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Economic efficiency of public secondary education expenditure: How different are developed and developing countries?

Eficiencia económica del gasto público en educación secundaria: ¿qué tan diferentes son los países desarrollados y en desarrollo?

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Abstract

This study measures the efficiency of public secondary education expenditure in 37 developing and developed countries using a two-step semi-parametric DEA (Data Envelopment Analysis) methodology. We first implement two cross-country frontier models for the 2012-2015 period: one using a physical input (i.e., teacher-pupil ratio) and one using monetary inputs (i.e., government and private expenditure per secondary student as a percentage of GDP). These results are corrected by the effects of GDP per capita and adult educational attainment as non-discretionary inputs. We obtain five important results: 1) developed and developing countries are similar in terms of the education production process due to the peers used in the non-parametric

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estimation of relative efficiency; 2) developing countries could increase their enrolment rates and PISA scores by approximately 22% and 21%, respectively, by maintaining the same teacher-pupil ratios and public-private spending levels; 3) Australia, Belgium, Finland, and Japan are efficient countries in the two frontier models; 4) robust empirical evidence indicates that both income and parental educational attainment negatively affect efficiency in both models; and 5) the physical frontier model significantly favours developing countries, bringing them closer to the efficiency frontier; however, it negatively affects developed countries.

Key words: Secondary education, government expenditure, private expenditure, efficiency, DEA.

Thesaurus key words: Secondary education, public expenditure, efficiency.
JEL Classification: H52, I22.

Resumen

Este artículo mide la eficiencia del gasto público en educación secundaria en 37 países en desarrollo y desarrollados usando una metodología semiparamétrica en dos etapas DEA (análisis de envolvente de datos). Primero, implementamos dos modelos de frontera a nivel país para el período 2012-2015: uno de ellos usa un insumo físico (razón profesor- alumno) y el otro usa dos insumos monetarios (gasto público y gasto privado por estudiante en secundaria como porcentaje del PIB). Estos resultados son corregidos por los efectos del PIB per cápita y el desempeño educativo de los adultos como variables no discrecionales. Nosotros obtenemos cinco resultados importantes: 1) los países desarrollados y en desarrollo tienen un proceso de producción de la educación similar, debido a los pares usados en la estimación no paramétrica de la eficiencia relativa, 2) los países en desarrollo pueden incrementar sus tasas de matrícula y puntajes PISA aproximadamente en 22% y 21%, respectivamente, manteniendo la misma razón profesor-alumno y niveles de gasto público y privado; 3) Australia, Bélgica, Finlandia y Japón son países eficientes en los dos modelos de frontera; 4) la evidencia empírica robusta indica que tanto el ingreso como el desempeño educativo de los adultos afectan negativamente la eficiencia de la educación pública en ambos modelos y 5) el modelo de frontera físico favorece significativamente los países en desarrollo, llevándolos más cerca de la frontera de eficiencia, pero afecta los países desarrollados.

Palabras clave: educación secundaria, gasto público, gasto privado, eficiencia, DEA.

Clasificación JEL: H52, I22.

Introduction

There is a significant difference between developed and developing countries in terms of student performance on international tests, such as PISA. Specifically, the mean score for high-income countries in 2015 was 497, whereas the mean score for lower- and middle-income countries in the same period was 411. Similar results are obtained if we compare other indicators for the quality of the education system, such as enrolment rates (Table 1). These data have led to intense political debates in developing countries (Colombia and Mexico have had debates in recent years), which have been trying to improve their poor results and promote economic growth and social well-being (Ben Mimoun, 2013; Gennaioli & Shleifer, 2013).

Most discussions have focused on the importance of increasing public expenditure on education, but less attention has been paid to the issue of efficiency in the use of public expenditure. Developed countries do spend more than developing countries on secondary education as a percentage of GDP per capita (23.38 as opposed to 17.95, Table 1); however, developing countries spend a higher percentage of their public budgets on education compared to developed countries (16.84 as opposed to 12.68, Table 1). Interestingly, there are less differences when we compare private spending, which suggests that the main differences between efficiency scores are more related to the use of public resources than private ones.

Analysis of the efficiency of public spending is even more important if we consider the scarcity of public resources and the mounting pressure on governments to improve their allocation (Afonso, Schuknecht, & Tanzi, 2010; Aristovnik, 2013).

How different are developed and developing countries in terms of the efficiency of their public and private expenditure on education? Could differences in coverage and quality indicators be explained exclusively by the efficiency of public and private expenditure? Is there any difference in the efficiency results between monetary and physical inputs? Does the family background of secondary school students affect countries' efficiencies? The aim of our paper is to make a contribution to answering these questions. We implement two frontier models using DEA (Data Envelopment Analysis) to assess the efficiency of education expenditure in 37 developed and developing countries between 2012-2015.

The first innovative element of this paper is that the efficiency results obtained are controlled in two ways. First, to control for differences in the cost of inputs between the two groups of countries, we implement two alternative frontier models. In the first model, we use government and private expenditure per secondary student as monetary inputs, whereas in the second model, we use the number of teachers per 100 students as a physical input. The PISA results and enrolment rates are considered as outputs of the production process in both models.

Additionally, we correct our efficiency estimations for each country using income level and adult educational attainment, which are considered by the literature as non-discretionary factors that can affect output variables (Afonso & Aubyn, 2006; Barro & Lee, 2001; De Witte & López, 2017; Fuchs & Woessmann, 2004). Specifically, following the Simar and Wilson (2007) approach, we implement a second-stage approach using a truncated regression to isolate the effect of these variables on the outputs, which allow us to correct for serial correlation in the estimated efficiency scores.

The second innovative part of the paper is that we compare the efficiency of developing and developed countries simultaneously; most papers consider only one of these groups to control for possible heterogeneity between countries (for example, Afonso & Aubyn, 2006). The results indicate that it is possible to compare both groups of countries, even when monetary input is considered. The main advantage of this consideration is that it allows us to obtain objective measures of the (in)efficiency of developing countries' expenditure compared to developed countries.

Table 1. Descriptive Statistics by Income Group Countries

Variable	Obs	Mean	Std. Dev.	Min	Max
High income					
Enrolment (%)	30	112.08	13.49	96.16	144.74
PISA	30	496.86	17.77	443.00	528.67
Teachers per 100 students	30	9.00	1.93	4.88	12.28
Private expenditure per secondary student (%GDP)	30	2.06	0.46	1.04	2.87
Public expenditure per secondary student (%GDP per capita)	30	23.38	4.29	16.12	34.70
Expenditure on education (% of total government expend.)	30	12.68	2.97	8.08	19.71
Lower and upper-middle income					
Enrolment (%)	7	97.88	10.90	81.79	114.30
PISA	7	411.19	11.86	395.00	424.33
Teachers per 100 students	7	6.08	1.34	3.96	8.17
Private expenditure per secondary student (%GDP)	7	2.10	0.56	1.00	2.68
Public expenditure per secondary student (%GDP per capita)	7	17.95	4.85	10.01	24.13
Expenditure on education (% of total government expend.)	7	16.84	3.49	11.77	23.15

Source: Author's own calculations based on WDI and UNESCO databases.

We obtain five important results: (i) Australia, Belgium, Finland, and Japan are efficient countries in the two frontier models; (ii) developed and developing countries are similar in terms of the education production process because the peers obtained as a result of the non-parametric estimation of relative efficiency, do not necessarily correspond with the same income group; (iii) developing countries could increase their enrolment rates and PISA scores by approximately 22% and 21%, respectively, by maintaining the same teacher-pupil ratios and public-private spending levels; (iv) robust empirical evidence indicates that both income and parental educational attainment negatively affect efficiency in both models; and (v) the physical frontier model significantly favours developing countries, which brings them closer to the efficiency frontier; however, this negatively affects developed countries.

The paper is organized as follows: In Section two, we present a brief literature review. In Section 3, we introduce the theoretical model and explain the second-stage semi-parametric methodology (DEA). In four section, we describe the data and certain stylized facts. Sections five and six present the efficiency score estimations using monetary and physical inputs and implement the two-step methodology proposed by Simar and Wilson (2007). The final part of the paper presents the conclusion.

I. Literature Review

Two approaches have been used to evaluate the level of efficiency that government expenditure has had on education. The first approach assesses the determinants of schooling quality across countries using cross-country regressions (for example, Barro & Lee, 2001; Fuchs & Woessmann, 2004). The determinants of educational performance used in these studies include resources allocated to education (teachers per pupil or public expenditure) as well as other factors, such as parental income or education level. The results imply that family inputs and school resources are key factors to improve educational performance.

The second approach studies the efficiency that public spending has on education by comparing the resources spent with performance obtained through DEA and FHD analysis. Previous studies have analysed the efficiency of the public sector in general (Afonso, Romero & Monsalve, 2013; Afonso, Schuknecht, & Tanzi, 2005; Afonso, Schuknecht, & Tanzi, 2006) or focused on specific sectors, such as health and education. Studies have also attempted to measure efficiency within each educational level to better focus public policies.

Almost all studies have focused their efficiency analyses on specific country groups that are homogeneous in terms of economic development.[3] For instance, Afonso and Aubyn (2004); Afonso and Aubyn (2006); and Afonso

3 According to Afonso and Aubyn (2004), the selection of OECD countries is based on the low heterogeneity within the sample given the countries' levels of wealth and development.

et al. (2005) analyse the efficiency of public expenditure exclusively for OECD countries. Afonso and Aubyn (2004) focus their discussion on the differences in efficiency score estimates based on whether inputs are measured in monetary or physical terms. As such, certain countries could appear very inefficient in monetary terms because they have higher costs than other countries but not in terms of performance.

Afonso et al. (2005) use a FDH methodology and conclude that countries with small governments have higher efficiency scores in terms of both inputs and outputs. Similarly, Sutherland, Price, Joumard, and Nicq (2007) analyse efficiency in primary and secondary education using both second-stage DEA and stochastic frontier analysis. They expand on previous research by conducting an efficiency analysis at macro and micro levels within schools. Part of their main results contains evidence showing that on the national level, if resources are held constant, PISA scores could increase by an average of 5% for OECD countries and by approximately 10% for the least efficient countries.

In addition to these studies, the work carried out by Afonso and Aubyn (2006); Afonso, Romero-Barrutieta, and Monsalve (2013); and Herrera and Pang (2005) uses a two-stage DEA methodology to estimate the effect that exogenous variables have on national efficiency scores. Herrera and Pang (2005) undertake an efficiency comparison in education and health for 140 developing countries using DEA and FDH; they found that the most inefficient countries could produce the same output levels with 50% less input. They also verified the statistical association between efficiency scores and certain exogenous variables such as *the share of wages in the total budget, the share of total services that is publicly financed, urbanization level, income distribution, and the degree of external aid financing.*

Afonso and Aubyn (2006) focus on 25 countries, almost all of which are OECD countries, and found that OECD countries could increase PISA scores by 11.6% with the same resources. In addition, they demonstrate that GDP per capita and parental education are significant variables that explain efficiency. Finally, Afonso et al. (2013) calculate the efficiency of the public sector in Latin America and the Caribbean. Using a Tobit analysis, they found that important determinants of relative efficiency in these countries include transparency, property rights, regulation, and quality control. In general, these countries could increase their performance by 19% through efficient public spending.

Among recent studies, Salazar (2014) measured the efficiency that public spending has on primary and secondary education in Latin American countries using both DEA and FDH. He found that countries could increase enrolment rates and PISA scores by 10% and 6% (using DEA and FDH, respectively) through efficient public spending. Moreover, countries could obtain even greater benefits by using efficient teacher-student ratios (11% and 9%, by using DEA and FDA, respectively). Similarly, Aristovnik (2013) studied the efficiency of primary, secondary and tertiary education in Eastern European countries and new EU member countries and found that the average country could increase secondary education outputs by nearly 7% through efficiency.

Finally, in terms of studies that conduct regional and income group comparisons, Gupta and Verhoeven (2001) analysed the efficiency that public expenditure had on education and health in 37 African countries and compared them with each other as well as with Asian and Western Hemisphere countries. The authors also conducted an efficiency analysis between country groups to isolate the effect economic development had on government expenditure. Afonso, Schuknecht, and Tanzi (2006) assessed public sector efficiency; they compared new EU members with emerging markets. They found that Singapore, Thailand, Cyprus, Korea, and Ireland define the efficiency frontier. The average output scores suggest that countries are delivering approximately 2/3 of their potential output if they were on the efficiency frontier. Using Tobit analysis, they found that security of property rights, per capita GDP, the competence of civil servants, and education levels affect expenditure efficiency.

In summary, only several studies have tried to compare the efficiency of public and private expenditure on secondary education for developed and developing countries. Additionally, very few try to correct the estimated inefficiency scores by including the effect of exogenous variables that are not under government control.

A. DEA Methodology and the Inclusion of Non-Discretionary Inputs

In this paper, we combine two strands of literature by estimating a semi-parametric model belonging to the secondary education production process using a two-stage approach. Theoretically, the measure of efficiency is based on the education production function that is specified by Barro and Lee (2001):

$$y = G(w, f) + \varepsilon \tag{1}$$

where educational achievement (*y*) depends on the physical and monetary resources used by schools (*w*) as well as on the student's family characteristics (*f*) These characteristics are crucial for measuring students' educational performance because they affect not only the probability of enrolment, attendance, and graduation rates but also students' learning outcomes. Usually, key variables such as income, parental education levels, and father's occupation are used as non-governmental explanatory factors related to educational performance.[4]

It is possible to estimate an envelopment frontier based on the inputs and outputs for each country. This frontier can be used as a reference to classify countries as being either efficient or inefficient based on their relative distances from the estimated efficiency frontier. The literature uses parametric and non-parametric methods to estimate this frontier. With the parametric approach, the researcher must specify the functional form of the efficiency frontier, that is, s/he must establish a previous relationship between inputs and outputs. In the non-parametric approach, the efficiency frontier is obtained using input and output data following an optimization program without any specification for the production function. It is then possible to compare the results for each Decision-Making Unit (DMU) (in our case, each country) included in the analysis (Aristovnik, 2013).

Following previous literature (for example, Afonso et al., 2010; Afonso et al., 2013; Afonso & Aubyn, 2006; Aristovnik, 2013; Salazar, 2014; Sutherland et al. 2007), we use the non-parametric approach – specifically, the DEA methodology – to assess the efficiency of government and private expenditure.[5] The objective of this technique is to classify DMUs as efficient or inefficient

4 This specification could suffer from endogeneity problems due to interactions between school inputs and outcomes. However, this problem is less severe in cross-country data than in cross-region data because individuals' mobility, given the school quality, is easier within a country than across countries (Barro & Lee, 2001).

5 Another available non-parametric technique is the FDH (free disposal hull). However, the use of this technique in the literature is limited because it is cannot be used in a multi-input and multi-output framework. See, for example, Aubyn (2003), who measures the efficiency of education and health in the Portuguese economy.

by calculating their efficiency scores, which represent their respective distances from the production point of the DMU at the PPF (production possibility frontier). The efficiency scores are bounded between 0 and 1 for the input-oriented approach and between 1 and infinity for the output-oriented approach. In the output-oriented approach used here, we can interpret these scores as how much outputs could increase while keeping inputs constant to reach the efficient frontier.

The DEA model is specified as the following optimization problem (Charnes, Cooper, & Rhones, 1978):

$$Max_{x\lambda,\delta i}\delta_i$$

$$s.t\ \delta_i\ y_i \leq Y\lambda$$

$$x_i \leq X\lambda$$

$$n1'\lambda = 1$$

$$\lambda \geq 0 \tag{2}$$

where X is the vector of inputs, Y is the vector of outputs, and λ is a vector of constants that correspond to the weights of the peer countries (that is, those that are more efficient than the inefficient DMUs being analysed) that are used to calculate a country's location and the best method for it to become efficient.

Likewise, each lambda in the previous linear program indicates the weight for each output and input for every country, because units, in general, value inputs and outputs differently. In our case, some countries could be more interested in enrolment rates than in PISA scores or vice versa. The DEA methodology implemented by Charnes, Cooper, and Rhodes recognised that units might value inputs and outputs differently and, therefore, each unit (country) is compared to the others by selecting, by default, its more favourable profile.

Additionally, the $n1'\lambda = 1$ constraint imposes convexity on the frontier with variable returns to scale. This program is solved for the *n* DMUs included in the analysis to estimate the output efficiency scores (δ_i). When $\delta_i > 1$, the

DMU is inside the frontier, meaning that it is inefficient. Conversely, when $\delta_i = 1$, the DMU is efficient.

One of the main advantages of the DEA method is that it can be applied in multi-input and multi-output frameworks. Additionally, multi-stage methods have been developed to capture the effect of non-discretionary variables in the DEA analysis and to correct the efficiency scores calculated in the first stage.

Although several studies have tried to determine the best method to correct this problem, the results are inconclusive (Cordero, Pedraja, & Santin, 2009; Huguenin, 2015). Nevertheless, the majority have incorporated discretional variables in a second stage procedure. As De White & Lopez (2016) summarized, Daraio & Simar (2005) use robust conditional estimators such as order-m frontiers and alpha-quantile approaches. Simar and Wilson (2007) use a truncated regression and bootstrap procedure to correct for serial correlation issues, while Badin, Daraio, and Simar (2012) implement a two-stage procedure in the context of robust, conditional estimators with second stage non-parametric regression. Some other papers have applied a dynamic approach such as a Malmquist index which allows the different changes in efficiency scores over the time to be evaluated, and support to be given to the findings obtained through DEA.

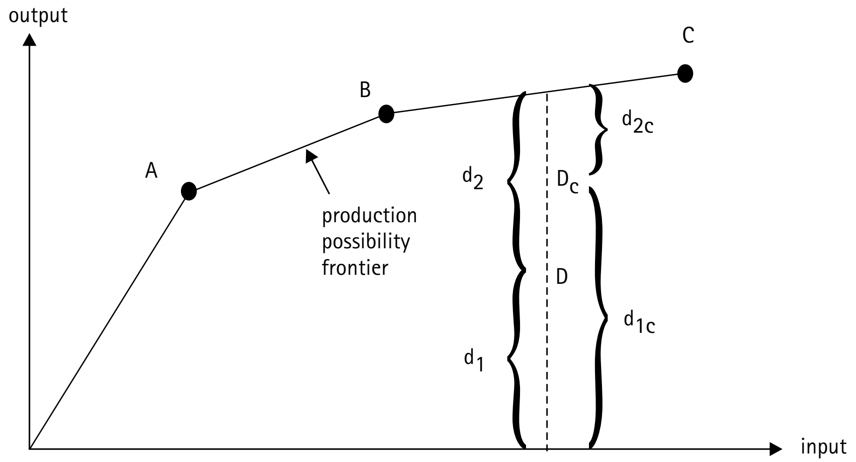
We opted to use the second-stage model because it is the most widely used model in studies on education expenditure efficiency that use cross-country data. Specifically, we implement the approach proposed by Simar and Wilson (2007), which allows us to correct for serial correlation among the estimated efficiency scores. This strategy involves correcting the error correlation problem using bootstrap methods to obtain consistent and unbiased estimates for the regression parameters.

In this way, after estimating the DEA efficiency frontier for all countries, we estimate a semi-parametric model for the education production process that includes income and adult educational attainment as external factors that affect educational performance (z_i). The estimated regression is as follows:

$$\hat{\delta}_i = z_i \beta + \varepsilon_i \tag{3}$$

Figure 1 shows the estimated efficiency scores with and without environmental variables. All efficiency scores within the PPF are greater than 1; those on the PPF are equal to one. Certain countries can be independently efficient if no other DMU uses less input and has a greater output. With one input and one output, we can see that countries such as A, B, and C are efficient. However, the inefficiency of country D could be attributable to a harsh environment. For example, if D's environment improves, D's efficiency score would improve to the point Dc. The correction given by the exogenous factors is calculated as the efficiency score in Dc minus the efficiency score in D.

Figure 1. Production Frontier with Non-Discretionary Inputs



Source: Afonso and Aubyn (2006, p. 481).

After measuring the efficiency scores for all DMUs in the sample in the first stage, we regress the estimated scores against the selected non-discretionary or environmental variables. The regression of estimated efficiency scores () on external variables with bootstrapping is as follows:

$$\hat{\delta}_i = \psi(z_i\beta) + \varepsilon_i \geq 1 \tag{4}$$

where ψ is a smooth function, β is the vector of parameters, and ε_i is a truncated normal random variable with $N(0,\sigma_\varepsilon^2)$ distribution and left truncation at $(1 - z_i\beta)$.

Most studies that employ second-stage approaches use censored (Tobit) and OLS regression models after estimating δ_i in the first stage. They therefore omit the efficiency score bias that was calculated in the first stage due to the serial correlation of ε_i and the correlation of X_i (inputs) and Y_i (outputs) with Z_i (external factors). Thus, the error ε_i is correlated with Z_i [6]

Simar and Wilson (2007) propose a single and double bootstrap procedure to avoid serial correlation among the estimated efficiencies. The first algorithm improves the inference but does not take into account the bias term. In contrast, the second algorithm improves both the inference and the bias. Therefore, we use the second algorithm method with bootstraping to estimate efficiency scores with environmental variables following subsequent steps (consult Simar & Wilson, 2007, pp. 42-43 for details).

B. Descriptive Statistics: Data and Stylized Facts

The data compiled in this study covers 37 countries from 2012-2014. The composition and size of the sample were determined based on the availability of data needed to compute efficiency scores. The descriptive statistics for the variables included in this study are listed in Table A.2 in the appendix.

Efficiency scores were calculated using alternative models and measures for inputs and outputs. In the first model, private spending (% of GDP) and government expenditure per secondary student (% of GDP per capita) are used as input variables.[7] For outputs, we consider two different variables related to the performance of secondary education systems: enrolment rates and performance in the PISA reading, mathematics, and science literacy scales in 2015.[8]

The second model considers the teacher-pupil ratio as the input. The idea behind this modification is to isolate potential input overestimations used in

6 Related papers are Afonso et al. (2013); Afonso et al. (2010); and Herrera et al. (2005).

7 There is scant availability of other data such as teacher salaries and education levels, length of school year, and availability of teaching materials. However, teacher salaries and instructional materials account for a major portion of educational expenditure per student. (Barro & Lee, 2001).

8 We use PISA data because it assesses 15-year-old children, who (based on their age) are approaching the end of the compulsory schooling period. For simplicity, we use the simple average of the three scores.

developed as opposed to developing countries due the high cost of salaries and other non-tradable goods included in the education process. That is, although the same quantity of physical input could be used in a developing and developed country, higher wages and prices in the developed country could artificially increase the input used when monetary valuation is considered.[9] Finally, for both models we control for the effect of GDP per capita in 2015 PPP and for parental education by including them as environmental variables in the second-stage approach.

Data shows high heterogeneity, particularly between countries across different income groups. For example, the lowest PISA score for a developing country is 395 (Brazil), whereas the highest score is 415 (Costa Rica and Mexico). In terms of developed countries, Israel has the lowest score (472), whereas Estonia has the highest (524). That is, the highest developing country group score is very far away from the lowest developed country group score.

The gross enrolment rate in secondary education ranges from 82% (Indonesia) to 145% (Belgium).[10] The teacher-pupil ratios range from 3.96 (Colombia) to 12.28 (Latvia); public spending per student ranges from 10.01% of GDP per capita (Indonesia) to 34.70% (Finland), and private spending ranges from 1% of GDP per capita (Indonesia) to 2.87% (New Zealand). The minimum value of GDP per capita is US$ 10,368 (Indonesia) and the maximum value is US$ 95,311 (Luxembourg). Finally, parental educational attainment ranges from 28.6% (Turkey) to 95.89% (Korea).

II. The Efficiency of Monetary Inputs: The Case of Public and Private Spending On Education

Although it is not conclusive, the low correlation between inputs and outputs provides a first idea about inefficiencies (Afonso et al. 2005). In fact, Table 2

9 Herrera and Pang (2005) explain the positive association between public expenditure and GDP per capita based on the Balassa-Samuelson effect, which suggests that prices are higher in wealthier countries than in poorer countries. Thus, the price of the same service (for example, education) will be higher in countries with higher GDPs.

10 The limitation of this variable is that it can, in principle, exceed 100% due to the inclusion of over-aged and under-aged students (because of early or late entry) and grade repetition. Nevertheless, increases in this variable indicate improvements in the education sector.

indicates low degrees of correlation between the inputs of teacher ratios and government expenditure per secondary student and the outputs of enrolment rates and PISA scores. Therefore, increases in inputs do not necessarily result in increases in outputs. However, to be more precise in terms of the degree of inefficiency between countries, it is necessary to estimate efficiency scores.

Table 2. Correlation Between Inputs and Outputs

Variable	Enrolment	PISA	Teacher ratio	Private expenditure	Public expenditure
Enrolment	1				
PISA	0.4849	1			
Teacher ratio	**0.206**	**0.5153**	1		
Private expenditure	**0.4565**	**0.0453**	-0.219	1	
Public expenditure	**0.4618**	**0.5894**	0.3658	0.2682	1

Source: Authors' own calculations based on WDI and UNESCO databases.

Table 3 shows the naïve[11] efficiency scores for a core group of 37 countries using public and private expenditure per secondary student as inputs. Three elements should be considered in their analysis: The first is the peers used in the efficiency score calculation for each country; these are those countries that use around the same level of inputs and obtain better output results. For example, Colombia is compared with Australia and Indonesia in the sample, which implies that they have similar levels of public and private expenditure but different resulting PISA scores. The second element to be considered is the efficient countries, which have associated an efficiency score of one. The final element to be considered is another country's degree of inefficiency, which can be calculated considering the distance between their efficiency score and one. Using this measure, it is possible to rank the countries from the most efficient to the least efficient.

Nine countries appear as efficient DMUs: Australia, Belgium, Switzerland, Spain, Estonia, Finland, Indonesia, Ireland, and Japan. These results can be explained by the fact that among the countries in the sample, Japan, Estonia, Finland, and Ireland are in the top five in terms of PISA scores. In the case of

11 These scores are called naïve efficiency scores because they are computed in the first stage without considering external factors.

Indonesia (a developing country), the main observation may be explained by a low input level rather than a high output level. In fact, Indonesia has the lowest level of government and private expenditure on secondary education in the entire sample (10.01% and 1.001%, respectively). These results are consistent with those in Afonso and Aubyn (2005) although that study uses PISA 2003 as the output.

These countries are used as peers to the rest of countries in the sample; the cases of Australia, Estonia, and Finland are especially important. Results show that developing countries have an 18% inefficiency average, relative to efficient countries, whereas, for developed countries, this value is around 4%. This huge difference is mainly due to countries such as Brazil, Argentina, Costa Rica, and Colombia that have degrees of inefficiency around 20% and 30%. Brazil, particularly, could improve its PISA scores and obtain greater enrolment rates than 29.7% with its current level of government and public spending. A country such as Denmark could increase its outputs by 2.6% while keeping its current input level.

Table 3. Naïve Scores- First Frontier Model

Inputs: public and private spending per student			
Outputs: enrolment rates and PISA			
Country	Naïve Score	Rank	Peers
Argentina*	1.2131	35	Australia Estonia Finland
Australia	1.0000	1	Australia
Austria	1.0722	26	Finland Japan
Belgium	**1.0000**	1	Australia Belgium
Brazil*	1.2970	37	Australia Estonia Finland
Switzerland	**1.0000**	1	Switzerland
Chile	1.0935	31	Australia Estonia Indonesia
Colombia*	1.2084	34	Australia Indonesia
Costa Rica*	1.2188	36	Australia Belgium Finland
Czech Republic	1.0714	25	Estonia Finland Japan
Germany	1.0361	15	Estonia Finland Japan
Denmark	1.0263	13	Australia Estonia Finland
Spain	**1.0000**	1	Spain

Table 3. Naïve Scores- First Frontier Model (continued)

Inputs: public and private spending per student			
Outputs: enrolment rates and PISA			
Country	Naïve Score	Rank	Peers
Estonia	**1.0000**	1	Australia Estonia
Finland	**1.0000**	1	Australia Finland
France	1.0571	21	Estonia Finland Japan
United Kingdom	1.0391	17	Australia Estonia Finland
Hungary	1.0861	30	Australia Estonia
Indonesia*	**1.0000**	1	Indonesia
Ireland	**1.0000**	1	Estonia Ireland
Iceland	1.0600	22	Australia Estonia
Israel	1.0609	23	Australia Estonia Indonesia
Italy	1.0808	29	Estonia Finland Japan
Japan	**1.0000**	1	Estonia Finland Japan
Korea, Rep.	1.0147	11	Estonia Japan
Lithuania	1.0386	16	Australia Estonia Indonesia
Luxembourg	1.0762	27	Australia Estonia
Latvia	1.0638	24	Switzerland Estonia Ireland
Mexico*	1.1882	33	Australia Estonia Indonesia
Netherlands	1.0083	10	Australia Estonia Finland
New Zealand	1.0253	12	Australia Estonia Finland
Poland	1.0417	19	Estonia Finland Japan
Portugal	1.0401	18	Australia Estonia Finland
Slovenia	1.0298	14	Estonia Finland Japan
Sweden	1.0420	20	Australia Estonia Finland Ireland
Turkey*	1.1387	32	Australia Indonesia
United States	1.0787	28	Estonia Japan

Note: (*) identifies developing countries.

Source: Authors' own calculations.

A. The Effect of Non-Discretionary Inputs in Efficiency Scores Using Monetary Inputs

To assess the effect non-discretionary variables have on efficiency scores, we implement the second-stage approach using a truncated regression with and without bootstrap correction. We consider the effect that adult educational attainment (as a proxy for parental education) has on the previously-computed efficiency scores. The GDP per capita (as a proxy for parental income) is another potential control variable, but it was not included because it is highly correlated with government expenditure. The following equation will be estimated:

$$\hat{\delta}_l = \beta_0 + \beta_1 * E_i + \varepsilon_i \tag{5}$$

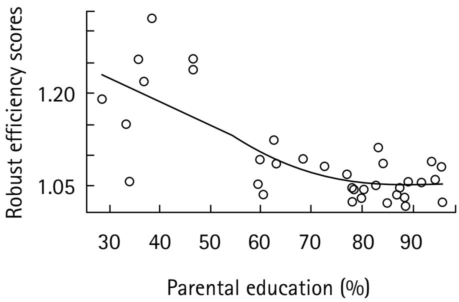
Using a truncated normal regression with and without bootstrap correction (Table 4), we find that lower parental education levels are related with higher inefficiency in expenditure, which are measured with the robust scores (Figure 2). That is, efficiency should be improved for countries with high adult educational attainment when aggregate expenditure in education is controlled for. Conversely, countries with low performance in this variable, could have a worse robust efficiency measure.

Table 4. Truncated regression with monetary inputs

	Truncated Regression	
	with Bootstrap adjustment	
Intercept	1.3425	***
E	-0.004	***
Sigma	0.0664	***
	Truncated Regression	
	without Bootstrap adjustment	
Intercept	1.3308	***
E	-0.0043	***
Sigma	0.0708	***

Source: Authors' own calculations.

Figure 2. Parental Education vs. Robust Efficiency Scores



Source: Authors' own calculations.

The second and third columns in Table 5 present the efficiency scores and country's ranking including parental education as a non-discretionary input (robust efficiency scores). As with the case of naïve scores results, the average efficiency score for developing countries is greater than that for developed countries (1.198 vs. 1.066). However, it is important to note that the mean inefficiency increases in both cases. These results are consistent with Sutherland et al. (2007), who found that PISA scores could increase by an average of 5% for OECD countries and by approximately 10% for emerging countries.

The inclusion of this external variable changes the country's ranking in a significant way. Australia, Belgium, Spain, and Indonesia, all of which were previously ranked higher (based on naïve scores), are now further away from the efficiency frontier, i.e., they are not as efficient as before as they have dropped down several positions in the ranking (see third column, Table 5). Considering parent's education and public-private spending, they should perform better in PISA and obtain higher enrolment rates. Even more notable is the case of Indonesia, which was considered efficient in stage 1 but fell numerous positions in the ranking after correction. This could be explained by the poor conditions of parental education as only 33% of population has secondary education. Conversely, Korea and the Netherlands acquire a better position in the ranking, meaning that external environment favours their results (see Annex 3).

Afonso et al. (2006) propose an alternative way to consider the effect external factors have on efficiency performance. The authors point out that the existence of a poor economic and social environment could worsen the results for efficiency. That is, the inefficiency of expenditure is not exclusively related with poor use or resource allocation but the existence of external conditions that limit their effectiveness. To assess this situation, they propose correcting the robustness scores and suppose that each country has the mean performance of the external variable (in this case, parental education). This means that, countries with an unfavourable environment could increase their aggregate expenditure efficiency. The fourth column presents the size of this correction, while the fifth and sixth columns show the fully corrected scores and final ranking.

In general, changes in the ranking positions are negligible; however, it is interesting to analyse some cases. A successful case is Indonesia, which improved its ranking position from 31st with a robust score to 1st with the correction. This means that its inefficiency in previous stages is attributable to a harsh environment, but, if its environment improves, Indonesia will become in an efficient country. A slightly less significant case is Portugal, which presents better ranking results as it has moved up four positions.

It is important to pay attention to Turkey, Costa Rica, Mexico, Brazil, Chile, and Colombia, which are in the top ten lowest in terms of parental education in the sample. The percentages of people with secondary education are around 40%, far from the sample average of 71%. This situation could suggest a priori that their low efficiency scores are associated with a hostile environment; however, when we consider that they have an average parental education of 71%, the changes in their relative efficiency scores and ranking positions does not change significantly.

To summarise, the results indicate that developing countries' efficiency in terms of their use of public and private education expenditure is smaller than developed countries (between 18-19.6%). Additionally, parental education is a significant non-discretionary input that explains developing countries' performances, which is in line with the literature. Finally, fully scores suggest that the main problem in most developing countries is effectively related with low level of resources and use of education resources; these are more important than having a poor economic or social environment.

Table 5. Robust Scores- First Frontier Model

Inputs: public and private spending per student					
Outputs: enrolment rates and PISA					
Country	Robust Score	Ranking	Correction	Fully score	Final Ranking
Argentina*	1.2393	34	0.0000	1.2393	35
Australia	1.0474	13	0.0149	1.0623	20
Austria	1.0821	22	-0.0002	1.0819	22
Belgium	1.0443	10	0.0087	1.0530	16
Brazil*	1.3224	37	-0.0006	1.3218	37
Switzerland	1.0338	7	0.0267	1.0605	25
Chile	1.1248	30	0.0030	1.1279	31
Colombia*	1.2557	35	-0.0093	1.2464	34
Costa Rica*	1.2558	36	-0.0017	1.2541	36
Czech Republic	1.0807	21	0.0015	1.0822	24
Germany	1.0453	11	0.0003	1.0456	8
Denmark	1.0428	9	0.0021	1.0449	10
Spain	1.0552	15	-0.0059	1.0494	7
Estonia	1.0306	5	0.0093	1.0399	11
Finland	1.0212	2	0.0049	1.0261	4
France	1.0681	20	0.0000	1.0681	18
United Kingdom	1.0504	14	0.0009	1.0513	13
Hungary	1.1119	29	0.0009	1.1128	30
Indonesia*	1.1516	31	-0.0986	1.0530	1
Ireland	1.0316	6	0.0072	1.0388	9
Iceland	1.0870	24	-0.0035	1.0835	21
Israel	1.0859	23	-0.0012	1.0847	23
Italy	1.0921	27	0.0000	1.0920	27
Japan	1.0188	1	0.0024	1.0212	2
Korea, Rep.	1.0236	3	0.0010	1.0246	3
Lithuania	1.0592	19	0.0082	1.0674	19
Luxembourg	1.0937	28	0.0001	1.0938	29
Latvia	1.0879	25	0.0008	1.0887	26
Mexico*	1.2205	33	-0.0036	1.2169	33
Netherlands	1.0257	4	0.0044	1.0301	5

Table 5. Robust Scores- First Frontier Model (continued)

Inputs: public and private spending per student					
Outputs: enrolment rates and PISA					
Country	Robust Score	Ranking	Correction	Fully score	Final Ranking
New Zealand	1.0368	8	-0.0002	1.0366	6
Poland	1.0563	16	0.0015	1.0578	15
Portugal	1.0582	18	-0.0016	1.0566	14
Slovenia	1.0470	12	0.0016	1.0486	12
Sweden	1.0579	17	0.0046	1.0626	17
Turkey	1.1904	32	-0.0115	1.1789	32
United States	1.0903	26	0.0017	1.0920	28

Note: (*) identifies developing countries.

Source: Authors' own calculations.

III. The Efficiency of Physical Inputs: The Case of the Teacher-Pupil Ratio

As has been noted in the literature, one limitation of using private and public expenditure as inputs relates to the cost of inputs, which implies that some countries spend a higher amount of resources on secondary education due to the real cost compared with emerging countries. As a result, for developed countries, we expect better results in terms of efficiency for this model.

Bearing this in mind, we conducted the same exercise using physical inputs such as the number of teachers per 100 students instead of monetary valuation. Table 6 shows the naïve efficiency scores using the number of teachers per 100 secondary students. In this case, eight countries appear on the efficiency frontier, including one developing country: Colombia; however, this is not related with high output levels (such as Japan, Finland, and Korea), but with low levels of input relative to the output obtained. In fact, Colombia has the lowest teacher-pupil ratio in the sample (3.96), and, also, one of the lowest PISA scores and enrolment rates. (Table A.2). Moreover, Belgium, Colombia, Finland, and the United Kingdom are independently efficient countries, i.e. there is no other country in the sample with lower inputs and higher outputs.

In terms of peer countries, it is important to note two aspects. First, some countries such as Finland and Japan are peers to several countries, not only using physical inputs, but also in terms of monetary input analysis. It shows their high efficiency and performance, independent of input measure. Second, as with the monetary input analysis, it is not possible to separate developing and developed countries using the peer country criterion, which implies that both groups of countries have a similar production function. This, in turn, allows the inefficiency of developing countries to be measured in relation with developed countries.

Table 6. Naïve Scores- Second Frontier Model

Inputs: Teacher-pupil ratio			
Outputs: enrolment rates and PISA			
Country	**Naïve Score**	**Ranking**	**Peers**
Argentina*	1.2276	36	Finland Korea, Rep. Netherlands
Australia	**1.0000**	1	Australia Belgium Netherlands
Austria	1.0722	23	Finland Japan
Belgium	**1.0000**	1	Belgium
Brazil*	1.2068	35	Colombia United Kingdom Netherlands
Switzerland	1.0438	17	Finland Japan
Chile	1.0160	11	Colombia United Kingdom Korea, Rep.
Colombia*	1.0000	1	Colombia
Costa Rica*	1.1521	33	Australia Netherlands
Czech Republic	1.0742	24	Finland Japan
Germany	1.0330	13	Finland Japan Korea, Rep.
Denmark	1.0354	15	Belgium Finland Netherlands
Spain	1.0369	16	Belgium Finland Netherlands
Estonia	1.0054	10	Finland Japan
Finland	**1.0000**	1	Finland
France	1.0509	19	Finland Korea, Rep. Netherlands
United Kingdom	**1.0000**	1	United Kingdom
Hungary	1.1074	31	Finland Japan
Indonesia*	1.2843	37	Colombia United Kingdom Korea, Rep.
Ireland	1.0004	9	United Kingdom Korea, Rep. Netherlands
Iceland	1.0895	28	Finland Japan

Table 6. Naïve Scores- Second Frontier Model (continued)

Inputs: Teacher-pupil ratio			
Outputs: enrolment rates and PISA			
Country	**Naïve Score**	**Ranking**	**Peers**
Israel	1.1088	32	Finland Japan Korea, Rep.
Italy	1.0855	26	Finland Japan
Japan	**1.0000**	1	Finland Japan
Korea, Rep.	**1.0000**	1	United Kingdom Korea, Rep. Netherlands
Lithuania	1.1072	30	Finland Japan
Luxembourg	1.0901	29	Finland Japan
Latvia	1.0802	25	Finland Japan
Mexico*	1.1718	34	Colombia United Kingdom Korea, Rep.
Netherlands	**1.0000**	1	United Kingdom Netherlands
New Zealand	1.0160	12	Finland Korea, Rep. Netherlands
Poland	1.0466	18	Finland Japan
Portugal	1.0559	20	Finland Japan
Slovenia	1.0347	14	Finland Japan
Sweden	1.0567	21	Finland Japan
Turkey*	1.0864	27	Colombia United Kingdom Korea, Rep.
United States	1.0653	22	Finland Korea, Rep. Netherlands

Note: (*) identifies developing countries.

Source: Authors' own calculations.

Once again, developed countries appear more efficient than developing countries (1.045 vs. 1.163) although the absolute difference is lesser that in the first case. A comparison of the results for both estimations with monetary and physical inputs (Tables 3 and 6) indicates that developing countries efficiency average is slightly better considering physical instead of monetary inputs (1.1613 vs. 1.1806). The opposite occurs in the developed countries, which increases the average efficiency score (1.045 vs. 1.036). This result contradicts our initial hypothesis that the monetary model frontier penalizes developed countries as they use more expensive inputs.

A. The Effect of Non-Discretionary Inputs On the Physical Input Case

As with the previous case, we use a second-stage analysis to measure the effect non-discretionary variables have on the efficiency scores computed previously (see Table 6). In this case, GDP per capita and adult educational attainment are used as proxies for parent's income and education, respectively. The equation that will be estimated is:

$$\hat{\delta}_I = \beta_0 + \beta_1 * Y_i + \beta_2 * E_i + \varepsilon_i \tag{6}$$

We found evidence that higher GDP per capita and parental educational inputs improve efficiency scores (Table 7). This negative relationship[12] is plotted in Figures 3 and 4.

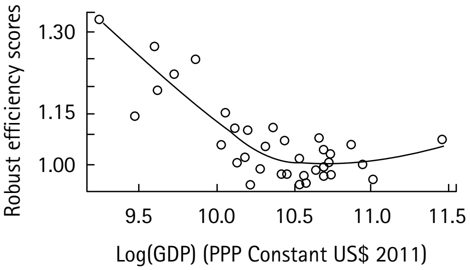
Table 7. Truncated Regression with Physical Input

Truncated Regression		
with Bootstrap adjustment		
Intercept	2.2985	***
Log(GDP)	-0.1069	***
E	-0.0017	***
Sigma	0.0561	***
Truncated Regression		
without Bootstrap adjustment		
Intercept	2.3766	***
Log(GDP)	-0.1215	***
E	-0.001	***
Sigma	0.061	***

Source: Authors' own calculations based on UNESCO database.

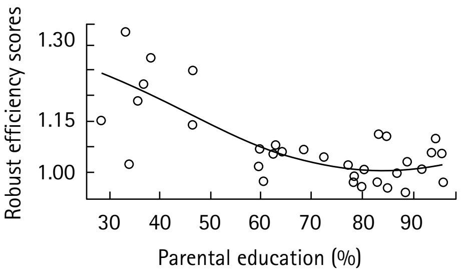
12 Please note that an increased efficiency score means that the DMU has moved farther away from the efficiency frontier, that is, the DMU is more inefficient.

Figure 3. GDP per Capita vs. Robust Efficiency Scores



Source: Authors' own calculations.

Figure 4. Parental Education vs. Robust Efficiency Scores



Source: Authors' own calculations.

Table 8 presents the robust efficiency scores considering both non-discretionary inputs corrected by bootstrapping and the new country rankings (second and third columns). Thus, countries with a relatively low GDP per capita and parental education perform poorly in terms of efficiency in secondary education. Again, there are important differences between the rankings based on naïve scores and those based on fully robust scores. First, Estonia, Ireland, and Poland, which were previously poorly ranked (Rank Naïve Scores), are now closer to the efficiency frontier. In contrast, the second stage negatively affects the performances of Colombia and Chile. For instance, Colombia is in the top 10 of lowest GDP and parental education, which does not allow it to obtain better efficiency.

Second, developing countries in the sample with the lowest percentages of persons aged 35-44 who have attained at least amount of secondary education and the lowest GDPs per capita exhibit poor performance, especially

Brazil, Argentina, Costa Rica, Indonesia, Mexico, and Turkey. Thus, we conclude that countries with harmful economic environments have a much lower performance in terms of efficiency in education.

In the fourth and fifth columns, we correct for GDP and parental education using the same procedure as in the first case. The sixth column includes the country's ranking using the fully corrected scores. For almost all countries, the correction for parental education, in absolute terms, is greater than the correction for GDP, meaning that economic policy could be focused on improvements in education rather than income to achieve better efficiency results in secondary. In general, when we finally put together both effects, the effect in the last rankings is insignificant, which gives a strong indication of high inefficiency for those countries at the top of the ranking in terms of the use of physical resources and the number of teachers. New Zealand ascended three positions, and Belgium, the United Kingdom, and Netherlands descended two positions.

Table 8. Robust Scores - Second Frontier Model

Inputs: public and private spending per student						
Outputs: enrolment rates and PISA						
Country	Robust Score	Ranking	Correction EDUC	Correction GDP	Fully score	Final Ranking
Argentina*	1.2509	35	-0.0019	-0.0005	1.2485	35
Australia	1.0314	6	0.0004	-0.0007	1.0310	5
Austria	1.0813	20	0.0008	0.0002	1.0823	20
Belgium	1.0413	10	0.0075	0.0019	1.0507	12
Brazil*	1.2761	36	0.0036	0.0069	1.2867	36
Switzerland	1.0533	13	-0.0002	0.0002	1.0533	13
Chile	1.0885	23	-0.0027	0.0028	1.0886	23
Colombia*	1.1429	31	0.0014	0.0058	1.1501	32
Costa Rica*	1.1902	33	0.0034	0.0015	1.1951	33
Czech Republic	1.0864	21	0.0007	0.0008	1.0879	22
Germany	1.0451	12	0.0027	0.0009	1.0486	11
Denmark	1.0559	15	0.0010	0.0005	1.0574	15
Spain	1.0610	16	-0.0002	-0.0016	1.0593	16
Estonia	1.0124	1	0.0001	0.0005	1.0131	1

Table 8. Robust Scores - Second Frontier Model (continued)

Inputs: public and private spending per student						
Outputs: enrolment rates and PISA						
Country	**Robust Score**	**Ranking**	**Correction EDUC**	**Correction GDP**	**Fully score**	**Final Ranking**
Finland	1.0200	3	0.0029	0.0010	1.0240	4
France	1.0647	17	0.0002	-0.0008	1.0641	17
United Kingdom	1.0307	5	0.0044	0.0006	1.0357	7
Hungary	1.1188	29	0.0013	0.0007	1.1208	29
Indonesia*	1.3257	37	0.0025	-0.0019	1.3263	37
Ireland	1.0212	4	-0.0002	-0.0011	1.0200	3
Iceland	1.1043	27	0.0006	-0.0010	1.1040	27
Israel	1.1216	30	0.0015	0.0012	1.1243	30
Italy	1.0980	26	0.0009	0.0005	1.0993	26
Japan	1.0139	2	0.0018	0.0009	1.0166	2
Korea, Rep.	1.0332	8	0.0037	-0.0010	1.0358	8
Lithuania	1.1163	28	0.0011	0.0003	1.1177	28
Luxembourg	1.0977	25	0.0011	0.0001	1.0989	25
Latvia	1.0894	24	0.0004	0.0006	1.0905	24
Mexico*	1.2225	34	0.0031	0.0011	1.2267	34
Netherlands	1.0331	7	0.0046	0.0048	1.0425	9
New Zealand	1.0332	9	-0.0006	0.0008	1.0334	6
Poland	1.0547	14	0.0004	-0.0006	1.0545	14
Portugal	1.0668	18	0.0005	0.0009	1.0682	18
Slovenia	1.0438	11	-0.0001	0.0001	1.0438	10
Sweden	1.0705	19	-0.0004	0.0000	1.0701	19
Turkey	1.1492	32	-0.0068	0.0043	1.1467	31
United States	1.0881	22	-0.0029	0.0007	1.0859	21

Note: (*) identifies developing countries.

Source: Authors' own calculations.

Finally, comparing the robust efficiency scores for the two estimated frontier models, we find that developing countries are less efficient than developed countries and that the gap increases when efficiency is measured in terms of the teacher-student ratio.

IV. Concluding Remarks

We measured the efficiency of secondary education expenditure in 37 developing and developed countries using a two-step semi-parametric DEA methodology for the 2012-2015 period. Our results highlight the importance of making comparisons between income groups (developing vs. developed countries) as a way of measuring the differences in the resource use between them and their implications in terms of output performance.

The results show that PISA and enrolment indicators in developing countries could increase, on average, between 16% to 20%, by just improving the use of public and private expenditure in education. Moreover, the performance of these items (especially for the PISA results) are importantly influenced by non-discretionary inputs such as parental education and income.

Additionally, our results do not significantly vary if monetary or physical input measures are used. In fact, it does not matter what controls are used in the frontier estimation (non-discretionary inputs or environmental conditions), it is clear that there are significant differences in the way developed and developing countries use their resources in education. However, we found that the physical frontier model favours developing countries, bringing them closer to the efficiency frontier. Estimating using the second model equally affects developed countries (they obtain higher scores), which contradicts our first hypothesis regarding the Balassa-Samuelson effect.

Given that the computed efficiency scores are computed in relative terms, the peer concept is relevant for our analysis. One important aspect of these results relates to the peer countries associated with each country. In both models, nearly all peer countries are developed countries. Moreover, Australia, Belgium, Finland, and Japan remain efficient regardless of whether efficiency is measured with monetary or physical inputs.

To sum, we provide robust evidence supporting the idea that educational performance in developing countries could be improved by efficiently using the existent resources. Moreover, both income and educational attainment negatively affect efficiency in both models. However, this does not imply that the only problem in these countries is efficiency. In fact, it is very important to continue expanding the public and private resources allocated in education to close the gap between the developed countries.

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Appendix

Table A.1. Data and Sources

Output	Enrolment rate	Gross enrolment rates. Average for 2012-2014. Source: WDI.
	PISA score	Average performance of 15-year-old children on PISA reading, mathematics, and science literacy scales, 2015. Source: OECD.
Input	**Teacher-Pupil ratio**	Teacher-pupil ratio in secondary education. Average for 2012-2014. Source: WDI.
	Private expenditure	Private spending as a percentage of GDP. Average for 2012-2014. Source: OECD.
	Government expenditure	Government expenditure per secondary student as a percentage of GDP per capita. Average for 2012-2014. Source: UNESCO.
Exogenous	**GDP PPP 2011**	GDP per capita, PPP (constant 2011 international $), 2015. Source: WDI.
	Parental education	Share of population, aged 35-44, that has attained at least secondary education, 2010. Source: Barro & Lee, 2013.

Source: Authors' own calculations.

Table A.2. Descriptive Data for Sample Countries

Country	Outputs			Inputs		Exogenous		Education expenditure (% total government expend.)
	Enrolment rate (%)	PISA	Public expenditure (%)	Private expenditure (%)	Teachers per 100 students	Parental education	GDP per capita	
Argentina*	106.10	422.00	21.24	2.46	8.17	46.55	19101.30	15.10
Australia	137.34	502.33	16.70	2.04	8.33	78.01	43832.43	13.71
Austria	98.67	492.33	27.22	2.26	10.41	72.43	44074.95	10.74
Belgium	144.74	502.67	25.80	2.77	10.60	78.44	41723.12	11.95
Brazil*	99.80	395.00	22.14	2.52	6.01	38.47	14666.02	15.76
Switzerland	98.20	506.33	26.01	1.04	10.72	86.81	56510.86	19.71
Chile	97.44	443.00	16.12	1.75	4.88	62.56	22536.62	16.09
Colombia*	99.65	410.33	16.29	2.15	3.96	46.69	12985.38	23.15
Costa Rica*	114.30	415.67	24.13	2.68	7.06	35.80	14914.21	9.58
Czech Republic	102.20	490.67	24.41	1.93	8.80	95.46	30380.59	13.86
Germany	102.60	508.00	23.38	2.23	8.00	86.76	43784.15	12.96
Denmark	127.78	504.33	28.77	2.52	8.86	80.33	45483.76	12.52
Spain	130.76	491.67	22.47	1.73	8.51	59.53	32215.97	9.70
Estonia	108.84	524.33	21.50	1.52	12.14	88.43	27328.64	11.10
Finland	132.06	522.67	34.70	2.59	8.83	84.97	38993.67	8.98
France	111.08	495.67	26.85	2.59	7.76	77.10	37765.75	17.50
United Kingdom	114.54	499.67	22.66	2.75	6.31	82.69	38509.21	17.79
Hungary	105.68	474.67	19.58	1.75	9.56	83.26	24831.35	13.63
Indonesia*	81.79	395.33	10.01	1.00	6.33	33.26	10367.70	14.21
Ireland	126.65	509.33	25.83	1.71	6.94	79.94	60944.02	8.08
Iceland	114.86	481.00	18.35	2.28	9.01	62.89	42674.42	9.45

Table A.2. Descriptive Data for Sample Countries (continued)

Country	Outputs			Inputs		Exogenous		Education expenditure (% total government expend.)
	Enrolment rate (%)	PISA	Public expenditure (%)	Private expenditure (%)	Teachers per 100 students	Parental education	GDP per capita	
Israel	101.49	472.00	16.68	2.01	8.04	84.06	31970.69	-
Italy	102.23	485.33	23.01	1.89	8.79	59.94	34244.71	16.79
Japan	101.82	528.67	24.42	1.64	8.56	88.55	37818.09	13.41
Korea, Rep.	97.46	519.00	23.03	2.43	6.46	95.89	34177.65	9.46
Lithuania	104.57	475.00	16.81	1.81	12.25	94.46	26970.81	18.22
Luxembourg	101.63	483.33	20.59	1.79	12.08	68.30	95311.11	11.90
Latvia	108.21	486.67	31.42	1.57	12.28	63.53	23057.31	18.70
Mexico*	87.56	415.67	16.34	1.92	5.80	36.93	16667.84	11.54
Netherlands	131.54	508.00	24.04	2.44	7.03	78.02	46353.85	10.22
New Zealand	117.76	505.67	23.00	2.87	7.06	60.50	34646.31	11.31
Poland	104.75	503.67	22.28	1.73	10.87	91.75	25299.05	9.45
Portugal	115.03	497.00	20.66	2.82	10.86	33.90	26548.33	14.86
Slovenia	106.49	509.33	25.54	1.59	9.93	87.34	29097.34	15.47
Sweden	119.80	495.67	26.83	1.96	9.32	88.99	45488.29	11.77
Turkey*	95.98	424.33	15.50	2.00	5.22	28.60	23382.25	13.29
United States	96.16	487.67	22.66	1.90	6.80	93.65	52789.97	13.74
Average	109.39	480.65	22.35	2.07	8.45	70.67	34795.88	13.49
Min	81.79	395.00	10.01	1.00	3.96	28.60	10367.70	8.08
Max	144.74	528.67	34.70	2.87	12.28	95.89	95311.11	23.15

Source: Authors' own calculations based on WDI, OECD, and UNESCO databases.

Table A.3. Relative Change in Rankings