Human Capital Stimulates Economic Well-Being: A Cross-Country Comparative Study

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ABSTRACT

With the advent of the knowledge economy comes the increased importance of education. In our global economy, there is more and more push to increase educational attainment so youth can readily compete against their global counterparts. As the significance of education in America has become not only a pertinent, but also pressing issue, there is a widening of skill differentials in the U.S. within the labor force that is making Americans and everyone else evaluate their education systems. The observed increase in years of education -- not only in the U.S. but in other countries as well -- is related to not only human capital, which is the skills the labor force has, but also to economic growth models. The more advanced skills the labor force has the more productive it can be; thus driving economic growth for a country. Measuring economic growth can be done using an exogenous growth model such as Solow's growth model. This paper examines data from numerous countries over a period of 23 years, and finds that human capital is a strong contributing factor to economic well-being and growth.

INTRODUCTION

Does the amount of education people of a country obtain help the country become more productive? Does the difference in educational attainment in countries explain the income disparities across countries in the world? With the advent of the knowledge economy comes the increased importance of gaining an education. In our global economy, there is more and more push to increase the quality and quantity of education so youth can readily compete against their global counterparts.

This research will explore the possible causes of income differences across countries within the scope of factor accumulation. There are several subproblems considered in this study. The first subproblem is to determine whether expected factors of production contribute to the income differences across countries. The second subproblem is to conclude that human capital components play a role in income differences. The third subproblem is to develop a benchmark where GDP per capita divides the sample into low income countries and high income countries. After developing benchmarks, the research will compare these samples to see how factors of production such as physical capital and population growth affect income as between low income and high income countries. Then, the research looks to see if these samples'

incomes are affected by human capital components. As there are several problems posed in this study, similarly there are several hypotheses used to predict answers.

The first hypothesis is that expected factors (from the Solow growth model) such as population growth and investment contribute to income differences across countries. The second hypothesis is that human capital components contribute to income differences. The third hypothesis is that there is a difference between low and high income countries in the effects of both population growth and investment as well as human capital components. Although this study focuses on human capital and economic well-being, there are several limitations that had to be considered throughout the study.

The study will not attempt to measure human capital through labor statistics. The measure of income will be GDP per capita, and in the data analysis the dependent variable will be the natural logarithm of GDP per capita. The study will be limited to a 23 year period sampling 124 countries from Africa, Asia, North America, Latin America and the Caribbean, Oceania, and Europe. The human capital variables will only be limited to the gross enrollment ratios for students enrolled in primary, secondary, and tertiary levels and will not consider graduation rates for these students. To further understand the significance of education variables in the model, there needs to be knowledge of human capital and economic growth. Human capital is the skills and knowledge people acquire that makes them more productive. Economic growth is measured as changes in output a country produces from one year to the next; essentially, economic growth is the change in GDP.

Assumptions include that data from the sources are accurate, the sample is representative of all countries, and the benchmark developed is an accurate indicator of what divides high income countries and low income countries.

As the significance of education in America has become not only a pertinent, but also a pressing issue, there is a widening of skill differentials in earnings in the U.S. within the labor force that is making Americans and everyone else evaluate their education systems. This increase in the importance of educational attainment is not related to the basic Solow growth model, but it is still an important factor influencing the level of GDP for a country. As the Solow growth model is used to measure income differences across countries by using factors such as investment and population growth, the study by Mankiw et al. (1992) adds a human capital component to the Solow growth model. Through a cross-country comparative study, my research will explore if human capital is a contributing factor to economic well-being and growth.

The organization of the rest of this paper is as follows. The next section will pro vide an overview of selected studies in this field and why they are significant to the present study. Then, the model and methodology will be described in the subsequent section where variables, countries, and criteria for selecting countries are listed as well as the formal methodology employed in the study. This is followed by a results and discussion section covering the findings and their interpretation. Finally, the paper closes with the conclusion and discussion of avenues of future research.

BACKGROUND

In the 1950's Robert Solow began analyzing and developing a model to explain economic growth. Using the production function which expresses a relationship between capital per worker and output per worker, Solow developed the Solow growth model to extend analysis to the factor accumulation related to physical capital such as investment and depreciation. The capital stock which is the entire physical capital in an economy is broken up into these two components: investment and depreciation. The Solow growth model is the change in capital stock, which is the difference between investment and depreciation, or:

$$\Delta k = \gamma f(k) - \delta k$$

where, Δk is change in capital stock, $\gamma f(k)$ is investment, and δk is depreciation. In addition to these variables, there is also the steady state which looks at how output per worker can be affected by the investment rate of a country, the Solow growth model uses investment rates and population growth rates. Generally, there is a negative relationship between population growth and output per worker, and a positive relationship between the rate of investment in physical capital and output per worker.

The Solow growth model only involves a physical capital component to economic growth. "A Contribution to the Empirics of Economic Growth" (Mankiw et al., 1992) extended the Solow growth model to human capital accumulation. The study showed that countries converge at their Solow steady state as the model predicts. This study will use components from both the Solow growth model and concepts from the Mankiw et al. (1992) paper. This will be further discussed in the next section: Methdology.

METHODOLOGY

As this study explores the effect of human capital on economic well-being, I used linear regressions for my study to see the relationship between factors that affect economic well-being, first using population growth and the investment rate and then adding human capital components. Initially I estimated regressions for an entire sample using data for GDP per capita from two different sources. As it is difficult to provide accurate data on GDP per capita for developing countries, using two sources allows the researcher to consider the robustness or consistency of the results. Independent variables include the rate of population growth, investment rate (inv./GDP), and the gross enrollment rates for primary, secondary, and tertiary education. Since this is a cross-country comparative study, I selected 124 countries from the UN-specified geographic divisions of the world: Europe, Oceania, Northern America, Latin America and the Caribbean, Asia, and Africa. The criteria for selecting the countries was the availability of information and if it was a developing country or developed country. This study used a time series approach, using data from 1980 to 2003. Two regressions were estimated in each case: a short version and a long version. The short version consists of log GDP per capita as the dependent variable and the gross investment rate and rate of population growth as independent variables. This is the basic Solow growth model. The long version consists of the variables in the short version as well as gross enrollment rates for

primary, secondary, and tertiary levels. The results of the regressions are discussed in the following section: the results section.

RESULTS

Several regressions were used to demonstrate the relationship between level of GDP per capita and human capital. The first set of regressions dealt with the entire sample of countries. One regression used World Bank data and the other regression used data from the Penn World Tables. Table 1 shows means for the variables in these regressions.

Table 1. Variables, Means and Standard Deviations
World Bank and Penn World Tables Data

Variable	World Bank		Penn World Tables	
	Mean	Std. Dev.	Mean	Std. Dev.
GDP/capita	6780	7025	6739	6505
log GDP/capita	8.1	1.3	8.2	1.2
Gross Investment Rate	14.5	9.6	14.3	9.7
Population Growth Rate	1.7	1.2	1.8	1.2
Primary Gross Enrollment Rate	95.2	23.0	95.2	23.3
Secondary Gross Enrollment Rate	58.3	34.6	57.7	34.4
Tertiary Gross Enrollment Rate	17.4	17.1	17.0	17.0
Sample Sizes:	World Bank Data: 1352			
	Penn World Tables Data: 1359			

Since several developing countries do not record economic data as frequently as developed countries and there are nonmarket (subsistence) production transactions occurring on a daily basis that are not recorded, this study used data from two sources in order to get an idea of the range of GDP per capita for these developing countries and to assess the consistency of results across two different sets of data. Table 1 shows that the means for the levels of GDP per capita and log GDP per capita from each source are comparable to each other. There is slightly more variance among the World Bank data for these two variables as compared to the Penn World Tables data. The gross investment for both sources is 14+% on average with the gross investment rate for the World Bank data at 14.5%. There is more variance in the Penn World Tables data than in the World Bank data for the gross investment rate. The means for primary, secondary, and tertiary gross enrollment rates are comparable to each other; the standard deviations for each source are similar.

Results of the regressions for the entire sample are found in Table 2. These results support the theory that investment has an impact on GDP/capita. The coefficients for the gross investment rate imply that a one-unit (i.e., one percentage-point) increase in the gross investment rate is associated with GDP per capita that is higher by 5-6%, holding population growth constant. In the short version of the model, there is a substantial impact of investment on GDP/capita. Log GDP per capita is negatively and significantly related to population growth. In the short version of the model, R^2 demonstrates that gross investment and population growth rates account for nearly 60% of the variation in the level of log GDP per capita. The short version of the model using data from the World Bank and the Penn World Tables gives different measures of the same equation. The results for the coefficients for both equations are significant at the 1% level. Even though both equations have a positive relationship between log GDP per capita and gross investment rates, there is a slightly larger impact of investment in the World Bank sample than in the Penn World Tables sample. These results demonstrate that the Solow growth model is an important model that explains a good deal of the variation in income per capita across countries.

Table 2. Determinants of log GDP/capita
Dependent variable: log GDP/capita

Variable	World Bank		Penn World Tables	
	Coefficient	Coefficient	Coefficient	Coefficient
Gross Investment Rate	.062**	0.021**	0.053**	0.017**
Population Growth Rate	-0.558**	-0.012	-0.490**	-0.061**
Primary Gross Enrollment Rate	-	0.005**	-	0.002**
Secondary Gross Enrollment Rate	-	0.024**	-	0.021**
Tertiary Gross Enrollment Rate	-	0.014**	-	0.012**
Intercept	8.179**	5.752**	8.343**	6.496**
F-Ratio	925.8**	1174.3**	917.6**	1129.2**
R -squared	0.579	0.814	0.575	0.807
Adj. R-squared	0.578	0.813	0.575	0.806

Sample Sizes: World Bank Data: 1352
Penn World Tables Data: 1359

**=coeff. sig. at 1% level
*= coeff. sig at 5 % level
+=coeff. sig at 10% level

Emulating the procedure from the Mankiw et al.(1992) paper on economic growth and human capital, equations 2 and 4 in addition to the basic Solow growth model components have human capital components: the primary, secondary, and tertiary gross enrollment rates. With the exception of the population growth rate in equation 2, both

regressions of the long version have significant coefficients for all of the variables with positive coefficients for each of the enrollment rates. The anomaly in these regressions is the impact of the secondary gross enrollment rates is much larger than that of the tertiary gross enrollment rates. The population growth rate has an inverse relationship to GDP per capita. Once human capital variables are added to the population growth rate and the gross investment rate, all the variables account for 80% of the variation in level of log GDP per capita, an increase by more than 20 percentage points from the short version. The results show that there is a relationship between the level of log GDP per capita and the investment in education levels. Essentially this means that countries that invest more in education will tend to have a higher GDP per capita.

To delve deeper, the sample of countries was stratified into high income and low income countries. The criteria for stratifying the countries was borrowed from the World Bank, whose definition of income groups designates those that have GNP per capita below 935 as low income countries. This second set of regressions divided the sample of countries into low income and high income countries. Table 3 has the means and standard deviations for low income and high income countries.

Table 3. Variables, Means and Standard Deviations by Income Level

Variable	World Bank				Penn World Tables			
	High Income		Low Income		High Income		Low Income	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
GDP/capita	17079	4586	3099	2828	16506	3891	3416	2837
Log GDP/capita	9.7	0.2	7.5	1.1	9.7	0.2	7.8	0.9
Gross Investment Rate	22.8	7.6	11.5	8.5	22.8	7.8	11.4	8.5
Population Growth Rate	0.9	0.9	2.0	1.1	0.8	1.1	2.1	1.1
Primary Gross Enrollment Rate	101.6	8.7	93.0	25.9	100.5	7.9	93.5	26.3
Secondary Gross Enrollment Rate	97.9	16.6	44.1	27.7	97.8	16.7	44.0	27.4
Tertiary Gross Enrollment Rate	37.0	17.2	10.4	10.3	36.9	17.7	10.2	10.1
Sample Sizes:	356		996		345		1014	

World Bank and Penn World Tables Data

The means for GDP per capita in the high income countries are about 5 times larger than the means in the low income countries. The coefficient of variation (standard deviation divided by the mean) indicates the degree of variability for a variable. These coefficients are shown in Table 4.

Table 4. Coefficient of Variation by Income Level
World Bank and Penn World Tables Data

Variable	WB Coefficient of Variation	WB Coefficient of Variation	PWT Coefficient of Variation	PWT Coefficient of Variation
	High Income	Low Income	High Income	Low Income
GDP/capita	0.27	0.91	0.24	0.83
Log GDP/capita	0.02	0.15	0.02	0.12
Gross Investment Rate	0.33	0.74	0.34	0.75
Population Growth Rate	1.00	0.55	1.38	0.52
Primary Gross Enrollment Rate	0.09	0.28	0.08	0.28
Secondary Gross Enrollment Rate	0.17	0.63	0.17	0.62
Tertiary Gross Enrollment Rate	0.46	0.99	0.48	0.99

Except for the population growth rate, there is more variability in the low income country sample than in the high income country sample. The results from the regressions for the stratified sample are shown in Table 5.

Table 5. Determinants of log GDP/capita by Income Level
Dependent variable: log GDP/capita

Variable	World Bank				Penn World Tables			
	High Income		Low Income		High Income		Low Income	
	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient
Gross Investment Rate	0.011**	0.010**	0.041**	0.013**	0.010**	0.009**	0.034**	0.009**
Population Growth Rate	0.022+	0.059**	-0.509**	-0.009	0.004	0.026**	-0.464**	-0.022
Primary Gross Enrollment Rate	-	-0.006**	-	0.006**	-	-0.009**	-	0.004**
Secondary Gross Enrollment Rate	-	0.004**	-	0.018**	-	0.003**	-	0.016**
Tertiary Gross Enrollment Rate	-	0.003**	-	0.030**	-	0.004**	-	0.029**
Intercept	9.446**	9.470**	8.106**	5.704**	9.443**	9.857**	8.327**	6.294**
F-Ratio	25.1**	38.5**	381.0**	509.1**	26.1**	34.4**	389.7**	514.3**
R -squared	0.125	0.355	0.434	0.720	0.132	0.337	0.435	0.718
Adj. R-squared	0.120	0.345	0.433	0.719	0.127	0.327	0.434	0.717
Sample Sizes:	356		996		345		1014	

**=coeff. sig. at 1 % level
*= coeff. sig at 5 % level
+ =coeff. sig at 10% level

Note: Creating a benchmark of $935 for gross domestic product per person, the binary variables indicate if a country is high income (or above $935) or low income (below $935). Simply, Organisation for Economic Co-operation and Development (OECD) countries comprise mostly of high income countries.

The high income regressions modeling the basic Solow growth model have significant coefficients except for the Penn World Tables' population growth rate. There is an anomaly for the population growth rate coefficient in the high income regression. There is a positive relationship between population growth rate and log GDP per capita. This is contrary to the expected results from the Solow growth model. The short version of the high income regressions only had the explanatory variables account for about 13% of the variation in the level of log GDP per capita.

The high income regression long versions of the model have significant coefficients for all of its variables. Although all of the coefficients are significant there are two anomalies in the results. The first is in both the WB and PWT data in which population growth is positively related to the level of GDP per capita. The second anomaly is the primary gross enrollment rate is negatively related to the level of GDP per capita. Primary gross enrollment rate should be positively related because primary school is when the students learn the basic skills to help them become productive in the workforce. The coefficients are comparable to each other, the gross investment rate and population growth rate are larger in the World Bank regression. The gross enrollment rates' coefficients are larger in the regression using the Penn World Table dataset. The power of the explanatory variables increases once the long version of the model is used: the R^2 increases to 34%.

The low income regression modeling the Solow growth model has significant coefficients with the expected signs. The longer version low income regression has significant coefficients for all of their variables except for the population growth rate. According to the World Bank data the variables have a larger impact on GDP per capita than the Penn World Table data; this is shown by the larger coefficients in the World Bank regression. The R^2 indicates that the model explains 72% of the variation in the level of GDP per capita in the low income country sample.

The high income and low income country samples have several differences. There is a larger impact of gross investment for low income countries than high income countries. Although this may be the case, there is a larger impact of the gross investment rate on the short form than on the long form. Also population growth rate has more of an impact for high income countries than low income countries, but this may not be a reliable result because the population growth rate coefficient for the high income country sample was an anomaly. Overall, the R^2 for the country samples are considerably higher for the low income countries than for the high income countries.

DISCUSSION

The study design in this research was based on contemporary literature from two economic tools: the Solow growth model and the Mankiw et al. model. The Solow growth model includes the rate of population growth and the gross investment rate with the log GDP per capita. As for the Mankiw et al. model, it adds to the Solow growth model and includes human capital variables. In this study, gross enrollment rates were used as the human capital variables.

The findings in the study illustrate that the there is a positive relationship between level of log GDP per capita and the tested variables: gross investment rate, rate of population growth, and gross enrollment rates. The relationship between the variables were significant, for the most part, in the stratified sample. Despite the anomalies found in the high income country, related to the population growth and primary gross enrollment rates, the gross investment rate and the other gross enrollment rates were significant. There were no anomalies found in the low income sample. As expected, the low income countries had a higher R^2 when the gross enrollment rates were added. Essentially there was a larger impact on the R^2 for these countries compared to their high income counterparts.

There are several educational implications of this research. First, this research shows that the gross investment rate is a crucial component in determination of the level of GDP per capita and overall economic well-being. With this in mind, this research can be used to help developing countries develop policies to further accelerate their human capital.

There are several avenues of future research. One of the limitations in this study was measuring human capital and economic growth directly. There was a very weak relationship between economic growth and human capital. A possible avenue of future research is to look more closely at economic growth when seeing the relationship between human capital, investment, and population growth. Another avenue of future research is comparing the results of the regressions for the short version and long version of the models by the regions. Lastly after researching more on education systems in other countries, recommend policies can be developed to accelerate human capital in low income countries.

SUMMARY AND CONCLUSIONS

In conclusion, all of the hypotheses of this study receive support from the data analysis. Through the different models, the researcher tested all of these hypotheses. Expected factors such as population growth and investment contribute to income differences across the countries. The human capital components also contribute to income differences across countries. Finally through the stratified income sample, there was a difference in both population growth and investment for low and high income components affecting these samples with different weights.

REFERENCES

Barro, Robert J. (1991). "Economic Growth in a Cross Section of Countries." *The Quarterly Journal of Economics*, 106, No. 2, 407-443

Becker, Gary S. (1964) *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education.* New York: National Bureau of Economic Research

Guisan, M. Carmen, Aguayo, Eva, & Exposito, Pilar. (2001). "Economic Growth and Cycles: Cross-Country Models of Education, Industry and Fertility and International Comparisons." *Applied Econometrics and International Development.* 1, 9-37

Krueger, Alan B. and Lindahl, Mikael. (2001). "Education for Growth: Why and For Whom?" *Journal of Economic Literature,* 39, 1101-1136.

Mankiw, Gregory N., Romer, David, & Weil, David N. (1992). "A Contribution to the Empirics of Economic Growth." *The Quarterly Journal of Economics,* 107, 407-437.

Solow, Robert M. (1970) *Growth Theory: An Exposition.*. New York: Oxford University Press

Weil, David N. (2005). *Economic Growth*. New York: Addison Wesley.