade by Summer and Heston, and the ones with population under one million; and the third sample, formed by OECD countries.

HDI is the arithmetic mean of years 1975, 1980 and 1985. HDI calculation for countries with missing values on at most two periods (1975, 1980 and/or 1985) was based on the HDI average growth of the countries that have the data for these three periods. The biggest sample is composed of 96 countries, since there is no HDI available data for Somalia and Liberia. The other two samples are composed of the same countries.

HDI is used in order to measure countries' degree of development. The assumption is that the more developed a country is, the better is its system of human capital formation. The new human capital proxies are composed of MRW human capital proxy times the average HDI, as defined previously, and by MRW human capital proxy times average HDI squared. In the creation of the first proxy, it is assumed that the quality of a human capital formation system is proportional to a country's level of development, while in the second one, the assumption is that quality is more than proportional.

The idea of using these proxies is because a vast part of empirical studies that measure the impact of human capital on income growth or on income level uses only a quantitative variable. This happens because of the lack of access to a database that takes into account human capital quality and is available for many countries. Usually, studies that use some type of proxy to measure differences in human capital quality are limited to a small sample of countries and to data quality. Because HDI is a high quality set of data and is available to many countries, it is a good candidate to take this role.

Because income per capita is an element in HDI construction, we should expect some problems as a higher level of correlation between it and the dependent variable. However, HDI is a composed average of previous periods in relation to the dependent variable, so if countries are out of steady state (which seems to be the case), we would expect a negative correlation between HDI and GDP per capita.

4. RESULTS

All variables are in natural log on the Tables presented below (1 – 4). Table 1 shows MRW results. They are presented because they will be compared to the results using the new proxies for human capital: schdi for school times HDI; and schdi2 for school times HDI squared. The first three columns of Table 1 are MRW results without the human capital proxy (school). The difference between the first three regressions is the sample size, defined by N. The three last ones make use of the human capital proxy. In the first column are the regressors.

TABLE 1

Solow and Augmented Solow Model – MRW Results

Dependent variable: ln 1985 income per capita						
	(1)	(2)	(3)	(4)	(5)	(6)
I/GDP	1.424	1.318	0.500	0.697	0.700	0.276
	(9.95)**	(7.71)**	(1.15)	(5.25)**	(4.65)**	(0.71)
n+x+δ	-1.990	-2.017	-0.742	-1.745	-1.500	-1.076
	(3.53)**	(3.78)**	(0.87)	(4.20)**	(3.72)**	(1.42)
School				0.654	0.731	0.768
				(9.00)**	(7.67)**	(2.62)*
cons.	-1.128	-0.722	5.719	0.622	1.202	3.830
	(0.79)	(0.55)	(2.13)*	(0.58)	(1.18)	(1.56)
N	98	75	22	98	75	22
R^2	0.60	0.60	0.11	0.79	0.78	0.35
R^2 a.	0.59	0.59	0.01	0.78	0.77	0.24

Absolute value of t statistics in parentheses. * Significant at 5%; ** significant at 1%.
I/GDP denotes the amount of physical capital investments divided by the GDP, n+x+δ represents effective physical capital depreciation with n being the rate of population growth, x the rate of technological progress, and δ the rate of physical capital depreciation. School is MRW's human capital proxy.

MRW human capital proxy enters significantly in the three samples. Its inclusion reduces the physical capital coefficient, besides improving regression adjustment, mainly for OECD countries. Table 2 displays the results with the variables schdi and schdi2. The regressions are equivalents to the last three in Table 1. The three first columns are the results with schdi variable, while the remaining regressions are those using schdi2.

TABLE 2

Augmented Solow Model Employing New Proxies

Dependent variable: ln 1985 income per capita						
	(1)	(2)	(3)	(4)	(5)	(6)
I/GDP	0.578	0.519	0.189	0.495	0.424	0.130
	(4.53)**	(3.58)**	(0.52)	(3.99)**	(2.98)**	(0.38)
N+x+δ	-1.463	-1.258	-0.841	–1.348	-1.119	-0.613
	(3.85)**	(3.37)**	(1.22)	(3.73)**	(3.13)**	(0.95)
schdi	0.532	0.614	0.775			
	(10.35)**	(9.18)**	(3.34)**			
schdi2				0.443	0.509	0.723
				(11.32)**	(10.00)**	(3.88)**
cons.	2.191	2.841	4.886	3.051	3.844	5.947
	(2.20)*	(2.89)**	(2.24)*	(3.16)**	(3.95)**	(2.92)**
N	96	75	22	96	75	22
R^2	0.82	0.82	0.45	0.84	0.83	0.51
R^2a.	0.82	0.81	0.36	0.83	0.83	0.43

Absolute value of t statistics in parentheses. * Significant at 5%; ** significant at 1%.
Schdi is school (MRW human capital proxy) times HDI. Schdi2 is school times HDI squared.

Comparing Table 2's results to MRW ones with human capital (school), it is interesting to notice that all coefficients values reduce, except regression 3's human capital coefficient. However, human capital t statistics increase in all the cases, and the proxy becomes significant at 1% level, in all the samples. The physical capital factor loses significance and the regression adjustment gets better, mainly for OECD countries. Thus, the inclusion of the new proxies has a similar effect as the school variable introduction in MRW's paper. The use of schdi2 instead of schdi has similar results, but they are even more expressive.

Table 3 presents the MRW convergence results. In all regressions, conditional convergence is considered. The control variables are in the left column of the Table. The dependent variable is the difference between ln of 1985 income and ln of 1960 income, as in Equation (2).

TABLE 3
Conditional Convergence: Solow and Augmented Solow Model – Mrw Results

Dependent variable: ln 1985 income per capita minus ln 1960 income per capita						
	(1)	(2)	(3)	(4)	(5)	(6)
Y60	-0.141	-0.228	-0.350	-0.288	-0.366	-0.398
	(2.71)**	(3.98)**	(5.32)**	(4.68)**	(5.43)**	(5.67)**
I/GDP	0.647	0.646	0.390	0.524	0.538	0.332
	(7.47)**	(6.22)**	(2.21)*	(6.03)**	(5.26)**	(1.91)
n+x+δ	-0.302	-0.457	-0.766	-0.506	-0.545	-0.863
	(0.99)	(1.49)	(2.22)*	(1.75)	(1.89)	(2.56)*
school				0.231	0.270	0.228
				(3.89)**	(3.37)**	(1.57)
cons.	–1.061	-0.725	0.344	-0.455	-0.012	0.179
	(1.46)	(1.03)	(0.28)	(0.65)	(0.02)	(0.15)
λ	0.00606	0.0104	0.0173	0.0137	0.0182	0.0203
N	98	75	22	98	75	22
R^2	0.40	0.38	0.68	0.49	0.47	0.72
R^2a.	0.38	0.35	0.62	0.46	0.43	0.65

Absolute value of t statistics in parentheses. * Significant at 5%; ** significant at 1%.
Y60 is the ln 1960 per capita income and λ is the speed of convergence.

The results indicate the existence of conditional convergence. The Y60 coefficients are negative and significant in all regressions. Moreover, λ is positive in all cases. It corresponds to how much each country reduces the gap between current income and steady state, each year.

In the last three regressions, we can see that the inclusion of human capital increases the speed of convergence. This is a sign that countries with more human capital achieve higher rates of growth in the transition period. Moreover, it reduces the physical capital coefficient and improves regression adjustment.

Table 4 shows the results when the new human capital proxies are employed. In the first three columns, we can see the results using schdi, while in the three subsequent ones are the results with schdi2.

TABLE 4

Conditional Convergence: Augmented Solow Model Using New Human Capital Proxies

Dependent variable: ln 1985 income per capita minus ln 1960 income per capita						
	(1)	(2)	(3)	(4)	(5)	(6)
Y60	-0.343	-0.414	-0.420	-0.372	-0.442	-0.439
	(5.44)**	(5.89)**	(5.82)**	(5.78)**	(6.16)**	(5.93)**
I/GDP	0.516	0.477	0.306	0.486	0.439	0.286
	(5.96)**	(4.60)**	(1.79)	(5.58)**	(4.18)**	(1.69)
n+x+δ	-0.438	-0.519	-0.794	-0.437	-0.494	-0.721
	(1.59)	(1.85)	(2.45)*	(1.62)	(1.79)	(2.27)*
scHDI	0.201	0.254	0.239			
	(4.26)**	(3.95)**	(1.87)			
scHDI2				0.179	0.224	0.233
				(4.64)**	(4.27)**	(2.08)*
cons.	0.329	0.751	0.671	0.756	1.286	1.150
	(0.47)	(1.01)	(0.58)	(1.05)	(1.63)	(0.97)
λ	0.0168	0.0214	0.0218	0.0186	0.0233	0.0231
N	96	75	22	96	75	22
R^2	0.53	0.49	0.73	0.54	0.51	0.74
R^2a.	0.51	0.46	0.67	0.52	0.48	0.68

Absolute value of t statistics in parentheses. * Significant at 5%; ** significant at 1%.

One effect resulting from the introduction of the new proxies is the increase, in absolute value, of the coefficient of per capita income in the beginning of the period and of λ, pointing to a higher speed of convergence. The changes go in the same direction when we use schdi2, but they are more pronounced. Therefore, the quality of human capital system formation affects the rate of growth in a positive way. The better its quality, the higher the country's rate of growth is going to be; therefore, when we control for this aspect of the human capital factor, there is an increase in the estimated speed of convergence. Conversely, when a large sample of different countries is taken into account, there is no convergence when other variables are considered. There is no absolute convergence. Making use of the same reasoning, when human capital quality is not considered, the speed of convergence is smaller.

Physical capital and effective depreciation coefficients diminish in all cases. The human capital coefficient goes in the same direction in the first two samples, whereas it goes in the opposite direction in the third (n = 96). Furthermore, its significance increases in all cases, and it becomes significant even for OECD countries, when schdi2 is employed. The regression adjustment increases marginally. In all situations, the effects of schdi2 utilization are similar to the results when schdi is used instead of school, but they are more accentuated.

Testing for problems of multicollinearity, heteroskedasticity, asymmetry and kurtosis to test residuals normality, the results indicate that the residual of the regressions does not suffer from them in a level that would change the regression results.

5. CONCLUSIONS

The use of the HDI is to measure countries level of development. The assumption made is that more developed countries have better systems of human capital formation because they have better educational infrastructure, more qualified instructors and professors, and so on, when compared to less developed countries.

In the present study, the employment of these new variables brought an improvement in regression adjustment. All results confirm those of Mankiw, Romer and Weil (1992), but human capital is even more important than one could conclude by their results. Physical capital loses importance possibly because it was explaining part of income growth that is due to human capital.

The increase in the speed of convergence is another indication that the introduction of the new proxies improves the results of the model. When there is a difference in human capital quality across countries and it is taken into account, one would expect an increase in the speed of convergence. Moreover, this agrees with Jones' (1997) results. In an assessment of countries' long-run steady state, he concludes that some studies, such as the one carried out by MRW, present a very low speed of convergence to justify some countries' high rate of growth. One example is the rapid growth of the Southeast Asian countries.

In general, the use of the new proxies improves the results because we take into account one aspect of human capital that is usually discarded. Therefore, the human capital proxies employed have higher quality.

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