EDUCATIONAL ATTAINMENT AND ECONOMIC GROWTH ACROSS COUNTRIES: DO TIMSS & PISA TEST SCORES EXPLAIN GROWTH?

David Brat & Trang Le, Randolph-Macon College, Ashland Virginia

Abstract

In recent decades, individuals and nations around the world have become more and more concerned with education. Parents want their children to go to school and be educated to better their lives. However, on a larger scale, education is believed to have important influences on the economic growth of countries because it directly affects human capital levels. This paper investigates the ways in which education may determine economic growth, following on a famous study, titled *Natural Resource Abundance and Economic Growth*, by Sachs and Warner in the 1990s. This study finds that cross-country economic growth rates are directly related to educational attainments, measured by international standardized test scores, including Trends in International Mathematics and Science Study (TIMSS) and Program for International Student Assessment (PISA). The paper also demonstrates that these results are robust to several widely known specifications in the literature.

Introduction

I.   Role of Education

Education has always been an important determinant of economic growth. People who have achieved higher levels of education attainment are seen as more skilled and more productive workers. Across countries, more educated workers are capable of utilizing advanced technology from developed countries to produce more goods and services effectively and efficiently. Some previous empirical studies measured educational attainment levels by school enrollment ratios or literacy rates. However, these measures do not provide an overall picture of the aggregate stock of human capital of any country. Thus, this paper will move beyond these traditional variables to study the influence of education on the overall performance of the economy.

In today's world, the knowledge of science and mathematics are especially important. Many of the world's problems, such as global warming, deforestation, rapid population growth, ozone depletion, rising obesity rates and pandemic virus infections, can be solved if the general public has sufficient scientific and mathematical knowledge to understand the cause of these problems and is able to reach consensus on what to do.

II.   Literature Review

The research conducted by Sachs and Warner found that cross-country levels of economic growth are negatively correlated to the ratio of natural resource exports to GDP. This study also investigates the relationships of other variables, which can influence a country's economic growth. In the *Working Paper* written by Sachs and Warner, new variables are added to regressions from four previous studies Barro (1991), DeLong and Summer (1991), King and Levine (1999) and Mankiw, Romer and Weil (1992) to examine the negative relationship between natural resource abundance and economic growth during the subsequent 20-year period 1970 to 1990. Sachs and Warner also looked at many different variables that contribute to a nation's economic development, such as the openness of the economy, to draw the above conclusion.

We will use these four studies as a baseline from which to investigate human capital as measured by TIMMS and PISA test scores. If our new variables are statistically significant in all four of these research papers, and their regression models, then we will be able to claim a robust relationship between them and economic growth.

Among the studies used in Sachs and Warner's paper, the study by Barro conducted in 1991 also includes the estimates of educational attainments for the population aged 15 and over because this age group corresponds better to the labor workforce in many developing countries (Barro and Lee, 2). Education attainment is hard to measure with precision in a quantitative form. However, educational attainment is approximated based on the component of the human capital stock obtained at school.

Thus, the education variables in this research paper are the TIMSS and PISA test scores, which are the alternative measures of human capital. TIMSS is used to compare the education achievement of the fourth and eighth-grade levels across nations in the areas of mathematics and science as well as to track changes in education attainments over time. In addition, TIMSS also provides an indication of the degree to which students have learned concepts in mathematics and science they have encountered in school to each country. The International Association for the Evaluation of Educational Achievement (IEA), has been administered TIMSS since 1995 with the participation of an increasing number of countries around the world. TIMSS requires countries to select random, national representative samples of schools and students. The fourth-grade assessment was offered in 1995 and 2003, while the eighth-grade assessment was offered in 1995, 1999, and 2003.

While TIMSS is based on attained curriculum knowledge at a particular grade level, PISA is based more on skills and abilities in certain areas of 15-year-olds in the member countries. The PISA assesses the knowledge and skills in reading literacy, mathematics literacy, and science literacy of 15-year-olds across nations. PISA is administered every 3 years starting in 2000 through the collaboration of participating countries and the Organization of Economic Cooperation and Development. PISA 2006 results include more than 400,000 students across nations making up close to 90 percent of the world economy. Furthermore, it also collects data on student, family and institutional factors that may influence or help explain differences in the performance on PISA. Thus, this assessment takes into account learning that may occur outside formal academic settings. Because of these technical and practical reasons, the results of TIMSS and PISA are not directly comparable. Thus, this paper will use both TIMSS and PISA scores to measure cross-country educational attainments.

Methodology

The hypothesis of this paper is that the TIMSS and PISA test scores are positively correlated with the economic growth rates in the most prominent economic growth papers in the literature. This research adds the new variables of cross-country educational attainments, measured by TIMSS Math, TIMSS Science and PISA test scores, to Sachs and Warner's regression equations to examine these variables' correlations to the countries' economic growth rates.

The results of these tests are not to be taken literally as there are many statistical problems with this approach. For one, the growth rates used as dependent variable in most of these studies predate the TIMMS and PISA test scores. This is a significant issue but one can interpret test scores in one year to embody significant investments in the educational sector several years prior, especially in the cross country context. Working out the interpretation for this lag structure is a complex issue for future work. The TIMMS and PISA data were not available in the years of interest and the results are therefore suggestive. From previous work in this area, however, the authors have good reason to suspect that these results will be robust in future work when test scores can be more accurately linked to growth rates.

The tables below are meant to present our findings in the most simple format possible. We have simply reported the T-statistics from our regression results and included the T-statistic for only our newly included educational variables. We added our TIMMS and PISA variables to the most widely reported

equation used in each prominent paper. We only added one variable at a time to ensure that you are seeing a true test of each variable. The results are very strong and highly suggestive. The full Stata regression log for each equation is available upon request.

We ran one further set of tests as well. Following standard econometric practice, we eliminated all non-significant variables from our equations as noted below. To reflect the relationship between the test scores and economic growth, the insignificant variables used by the Sachs and Warner et.al. (with absolute values of t-statistics lower than 1.5) are eliminated. Then, the regressions are run to test the t-statistics of those test scores against other variables in the original studies as well as Sachs and Warner's study. We now present our findings.

Results

Table 1: Regressions from Barro Paper (1991), Sachs and Warner's paper (2000) with TIMMS and PISA educational variables included. T statistics reported below.

Educational Variables	Barro	Sachs & Waner	Barro without insignificant variables	Sachs & Warner without insignificant variables
TIMSSMATH95	0.23	-	2.61	2.24
TIMSSMATH99	4.75	2.91	3.85	3.44
TIMSSMATH03	4.49	3.29	3.78	3.26
TIMSSSCI95	-0.99	-	0.90	2.28
TIMSSSCI99	3.70	2.69	2.24	2.08
TIMSSSCI03	4.61	3.45	2.53	2.04
PISA00	1.99	0.96	3.37	1.58
PISA03	5.73	4.33	3.23	2.81
PISA06	6.31	4.91	4.04	4.02

Table 2: Regressions from King and Levine Paper (1993), Sachs and Warner's paper (2000) with TIMMS and PISA educational variables included. T statistics reported below.

Educational Variables	King & Levine	Sachs & Warner	King & Levine without insignificant variables	Sachs & Warner without insignificant variables
TIMSSMATH95	0.97	-3.54	3.15	2.05
TIMSSMATH99	5.34	3.26	5.08	4.77
TIMSSMATH03	5.05	3.07	5.17	4.15
TIMSSSCI95	1.32	-5.32	2.38	1.62
TIMSSSCI99	4.19	2.12	3.62	2.90
TIMSSSCI03	4.87	2.64	3.82	2.65
PISA00	1.62	3.77	2.05	4.57
PISA03	3.04	2.85	4.09	3.99
PISA06	3.63	3.15	5.64	5.91

Table 3: Regressions from Mankiw, Romer and Weil (1992) Paper, Sachs and Warner's paper (2000) with TIMMS and PISA educational variables included. T statistics reported below.

Educational Variables	Mankiw, Romer & Weil	Sachs & Warner	Mankiw, Romer & Weil without insignificant variables	Sachs & Warner without insignificant variables
TIMSSMATH95	2.85	1.51	2.85	1.79
TIMSSMATH99	4.03	3.54	4.03	3.19
TIMSSMATH03	4.07	3.32	4.07	3.23
TIMSSSCI95	0.95	1.01	0.95	0.72
TIMSSSCI99	2.47	2.10	2.47	1.70
TIMSSSCI03	2.93	2.33	2.93	1.88
PISA00	1.87	3.73	1.87	3.04
PISA03	3.05	3.38	3.05	3.37
PISA06	3.85	4.88	3.85	4.53

Table 4: Regressions from DeLong and Summers (1991) Paper, Sachs and Warner's paper (2000) with TIMMS and PISA educational variables included. T statistics reported below.

Educational Variables	DeLong & Summers	Sachs & Warner	DeLong & Summers without insignificant variables	Sachs & Warner without insignificant variables
TIMSSMATH95	0.32	-	-0.73	-
TIMSSMATH99	4.44	2.14	4.94	1.64
TIMSSMATH03	3.17	1.45	3.61	0.80
TIMSSSCI95	-5.27	-	-7.00	-
TIMSSSCI99	5.24	1.44	4.98	1.77
TIMSSSCI03	4.10	1.23	4.64	0.94
PISA00	2.20	4.30	2.29	3.22
PISA03	4.56	3.48	3.91	3.59
PISA06	5.46	3.91	5.02	3.69

The numbers, which are shown in the tables, are the t-statistics of the educational variables. The t-statistics show that TIMSS Math, TIMSS Science and PISA all demonstrate a strong positive relationship between educational attainment and economic growth.

Conclusions

We find that the economic growth rate is positively related to educational levels, as measured by the TIMSS and PISA test scores over a broad range of countries. The results of this study support the stated hypothesis that education attainment level is positively correlated with a country's economic growth. In short, education is an important factor in the economic development of any country. The study also implies that the inclusion of these new human capital measures matter. Future work will focus on linking TIMMS and PISA scores to growth rate series closer to those test scores. We await the data and regression papers which will make this possible.

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