E C O N O M I C S B U L L E T I N

Schooling Quality in a Cross Section of Countries: a replication exercise and additional results

Tiago Sequeira
Universidade da Beira Interior and INOVA, Fac. Economia, Universidade Nova de Lisboa

Pedro Robalo
Fac. Economia, Universidade Nova de Lisboa

Abstract

In this note we begin by replicate the results in “Schooling Quality in a Cross-Section of Countries” [Barro and Lee 2001, Economica 68]. Then, we go further and show that results can be different when more meaningful variables are considered. In particular, school inputs lessen their effects in some specifications, approximating the macroeconomic result from the microeconomic ones.

We acknowledge support from Fundação para a Ciência e Tecnologia, through POCI/EGE/60845/2004. The usual disclaimer applies.
Citation: Sequeira, Tiago and Pedro Robalo, (2008) "Schooling Quality in a Cross Section of Countries: a replication exercise and additional results." *Economics Bulletin*, Vol. 9, No. 9 pp. 1-7
Submitted: April 11, 2008. **Accepted:** April 28, 2008.
URL: http://economicsbulletin.vanderbilt.edu/2008/volume9/EB-08I20008A.pdf

1 Introduction

In this note we present a replication exercise of results in the influential article "Schooling Quality in a Cross Section of Countries" [Barro and Lee 2001, *Economica* 68]. This note is inserted in a scientific discussion about the influence of inputs on schooling performance - see Hanushek (1989, 2003) for review articles. On its majority, the literature has reached a consensus on the inefficiency of public resources in determining the quality of schools. Some exceptions arise: Hedges at al. (1994) using more sophisticated techniques found that an increase in average spending per pupil would significantly increase student achievement. Also Crampton (1995) for New York State schools found that expenditures seemed to matter when they bought smaller classes and more experienced, highly educated teachers.

Barro and Lee (2001) concluded that income, social or family background and also inputs are important determinants of tests outcomes, repetition and dropout rates in their macroeconomic dataset. The significance of inputs obtained by Barro and Lee (2001) are in contradiction with most micro-evidence.

Fortunately, some variables about schooling quality are available, mainly due to Barro and Lee (2001), but some of that data were not used in estimations yet. We present further results based on variables that were not used and show that some inputs, when correctly measured, are not significant, approximating the macroeconomic result from the microeconomic one.

2 Data and Results

Data closely follows the data used in Barro and Lee (2001). The variables have been drawn from two sources: the "barro.lee" dataset (www.nber.org/pub/barro.lee) and the "barro.lee.90" dataset (www.nber.org/barro.lee.90). For ease of exposition, we refer to the former as the "first dataset" and to the latter as the "second dataset". We use data on the following measures:

- Test Scores - scores obtained at "examinations in mathematics, science and reading that have been conducted in various years for up to 58 countries by the International Association for the Evaluation of Educational Achievement (IEA) and the International Assessment of Educational Progress (IAEP)." We used the test scores for students aged 9 to 14. The source of these scores is the compilation made by Barro and Lee in the second dataset.

- Dropout Rate - drop-out rate at primary school (in percentage); the source is the second dataset.

- Repetition Rate - repetition rate at primary school (in percentage); the source is the second dataset.

- Gross Domestic Product per capita (1985 international prices) from the Summers-Heston (Penn World Table) database, version 5.5; the source is the first dataset.

- Primary Education of Adults - average years of primary schooling in the population aged 25 and over; the source is the second dataset.
- Pupil-teacher ratio - pupil-teacher ratio at primary school; the source is the second dataset.
- Average Teacher Salary - average real salary of primary school teachers (PPP-adjusted 1985 international dollars); the source is the second dataset.
- Education Expenditure per Pupil - real government current educational expenditure per pupil at primary school (PPP-adjusted 1985 international dollars); the source is the second dataset.
- Length of School Days - number of school days per year at primary school (missing values are filled in by regional averages); the source is the second dataset.
- Dummy for Asia - binary variable that takes the value 1 whenever a country is located in East Asia and 0 otherwise; the source is the first dataset.

2.1 Replication Results

In the following tables, we present a comparison between estimations in Barro and Lee (2001), Tables 3 and 6 - columns (1) and (2) - and our replication results - columns (3) and (4). As it can be seen, exact results could not be obtained but we have reached quite similar coefficients and significance levels. Apparently, different results come from the omission of observations that are in Barro and Lee (2001) article but are not included in the database.[1] We only show replication of Table 3 and 6 for space reasons, but we tested other results in the article and the comparison between our replication estimations and theirs is similar to results presented here. In Table 2, our results are particularly close to those in Table 6 in Barro and Lee (2001).

[1] In the data file, we detail the countries and years that entered in our regressions.

Table 1 - Regression for Test Scores

	(1)	(2)	(3)	(4)
Estimation method	SUR	SUR	SUR	SUR
Log (GDP per capita)	3.19	4.16	3.02	4.07
	(3.00)	(4.23)	(2.58)	(3.82)
Primary education of adults	1.33	1.33	1.60	1.45
	(4.93)	(4.94)	(5.21)	(4.92)
Pupil-teacher ratio	-0.15	-	-0.16	-
	(2.44)		(2.27)	
Log (average teacher salary)	1.62	-	0.81	-
	(1.81)		(0.82)	
Log (education expend. per pupil)	-	1.06	-	0.57
		(1.46)		(0.72)
Length of school days	0.01	-	0.04	-
	(0.46)		(1.73)	
No. of observations	214	214	209	209
R-squared	-0.19, 0.09. -0.53	-0.33, 0.12, -0.46	-0.11, 0.12, -0.13	-0.28, 0.17, -0.36
	0.26, 0.55, 0.52	0.24, 0.51, 0.49	0.41, 0.59, 0.32	0.34, 0.53, 0.14
	0.22, 0.34, -0.15	0.26, 0.30, -0.10	0.59, 0.25, 0.37	0.52, 0.28, 0.33
	0.16, 0.72, 0.65	0.16, 0.72, 0.65	0.43, 0.72, 0.28	0.37, 0.69, 0.41
	0.44	0.44	0.40	0.53

Notes: Columns (1) and (2) are from Barro and Lee (2001), Table 3.
Columns (3) and (4) are our replication results. Absolute values of t-statistics appear in parenthesis.
Systems of regressions allowed for a different constant by equation. They are not showed in the table.

Table 2 - Regression for Repetition rates and Dropouts

	(1)	(2)	(3)	(4)
Estimation method	SUR	SUR	SUR	SUR
Log (GDP per capita)	-2.09	-4.91	-2.06	-4.72
	(2.57)	(2.18)	(2.46)	(2.17)
Primary education of adults	-1.11	-2.30	-1.04	-1.92
	(3.62)	(2.77)	(3.37)	(2.31)
Pupil-teacher ratio	0.16	0.34	0.17	0.40
	(4.35)	(3.29)	(4.34)	(3.82)
Log (average teacher salary)	0.08	-4.32	0.02	-4.34
	(0.14)	(2.97)	(0.03)	(2.96)
Length of school days	-0.08	-0.08	-0.08	-0.07
	(3.42)	(1.14)	(3.32)	(1.03)
No. of observations	337	346	333	341
R-squared	0.41, 0.32, 0.43	0.46, 0.44, 0.48	0.42, 0.33, 0.43	0.46, 0.45, 0.49
	0.45, 0.53	0.49, 0.42	0.45, 0.57	0.50, 0.45

Notes: Columns (1) and (2) are from Barro and Lee (2001), Table 6, columns (1) and (3).
Columns (3) and (4) are our replication results. Absolute values of t-statistics appear in parenthesis.
Systems of regressions allowed for a different constant by equation. They are not showed in the table.

Overall, these results support the importance of both background (income and education) and inputs to measures of school quality.

2.2 Further Results

In this section, we present a few further results using both different variables to measure inputs and also other techniques. Different variables to measure inputs are the ratio of education expenditure per pupil to real per capita GDP (in percentage) and the ratio of average teacher salary to real per capita GDP (in percentage). The first variable measures the relative well-being of a student in each economy or the government contribution to subsidize the opportunity cost of going to school. The second variable measures the incentive

in terms of the opportunity cost of being a teacher. Thus these variables are better in assessing the incentives to go to school and to teach at school than those variables used in Barro and Lee (2001). Tables 3 and 4 present results using these variables. Results indicate that the inputs loose explanatory power in explaining quality measures, approximating this result from the "consensus" based on micro evidence, according to which inputs are insignificant or even negatively related to outcomes. An exception occur in the pupil-teacher ratio, which means that if an input is important, it is smaller classes.

Table 3 - Regression for Test Scores

	(1)	(2)	(3)
Estimation method	SUR	SUR	SUR
Log (GDP per capita)	1.94	4.40	2.09
	(2.99)	(7.32)	(3.41)
Primary education of adults	1.44	1.37	1.50
	(5.33)	(4.59)	(5.70)
Pupil-teacher ratio	-0.30		-0.42
	(4.56)		(5.20)
Average teacher salary / GDP	0.00		0.01
	(0.03)		(1.49)
Education expend. per pupil / GDP		0.03	-0.17
		(0.62)	(2.33)
Length of school days	0.04		0.04
	(1.71)		(1.88)
No. of observations	175	191	175
R-squared	0.03, 0.04, 0.23	-0.27, 0.16, -0.29	0.22, 0.09, 0.27
	0.48, 0.59, 0.60	0.35, 0.51, 0.32	0.48, 0.59, 0.69
	0.65, 0.16, 0.33	0.49, 0.27, 0.32	0.65, 0.09, 0.34
	0.66, 0.63, 0.03	0.35, 0.67, 0.26	0.65, 0.62, 0.07
	0.56	0.62	0.56

Notes: Absolute values of t-statistics appear in parenthesis. Systems of regressions allowed for a different constant by equation. They are not showed in the table.

Table 4 - Regression for Repetition Rate and Dropout Rate at Primary School

	(1)	(2)	(3)	(4)
Estimation method	SUR	SUR	SUR	SUR
Log (GDP per capita)	-1.86	-2.09	-9.74	-9.95
	(2.66)	(3.07)	(5.40)	(5.53)
Primary education of adults	-0.95	-0.72	-1.43	-1.49
	(2.91)	(2.22)	(1.64)	(1.72)
Pupil-teacher ratio	0.16	0.15	0.38	0.35
	(4.20)	(3.33)	(3.66)	(2.94)
Average teacher salary / GDP	0.00	0.00	0.00	-0.01
	(1.47)	(1.37)	(2.31)	(1.22)
Length of school days	-0.07	-0.06	-0.05	-0.04
	(2.77)	(2.44)	(0.78)	(0.54)
Dummy for Asia		-5.57		-8.80
		(4.02)		(2.08)
Education expend. per pupil / GDP		-0.06		0.00
		(0.78)		(0.02)
No. of observations	320	319	330	330
R-squared	0.42, 0.36, 0.43	0.50, 0.40, 0.46	0.43, 0.43, 0.48	0.46, 0.43, 0.49
	0.45, 0.60	0.50, 0.63	0.50, 0.46	0.51, 0.46

The dependent variable in columns (1) and (2) is the primary school repetition rate. In columns (3) and (4), the dependent variable is the school dropout rate. Absolute values of t-statistics appear in parenthesis. Systems of regressions allowed for a different constant by equation. They are not showed in the table.

2.2.1 Robustness Analysis

As a robustness tests of our results, we present some fixed effects estimation of the specifications that appeared in tables 3 to 4. In order to do this, we have constructed a new variable, named tests, which is an average of all observations for each pair year/country, independently of the type of test (science, math and reading) and of the age in which the test was attained (9, 10 and 14 years old). This will show us that inputs are not significant and robust across all simulations. A lower level of significance of inputs when fixed-effects were used was also obtained by Barro and Lee (2001). Also, the background proxies loose some explanatory power. It is worth noting that the only regressor that remains significant throughout the specifications is GDP. Class size and relative teacher salary are significant in the tests regression.

Table 5 - Fixed Effects Regressions

Dependent Variable	Test Scores		Dropout Rate		Repetition Rate	
	(1)	(2)	(3)	(4)	(5)	(6)
Log (GDP per capita)	12.77	13.83	-9.15	-8.15	-3.62	-3.58
	(1.67)	(1.85)	(1.83)	(1.72)	(2.62)	(2.64)
Primary education of adults	2.60	2.49	-0.47	-0.87	0.53	0.52
	(0.41)	(0.41)	(-0.32)	(0.59)	(0.50)	(0.49)
Pupil-teacher ratio	-0.91	-1.23	0.14	0.04	0.03	0.02
	(1.80)	(2.86)	(0.48)	(0.16)	(0.34)	(0.28)
Average teacher salary / GDP	0.05	0.06	-0.01	0.00	-0.01	-0.00
	(2.01)	(2.68)	(0.62)	(0.06)	(1.24)	(1.01)
Education expend. per pupil / GDP	0.62		0.29		0.02	
	(1.23)		(1.25)		(0.34)	
No. of observations	80	80	137	137	180	180
R-squared	0.20	0.23	0.49	0.51	0.10	0.11

Notes: Absolute values of t-statistics appear in parenthesis. Test Scores is an average of science, reading and maths tests, each averaged in all year observation.

3 Conclusion

We implemented a replication exercise of results in the article from Barro and Lee (2001). Using the authors' sources, we have reached slightly different results due to less observations included in this case when compared with estimations reported in their article. We additionally showed that the significantly robust effect of inputs disappear when we considered teachers salaries and expenditures *as a proportion to GDP per capita*. Moreover, when fixed-effects are considered, only GDP remains as an overall significant determinant of school quality. These results are important as they approximates the macro results to the micro evidence.

The main constraint to implement more efficient methods to estimate macroeconomic input-quality regressions are the lack of data for quality measures through time. Thus, future contributions may overcome this constraint.

References

[1] Barro, R. and J. Lee (2001), "Schooling Quality in a Cross Section of Countries", *Economica,* 68 (272), 465-488.

[2] Crampton, F. (1995), *Is the Production function dead? An Analysis of the Relationship of Educational Inputs on School Outcomes*, American Education Finance Association Conference.

[3] Hanushek, E. (1989), "The impact of Differencial Expenditures on School Performance", *Educational Researcher,* 18 (4), 45-51.

[4] Hanushek, E. (2003), "The failure of Input-Based Schooling Policies", *The Economic Journal*, 113, 64-98.

[5] Hedges, L., L. Richard and R. Greewald (1994), "Does Money Matter? A Meta-Analysis of the Effects of Differencial School Inputs on Students Outcomes", *Educational Researcher,* 23 (3), 5-14.

[6] Summers, R. and A. Heston (1991), "The Penn World Table (Mark 5): An Expanded Set of International Comparisons, 1950-1988", *Quarterly Journal of Economics*, 106 (2), 327-368.