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Comparative Country Performance on International Education Assessment

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Abstract. The international community agrees that investing in education is vital for a country's development. An anomaly in the literature is that while education has a demonstrable positive impact on individual earnings, it has minimum economic impact on a country's income in aggregate. One of the reasons for this is that most studies account for increased enrollment while neglecting the impact of educational quality. As universal school access becomes a reality, there is growing interest among countries in determining the factors that influence the quality of education. This study uses data from one international educational assessment program to study the impact of family background and the interaction between public funding and public school management on reading, writing, and science test scores. I show that family background, particularly mother's education level, has a strong influence on performance. The study also suggests that school performance can be improved when public funding is allocated to privately managed schools.

Introduction

Every nation that aspires to be productive and prosperous realizes education is the foundation on which to build a great society. Nelson Mandela (2003) famously stated that, "Education is the most powerful weapon which you can use to change the world." The 2011 UNESCO Education Counts Report has shown how access to education creates positive spillovers, affecting global development challenges such as eradicating poverty, promoting gender equality, reducing child mortality, improving maternal health, combating HIV, malaria and other preventable diseases, and encouraging environmental sustainability (UNESCO, 2011).

Achieving universal education access is a focus of the international development agenda. Many efforts, such as the "Education for All" initiative, express the international community's commitment to provide basic education for all children, youth, and adults. During the past two decades, poorer countries have considerably improved school enrollment rates, primary school completion, and the proportion of students starting grade 1 who reach grade 5, narrowing the schooling gap between richer and poorer countries. Although these are all great achievements, empirical evidence shows that these improvements in the quantity of schooling have not had a significant economic impact on poorer countries (Hanushek & Woessmann, 2008). Hanushek & Woessmann (2008) also note that the positive correlation between education and economic growth is clearly observed when models include qualitative elements such as cognitive skills measured by international assessment scores.

Since empirical evidence suggests a strong positive correlation between cognitive skills and desirable economic outcomes, understanding how to achieve this on an individual, school, and country level is essential to promote economic growth. Currently, cognitive skills measurement relies on international assessment scores and surveys. In the mid-1960s, an international consortium was created to implement and compare students' exam performance across nations. The study collected specific data on student background and study habits, as well as school attributes, such as if the school is private or public, and how it is funded. Currently, three major international testing programs conduct worldwide assessments of educational quality. The most comprehensive and rigorous of these is the Programme for International Student Assessment (PISA), which has tested the reading, mathematics, and science skills of 15 year old children every three years since 2000.

This study in particular uses PISA 2009 data from 65 participating countries. Given countries' growing interest in improving school quality and student outcomes, using PISA data to perform educational analysis and comparisons on all levels is a powerful tool to understand and promote policies that foster higher student performance. This paper makes a country-level analysis investigating the impact a country's GDP per capita, the school type (private or public), government funding, and parents' background, has on a country's performance on PISA

Brief Litereture Review

The assumed public benefits of education for society has prompted governments to take a leading role in managing and funding schools. However, a large constituency interested in improving school quality and student outcomes has challenged governments' primary role in education (Brewer & Hentschke, 2009). As public schooling levels increase around the world without major economic impact, an increasing number of countries are wondering whether the public interest might be better served when private entities are involved in managing and funding schools (OECD, 2012). Recently a number of countries have welcomed involvement of private entities in funding and managing schools. The hope is that this approach not only broadens responsibility for schools beyond governments, but also provides parents and students with more choices while spurring creativity and innovation.

Findings from studies investigating the impact of public and private involvement on performance are mixed. Studies in Chile (Lara, Mizala and Repetto, 2009), Czech Republic (Filer and Munich, 2003), Sweden (Sandström and Bergström, 2005), the United Kingdom (Green, et al., 2011) and the United States (Peterson, et al., 2003) demonstrated through cross-sectional and longitudinal data that higher private school enrollment is correlated with better academic performance. Additionally, cross-country studies based on data from PISA 2000 and PISA 2003 indicated that countries that allocate public funds to privately managed schools tend to have overall higher scores (West &Woessmann, 2010; Woessmann, 2006; Woessmann, 2009). On the other hand, other studies showed little or negative effect of private involvement on performance. Studies using USA data indicated that higher private school enrollment had no significant effect on performance (Geller, Sjoquist and Walker, 2006), and other studies showed a small negative effect for low-income district (Maranto, Milliman and Scott, 2000). The differences in results are related to methodological choices, and vary among countries.

The literature indicates that another major determinant of student performance is family background (Coleman et al, 1966). The relationship between family background and performance is well understood to some extent, but some connections are not so clear (Levin & Belfield, 2002). In general, parents with high levels of education may spend more time with their children and may interact with their children in ways that promote better educational outcomes. Also, parents with prestigious careers may become role models to their children, who in turn devote more efforts to be successful in school (Kohn, 1969). In addition, families from wealthier socioeconomic backgrounds can provide a proper study place for their children, such as a quiet place, computer, and other resources that can enhance and motivate learning. Community may also play a role in student performance, since the location of the school is related to the types of resources nearby, such as libraries and museums, which support learning outcomes. Students without these privileges might find it more difficult to perform well in school.

The PISA assessment includes an index of social, economic, and cultural status - a broader concept than family background. The index is calculated using parents education and occupation, as well household possessions. The average socioeconomic index of students attending a school refers to the school's socioeconomic background. When high performing schools within a country are accessible only to students from affluent backgrounds, leaving students from disadvantaged backgrounds to the least efficient schools, this segregation leads to high socioeconomic stratification between schools. When 'classes' of schools are created based on the socioeconomic backgrounds of the students the consequence is unequal educational opportunities and outcomes. Some countries have low levels of socioeconomic stratification in their education systems, thereby maximizing equity and social cohesion, along

with a high performance on PISA. In most PISA participating countries, students that attend private schools tend to have a higher average socioeconomic status than those who attend public school.

Socioeconomic stratification between private and public schools is more pronounced in some countries than others. For example, in Sweden, Finland, Netherlands, the Slovak Republic, Slovenia, Germany, Belgium, Hungary, Luxembourg, and Ireland, over 80% of private schools are publicly funded, while in New Zealand, Panama, Brazil, Kazakhstan, and Peru, public funding accounts for less than 10% of private school funding. Results show that socioeconomic stratification is not affected by the number of private schools. However when private schools are publicly funded there is less social stratification between public and private managed schools.

One approach to transferring public funds to privately managed schools is through vouchers and tuition tax credits given to parents. Vouchers are classified into two types: universal, available to all students, and targeted vouchers provided to disadvantaged students. Both influence socioeconomic stratification differently. PISA scores show that countries with low levels of socioeconomic stratification are overall better performers, ultimately creating policies that promote equity and social cohesion without sacrificing strong performance in the school system (OECD, 2012). Our study seeks to replicate some of these findings with a particular focus on the effects of parental education and the interaction between public funding and public ownership of schools.

Data

The data used for this study was retrieved from The Program for International Student Assessment (PISA) 2009 database and the World Bank Education database. In 2009, a sample of 470,000 students from 65 countries completed the PISA assessment in mathematics, reading, and sciences, representing a population of 26 million 15-years olds. In order to provide valid estimates on student achievement and characteristics, the program enforces international guidelines on each participating country to select a diverse sample of students to represent the full population of 15-years old. Each country is required to select a minimum of 4,500 students from at least 150 schools, both privately and publicly managed. The guidelines also require that samples of 35 students be selected with equal probability within schools. More specifically, the age of students selected ranges from is 15 years and 3 months to 16 years and 2 months at the beginning of the testing period, and they were in 7th grade or higher. The age criteria and exam questions enforce PISA's emphasis on measuring functional skills that students have acquired as they approach the end of compulsory schooling (Fleischman, Hopstock, Pelczar & Shelley, 2010).

During the assessment, each student spends approximately two hours answering multiple-choice questions, constructing their own answers, and carrying out tasks in reading, mathematics and science. Students also answer a survey about their background, learning habits, attitudes towards reading, their involvement and motivation. PISA also reaches out to school principals to complete a questionnaire about demographic characteristics, quality of learning environment, and more issues related to school operation (OECD, 2010-a).
PISA's data collection methodology generates a wealth of micro-data which is very useful in drawing conclusions on educational outcomes. Since our main goal was to observe the impact of parents' educational background and the interaction between public funding and public management of schools on performance, we selected the variables described below in Table 1. The PISA data was merged with income data from the World Bank's World Development Indicators.

PISA data shows countries with varying income levels and number of public schools. Interestingly, the mean number of mothers with upper secondary education is slightly higher than the number of fathers, although the variance is higher for mother's education. In Table 2, we separate countries by income level into approximately equal two equal sized groups, one group with income greater than $25,000 in purchasing power parity (PPP) dollars and the other with income less than PPP $25,000. As one might expect, richer countries perform better on all three testing categories in PISA than poorer countries. Although there are great socio-economic variations within countries, richer coun-

tries in general have access to better educational resources and may be able to allocate resources more efficiently than a country with lower income per capita.

In Table 2 countries are separated by income levels (less $25,000 PPP and income more than $25,000 PPP). There

Table 1 - Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Reading Score	58	462.0659	47.28554	361.52	535.88
Math Score	58	462.796	54.34948	359.75	562.02
Science Score	58	468.4848	52.22789	369.35	554.08
Percent Public Schools	68	81.77118	22.22892	3.98	100
Percent Govt. Funding	63	84.54762	14.0527	43.9	99.8
Gov*Pub	57	64.08063	178.0856	-571.457	638.0826
% of Father's with Upper Secondary Education	58	64.70552	18.31788	30.18	93.5
% of Mother's with Upper Secondary Education	58	65.91034	20.42483	18.26	94.96
PPP Income per Capita	63	$25,393.69	$16,123.66	$2,866.24	$79,351.88

are about the same number of countries in each income group. As expected, high-income level countries perform better than low-income level countries in all three subjects.

In a number of countries, public funding for schools is available regardless of whether a school is publicly or privately managed. For example, the system of providing student vouchers would result in public funds going to private schools. We are interested in whether this is an effective way to improve school quality and Table 5 shows the differences in test scores based on whether a government funds schools regardless of whether the school is a public or private school. Countries with a higher number of schools subsidized by government funding have higher average scores on all three PISA assessments.

Hypothesis and Methodology

Table 2 - Mean Score by Income Level

	Average Math Score	Average Reading Score	Average Science Score
Income less than $25,000PPP	429.6996	433.9829	438.1546
Income more than $25,000PPP	495.945	491.0971	499.3943
Total	462.8223	462.54	468.7745

Table 3 describes the differences between school funding and parental education by income level. Higher income countries have a smaller percentage of public schools, more government funding, and higher education levels for mothers and fathers.

Table 3 - Mean Values by Country Income Level

	Govt. Funding	Percent Public Schools	Mother's Education	Father's Education
Income < $25,000PPP	83.38182	87.767419	61.137097	61.334194
Income > $25,000PPP	86.51071	83.6732	71.611154	68.555385

In most countries, educational systems are composed of public and private schools. Public schools are managed and funded by the government, while private schools are managed by a non-governmental organization relying on public and/or private funding to operate. The PISA database allows researchers to analyze the impact of public and private school management and funding on student performance. In Table 4, the mean scores by public schooling indicate that countries with a greater number of public schools perform better. Once again, the dividing line of 90% was chosen so that there were roughly equal numbers of countries in each group.

Table 4 - Mean Scores by Public Schooling

	Average Math Score	Average Reading Score	Average Science Score
Less than 90% Public	438.7486	445.8659	447.3909
Greater than 90% Public	481.7548	477.911	487.5307
Total	463.2031	464.0876	470.2155

The model we estimate is based on the idea of an educational production function, where the output is the score on a test, as well as results from a number of educational inputs such as family background, educational spending and policy measures (which would impact the effectiveness with which these variables affect test scores). We use PISA scores on reading, mathematics and science as the dependent variables for this paper. PISA ranks countries based on their mean score on each area; they do not provide a collective score of all subjects combined. While we could have simply added the scores together, keeping the data in its raw form from the three subject areas allow us to analyze any possible differences between them.

Table 5 - Mean Scores by Government Funding

	Average Math Score	Average Reading Score	Average Science Score
Less than 90% Govt. Funding	439.9671	448.3404	449.31
Greater than 90% Govt. Funding	483.2286	474.2996	485.6743
Total	461.5979	461.32	467.4921

The independent variables selected were the country's per capita income (pcippp), percentage of the total funding for a typical school year that comes from the government (%govtfunding), the percentage of public schools (%pubschools), the interaction between government funding and public schools (%pubschoolsx%govtfunding), the percentage of fathers with upper secondary education or more (FEDU), and the percentage of mothers with upper secondary education or more (MEDU).

Economic theory favors private schools over public schools for many reasons. First, private schools in general enjoy autonomy to define their own curriculum and greater flexibility to allocate resources - which may lead to more innovation. Second, competition leads to efficiency among private schools that translates into more resources to attract better teachers, equipment and infrastructure. We test whether students attending private schools will have better academic achievement.

However, better performance at private schools may simply reflect the selection of more affluent students who can afford private schools and have access to more resources at home. Thus, school type might lose significance when family background is controlled for. Regardless of whether the school is private or public, parents with high levels of schooling are better capable to provide more resources for education at home, more likely to participate in children's learning experience, and motivate children to be high achievers.

Table 6 - Correlation between Variables

	Math	Science	Reading	PCIPPP	Govt. Funding	Percent Public Schools	Father's Education	Mother's Education
Math	1.00							
Science	0.97*	1.00						
Reading	0.95*	0.98*	1.00					
PCIPPP	0.57*	0.53*	0.53*	1.00				
Govt. Funding	0.52*	0.49*	0.43*	0.14	1.00			
Percent Public Schools	0.18	0.16	0.14	-0.11	0.28*	1.00		
Father's Education	0.43*	0.43*	0.38*	0.21	0.57*	0.41*	1.00	
Mother's Education	0.50*	0.51*	0.46*	0.24	0.62*	0.37*	0.97*	1.00

*significant at 5%

Additionally, affluent families tend to live in affluent communities, which leads to better learning environments and associations in general, regardless of whether the school is publicly or privately-managed. In less affluent communities, public schools are more likely to have difficulty attracting quality educational resources, such as quality teacher and administrators, leaving the child at a disadvantage especially if the family has low education levels. Hypothetically, students from 'advantaged' background families can afford private school or have access to a high quality public school, while disadvantaged background family cannot afford private school and are limited to a low quality public school. We predict that allocating public funds to privately managed schools will lead to better performance, since the underlying assumption is that disadvantaged children will be able to enjoy a better education.

Although at first glance the data seems to favor public schools, we hypothesize that countries that allocate public funds to privately managed schools are better performers on PISA. Thus, we include the interactive variable between percentage of public schools and per-

Table 7 - Regression Results (*Standard Errors in Parentheses*)

Variable	Math Score	Science Score	Reading Score			
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Percent Public Schools	0.4332 (0.3772)	0.3832 (0.3762)	0.2599 (0.3733)	0.2315 (0.3678)	0.2592 (0.3438)	0.2411 (0.3451)
Percent Govt. Funding	1.6941*** (0.4668)	0.8703 (0.5191)	1.7312*** (0.462)	0.8785 (0.5075)	1.3424*** (0.4254)	0.6277 (0.4762)
Gov*Pub	-0.0645* (0.0322)	-0.0887*** (0.0326)	-0.0567* (0.0319)	-0.0802*** (0.0319)	-0.0564* (0.0294)	-0.0757*** (0.0299)
Father's Education		-1.577 (1.1181)		-1.8264 (1.093)		-1.5786 (1.0255)
Mother's Education		2.3002** (1.0174)		2.5232*** (0.9946)		2.1499** (0.9332)
per Capita Income PPP	0.0013** (0.0004)	0.0012*** (0.0004)	0.001** (0.0004)	0.0009** (0.0004)	0.001*** (0.0003)	0.0008** (0.0003)
Constant	249.3607*** (42.0554)	279.1216*** (40.6078)	275.1595*** (41.6205)	306.8161*** (39.6964)	304.8187*** (38.323)	331.5608*** (37.2463)
Number of Obs.	50	50	50	50	50	50
Adjusted R^2	0.4583	0.5288	0.4076	0.4972	0.3634	0.439

***significant at 1% **significant at 5% *significant at 10%

centage of government funding as a way to measure the impact of public funding on different types of schools. The coefficient on the interactive term measures whether an increase in government funding is likely to have a different impact on public schools vs. private school. For instance, a positive coefficient would suggest that an increase in government funding has a higher marginal impact on public schools while a negative coefficient suggests that additional public funding would be better allocated to privately managed schools.

Model 1:

$$PISA_{score} = \beta_1 + \beta_2(pcippp) + \beta_3(\%govtfunding) + \beta_4(\%pubschools) - \beta_5(\%pubschool \cdot \%govtfunding) + e$$

Model 2:

$$PISA_{score} = \beta_1 + \beta_2(pcippp) + \beta_3(\%govtfunding) + \beta_4(\%pubschools) - \beta_5(\%pubschool \cdot \%govtfunding) - \beta_6(FEDU) + \beta_7(MEDU) + e$$

Results for both models are shown in Table 7. The estimates are ordinary least squares, obtained using Stata.

Results

Even though the model is constrained to 50 observations, the results turned out very close to what was expected. Model 1 does not include parents' education. In both models, the country's income level has a significant and positive impact on test scores. As one might expect, countries with more resources can improve test scores. Equally, public schools do not have any clear advantage over private schools when it comes to educational quality. The effects of public spending on schools are generally positive.

The regression results reported in Table 7 show that the proportion or percentage of public schools have a significant effect on test scores in science, mathematics, or reading. Government funding of education has a positive impact, and based on the interactive term – which is negative and significant – increasing government spending for a given percentage of public schools has a negative effect on math, science, and reading scores. There are a few possible explanations as to why this might occur. First, the level of government spending in public schools is quite high and the marginal effect of an extra dollar spent in the public schools may be lower simply because of diminishing returns. Second, the money may in fact be better managed in private schools, resulting in a bigger improvement in scores. Lastly, it is possible that public funding of private schools may reduce the social stratification of schools and reduce the effect of affluence, allowing poorer students access to better schools.

When the parents' educational background is included in Model 2, we observe a significant and positive impact of mother's education on student performance, but not of father's education. The results suggest that mother's background is more important than father's background in predicting academic achievement, but this result may be a result of the lack of variation in father's educational attainment. The results might also reflect the importance of mothers in the household in helping children with their assignments/homework. In developing countries, mothers play a more important role in with regards to training and nurturing children. Note that the two variables are highly correlated and this could just be a statistical problem.

The effects of public spending on education are stronger when we include variables reflecting parental education. This is surprising since we do expect that families with higher levels of parental education are more likely to be affluent and live in areas with better schools as well as providing the resources for students to perform better. The government spending variable is significant when we add parental background. This suggests that schools with higher government spending were probably associated with more affluent families. The interaction between government spending and public schools is still significant and negative. This finding suggests that public money going to public schools has a slightly more negative impact on academic performance than money going to private schools, even after controlling for family background. We can speculate that public funding through programs such as voucher programs for children in poor families may mitigate some of the familial effects of lack of parental education in such families.

Conclusion

If education is a fundamental element of a sustainable development strategy, it is important to ensure educational quality along with more access to education. This paper investigated factors that explain country performance on the PISA assessment. Although encompassing all the elements that lead to academic success is a daunting task, by using PISA data this study was able to demonstrate some correlations between performance and country income, family background, type of school, as well as funding methods. Not surprisingly, high-income countries perform better than low-income countries. Countries with a higher percentage of public schools perform no better than countries with fewer public schools (and by default more private schools) after controlling for family background. However, public funding to privately managed school may improve performance. Also, mother's education plays a very important role and suggests that early childhood education programs may help children of less educated mothers achieve academic success.

Countries are able to make better decisions concerning education policy when utilizing cross-country student performance data as opposed to how long students have been in school. Currently international assessments provide unique data concerning both the various factors that influence achievement as well as the impact of skills on social and economic outcomes. Even our simple study suggests that parental background and public funding play an important role in ensuring educational quality. While countries can strive to increase female educational attainment in order to enhance educational quality for children, it is important to mitigate these parental effects for children of uneducated parents through school involvement and possibly early childhood education programs.

The role of public funding is more nuanced. At first glance, higher scores seem to be associated with public schooling and public funding of all schools. However, using a slightly different methodology we find that additional public dollars spent on public schools do not have a positive effect. In fact, public funds may be more effective when distributed to private schools.

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