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COVARIATES OF EFFICIENCY IN EDUCATION PRODUCTION AMONG DEVELOPING PACIFIC- BASIN AND LATIN-AMERICAN COUNTRIES

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ABSTRACT

The paper investigates why some schools in East Asia and Latin America are more efficient in the use of resources than others. It estimates input and output efficiencies and uses efficiency scores as dependent variables in analysis of variance and regression analyses. Input and output efficiencies are calculated using "hard" inputs such as number and quality of teachers and student socio-economic status, and "soft" inputs such as management; sorting and school autonomy are then used as explanatory variables in the variance and regression analysis. The results indicate that private management and student selection lead to high efficiencies and this result is negative for those who hope for quality public education for all; greater school autonomy leads to higher efficiencies, even for public schools that do not practice selection.

Keywords: efficiency, education quality, school inputs.

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1 INTRODUCTION

Most, although certainly not all, Latin American and Pacific Basin countries have had considerable success in providing places in school to almost all of their school age children. Although in many countries, this success has taken longer than anticipated a few decades ago and some countries are still struggling, in much of Latin America and the Pacific Rim providing places in school is no longer the most important educational challenge. According to the World Development Indicators, average net enrolment in Latin America has risen from 85% in 1985 to 95% in 2001. In both regions combined, the number of countries with net enrolment above 95% has gone from 38% in 1980 to 75% in 2001. The battle for access has largely been won.

Victory over low enrolment, however, will be pyrrhic if the schools receiving children are incapable of teaching them the skills they need in life. Low quality schooling will prevent children from progressing, and even if they progress through artificial promotion mechanisms, it will condemn them to carrying degrees that do not correspond to the acquisition of knowledge supposedly imbedded in them. This means that the battle for quality must be joined at once.

An obvious way to increase quality in education is to increase the volume of resources received by school systems. Those familiar with schools or educational statistics, however, will respond that the link between resources and educational outcomes is tenuous. Forty years of research into the determinants of educational success have pointed to low and often insignificant effects of school resources on educational outcomes. There are many reasons for this: educational resources are usually measured omitting important factors such as family background,[1] educational outcomes in quality are usually measured in levels and not through value added, and also because a fundamental issue in education is not only the volume of resources, but also how they are used. In other words, the efficiency of schools is as important as the volume of resources devoted to them.

The objective of this paper is to investigate why some schools are more efficient in the use of resources than others. The theoretical and measurement difficulties explained below mean that no attempt at rigorous causality between school management or pedagogical approaches will be made. Rather, we will look at covariates of two particular efficacy measures and try to draw tentative conclusions from the available data.

The remainder of the paper is divided into the methodological discussion below, the empirical results that follow, and the tentative conclusions at the end.

2 WHAT DO WE MEAN BY EFFICIENCY?

Schools fall into the category of production units whose efficiency is excruciatingly difficult to measure. They are very different from a firm which specializes in one output and whose inputs are easily valued using market prices. They are even quite different from other public services such as sanitation, whose outputs are perhaps more easily measured and which usually contain only one or two such outputs.

First of all, schools produce multiple outputs. Not only should children be learning content along multiple dimensions such as mathematics, communications, and science, but also much of what schools should impart to children are socialization skills and values. Schools also select students through promotion and retention: a given school could produce excellent graduates if it allowed only the very best to graduate and many are known to resort to this scheme.

This means that in addition to multiple dimensions of achievement (some measurable by test results) educational attainment (grade level) is also an important output of schools.

In addition to the existence of multiple outputs, an added difficulty is that some of these outputs are very difficult to quantify. While measurement of attainment is quite easy, measurement of socialization skills and content mastery is still in its infancy and there is no accepted yardstick for it. Measurement of knowledge of content, while an advanced science, is subject to some difficulties such as what content will be measured. Most learning evaluations are curriculum-based and highly academic, which means that the link between knowledge and its use in the lives of individuals becomes relatively tenuous. Some learning evaluations, however, adopt a "life skills" approach which attempts to measure knowledge in the context of how useful it is in real life situations.

Finally, schools also use multiple inputs which are difficult to value. Two of the most important factors affecting learning are family background, whose price can never be estimated, and teachers, whose price is very far from a market price, as teachers in most countries have career structures that are more affected by political negotiation and budget availability than marginal returns.

In order to address these difficulties, we chose to use the efficiency frontier approach to measuring efficiency and the Program for International Student Assessment (PISA) as our source of data.

PISA is as good a learning assessment as can be found. In addition to using the best measurement technology available, its philosophical approach is life skills measurement which is coherent with attempting to measure not only volume of knowledge but also its usefulness. PISA also tests children by age and not by grade – all 16-year-olds in school are tested independent of what grade they are actually in. This is fundamental to our purposes as it means that educational attainment (grade level attained by sixteen) can also be measured and not only achievement (content learned). In addition many countries participate in PISA. The 2000 samples for both Latin America (Argentina, Brazil, Chile, Mexico, and Peru) and East Asia (Hong Kong, Indonesia, Korea, and Thailand) include a reasonable number of countries. Finally, PISA is undertaken every three years, which means that our 2000 results will be reproducible using the 2003 and 2006 data at some future date.

Explaining what is meant by efficiency is somewhat more complicated. In a companion paper, Wilson (2005) provides both a heuristic and a rigorous mathematical explanation of efficiency frontier and how to estimate it. In the same paper, Wilson provides estimates of input and output efficiency for schools in the PISA sample. In this paper, we will use these estimates and some poetic license to discuss the concepts of efficiency as applied to learning.

Wilson estimates input and output efficiency using as outputs: (i) number of students, (ii) a principal components measure of PISA scores for all subjects, and (iii) grade attainment. Inputs used were: (i) a principal components index of socio-economic status, (ii) number of teachers, and (iii) quality of teachers as measured by the proportion of certified teachers in the school. The outputs are obvious and the inputs were chosen to represent "hard" inputs over which schools usually have limited control. Note that control is limited but not entirely absent: schools can exert some measure of control over socioeconomic status through sorting, number, and quality of teachers, either through hiring (if they have enough autonomy), or bureaucratic and political pressure (if they do not). The approach to be followed here is to use these hard efficiency estimates and find their most important covariates among soft variables such as autonomy, management style, the role of evaluation, and sorting and selection policy.

We will use very simple analytical tools to compare the two types of variables: cross-tabulations, one way analysis of variance, and partial correlations. The approach is similar to that of Santiago Herrera and Gaobo Pang (2004) for comparing expenditure efficiency among countries. Finally, while Wilson estimates efficiency using both Free Disposable Hull (FDH) and Data Envelopment Analysis (DEA), we will concentrate on the DEA estimations since both lead, more or less, to the same conclusions.[2]

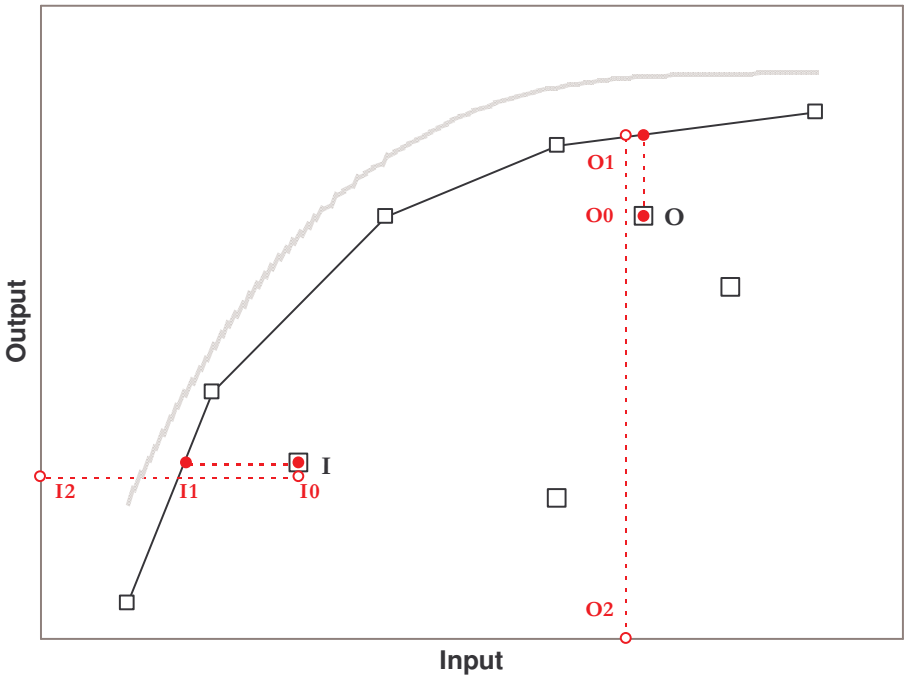
Figure 1 illustrates the different concepts of output and input efficiency. The light grey line enveloping the rest of the graph represents a hypothetical unobservable production possibilities frontier. In other words, it shows the maximum that a given school could achieve with a given volume of input. The squares within the grey line represent hypothetical observed data points; those joined by line segments represent the observed efficiency frontier, and those within represent schools that achieve less than they could from their inputs than their peers.

Two types of efficiency can be defined: input and output. Input efficiency means that a school is using as little input volume as possible to obtain a given output volume. In Figure 1 input efficiency is defined as: I = (I0-I2)/(I1-I2). In perfectly efficient schools, input efficiency will equal unity, and the higher the index, the more input that is being used to obtain a given level of output. Output efficiency measures how much output a school is obtaining from a given input volume and is defined as: O = (O0–O2)/(O1-O2). Once again, for schools on the frontier, output efficiency will be 1, but for inefficient schools, it will be less than one.

Figure 1 makes clear that while efficient schools are efficient in both definitions,[3] inefficient schools may be much more so in one than in the other. Points **O** and **I** are both inefficient, but while point **I** is close to the frontier in the input sense, but quite far in the output sense, point **O** is close in the output sense, but far in the input sense. This distinction will be crucial in the analysis from this point onwards.

FIGURE 1

Output and Input Efficiency



Source: Authors´ calculation from efficiency data calculated by Wilson(2005).

A problem with Figure 1 is that it is valid with only one input and a single output. Since we live in a three-dimensional world, Figure 1 is impossible to visualise with more than two inputs or outputs. Likewise, it is impossible to make a linear projection of inputs and outputs since schools which are far from the frontier may be far from the frontier in any one of six dimensions (three inputs and three outputs). However, we will take considerable poetic license and force Figure 1 upon our six dimensions by looking at actual results.

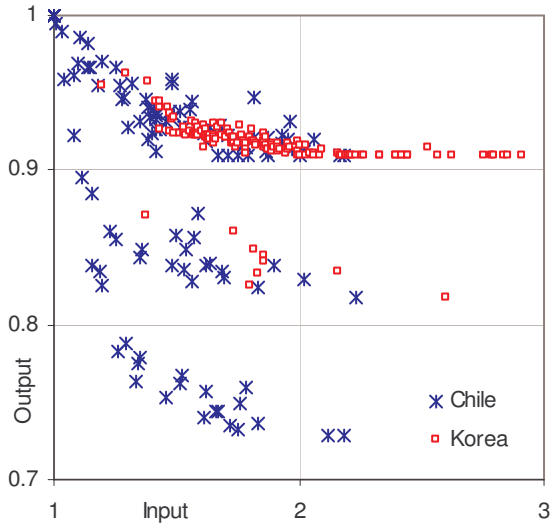
Figure 2 shows output and input DEA efficiency for two countries in the PISA sample: Chile and Korea. Panel 1 shows observed efficiency scores for both countries in efficiency score space. The difference in the two patterns is visible. While Korean schools are almost all quite close to the frontier in the output sense, many are far from the frontier in the input sense. Chilean schools, on the other hand are perhaps closer in the input sense, but clearly farther in the output sense.

In order to reduce the dimensionality of the six-dimensional input-output space, we constructed ellipses to show where the Korean and Chilean schools fall. The ellipses were constructed using the variance covariance matrix of the logarithms of input and output efficiencies. The placement of the ellipses was more delicate and two criteria were used. Since each country has some efficient schools, the ellipses were placed so as to be tangential to the arbitrary observed efficiency frontier in Figure 1. The second criteria used was that Chilean schools are about 20% more input efficient and about 20% less output efficient in logs than Korean schools, so the centre of the two ellipses were placed on a 45 degree line in relation to each other. Note that this construction is impossible in reality and was undertaken with considerable poetic license so as to illustrate concepts.

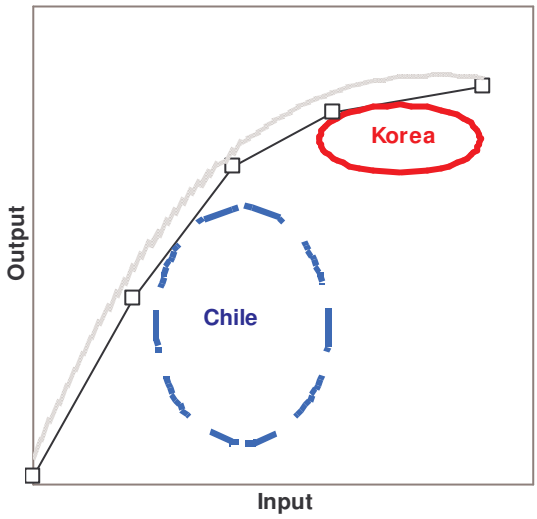
FIGURE 2

Output and Input Efficiency in Chile and Korea

Panel 1 –Efficiency Space



Panel 2 – Input and Output Space



Source: Authors´ calculation from efficiency data calculated by Wilson(2005).

What does Panel 2 of Figure 2 show? It shows that while Korean schools cannot get much more out of their inputs (they are close to the frontier in the output sense), some of them could be getting the same output for less (many are far from the frontier in the input sense). The message is that Korean schools have long entered the land of decreasing returns for

inputs. Chilean schools, on the other hand, could definitely get more output for the same input, although they could not achieve the same results with much less input. The Chilean corollary is that more inputs could probably get better results as well.

Now that the difference between output and input efficiency is clear, the remainder of this paper will be devoted to examining the behaviour of these two measures in Latin American and Pacific Rim schools.

RESULTS – PUBLIC AND PRIVATE MANAGEMENT

A first question is whether private or public management of schools is better in terms of efficiency. In order to answer this, we calculated average input efficiency scores by type of management and country; these are shown in the second and third columns of Table 1. Average output efficiency scores are shown in the fifth and sixth columns. The probability that the two sub samples are random draws from the same sample, calculated using one way Analysis of Variance, is shown in the fourth and final columns. To illustrate, average input efficiency of public and private schools in Argentina is 3.49 and 2.68, respectively, and the p-value for the Analysis of Variance is 0%. This means that public schools are less input efficient than private ones and the probability that the two sub-samples are random draws from a larger sample is nil.

The results show very different patterns in Latin American and Pacific Rim countries. In Latin America input efficiency is either statistically indistinguishable or slightly higher in private schools. In Brazil and Peru, the two could be random draws from the same sample with probabilities of 81% and 85%. In Chile and Mexico, public schools are slightly and significantly more input efficient. The exception is Argentina, in which private schools are considerably more input efficient.

TABLE 1

Efficiency by Public and Private Management

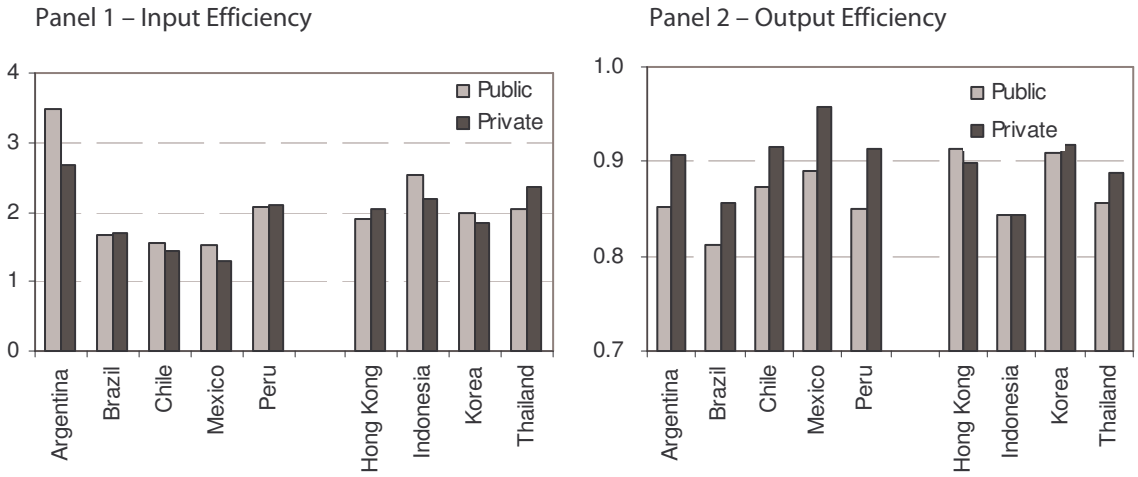
Country	Input			Output		
	Public	Private	P-Value	Public	Private	P-Value
Argentina	3.49	2.68	0%	0.852	0.907	0%
Brazil	1.67	1.71	81%	0.811	0.857	1%
Chile	1.57	1.44	2%	0.873	0.915	0%
Mexico	1.54	1.28	2%	0.890	0.958	0%
Peru	2.07	2.09	85%	0.851	0.913	0%
Hong Kong	1.90	2.04	33%	0.913	0.899	22%
Indonesia	2.53	2.20	0%	0.843	0.843	99%
Korea	1.98	1.83	3%	0.910	0.918	4%
Thailand	2.03	2.35	5%	0.857	0.888	2%

Source: Authors´ calculation from efficiency data calculated by Wilson(2005).

In output efficiency, private schools get significantly more output out of their inputs than public ones and the difference is large. In Figure 2 terms, while Latin American private schools are relatively over funded Koreas, the public schools in the region are relatively under funded Chiles.[4] In addition, Latin American public schools are further from the frontier along both dimensions, at least in Argentina, Chile, and Mexico.

FIGURE 3

Efficiency by Public and Private Management



Source: Authors´ calculation from efficiency data calculated by Wilson(2005).

In East Asia, the story is quite different as public and private schools are closer in the output sense than in the input sense and not very far in either sense. In Korea, public schools are significantly more input inefficient and less output efficient, but the magnitude is small. In Thailand, private schools are more output efficient, but less input efficient, with somewhat larger differences. In Indonesia and Hong Kong, there are no significant differences in output efficiency. There is no pattern to be observed other than small differences.

RESULTS – SCHOOL AUTONOMY

Defining school autonomy is not a straightforward endeavour. The schooling process involves a plethora of actors and of processes, and the combinations of actors deciding upon processes is quite large and difficult to classify as more autonomous or less autonomous. Some processes could be defined as being more important than others and some actors as more "autonomous" than others, but it is difficult to put states in order that are different along both dimensions. What is more autonomy: having parents decide pedagogical guidelines, or teachers decide budgets?

Often real world data offer a way out since the number of questions on autonomy is quite limited. In the case of PISA, this is not true. The school questionnaire has 60 different questions on autonomy. PISA asks four questions on human resource autonomy, two on financial autonomy, and six on pedagogical autonomy. Each question allows for four non-exclusive possible actors to decide – the school board, the principal, the department head, and teachers – in addition to an option stating that that a given measure is not an attribute of the school. The questions allow for 281 trillion possible states of autonomy – so analyzing each possible state separately is not possible. Finally, an IRT measure of autonomy based upon these sixty questions is provided with the database, but it is difficult to know what is driving it.

Two approaches are possible: either use the autonomy measure provided, or make a simpler one directly based upon the questions. The IRT variable divides the observations into two, three or even four natural groups as shown in Figure 4, but the use of variables whose construction cannot be replicated is problematic. Furthermore, the IRT autonomy scale is one-dimensional when autonomy could probably be divided into multiple dimensions. Due to this, we decided to build our own autonomy variable as follows:

1. Schools answering all six pedagogical autonomy questions with any answer but "Not an attribute of the school" were classified as having Pedagogical Autonomy.
2. Schools answering both financial autonomy questions with any answer but "Not an attribute of the school" were classified as having Financial Autonomy.
3. Schools answering all four human resource autonomy questions with any answer but "Not an attribute of the school" were classified as having Human Resource Autonomy.
4. All other schools were classified as No Autonomy Schools.
5. Human Resource Autonomy was arbitrarily set as the most autonomous autonomy and Pedagogical as the least autonomous one, so a school with both Human Resource and Pedagogical Autonomies was classified as Human Resource Autonomous. In order to check this classification, averages for the IRT school autonomy variable were calculated for each type of autonomy and show that indeed the arbitrary ranking is coherent with the IRT ranking and the results are shown in Table 2 below.

FIGURE 4

School Autonomy (IRT)

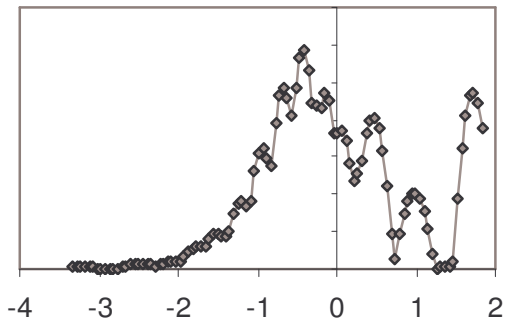


TABLE 2

Autonomy Categories

Type of Autonomy	Mean IRT Score	No of Schools
None	-1.0342	332
Pedagogical	-0.4679	252
Financial	-0.0241	817
Human Resource	1.6144	358

Source: Authors´ calculation from efficiency data calculated by Wilson(2005).

Using this admittedly simplistic classification of school autonomy, DEA input and output measures were once again calculated.

TABLE 3

Input and Output Efficiency by Autonomy Categories

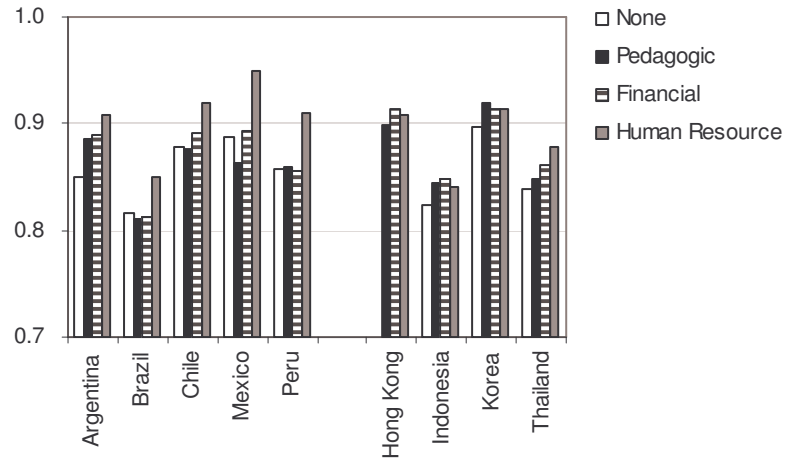
	Input					Output				
	Type of Autonomy					Type of Autonomy				
	None	Pedagogic	Financial	Human Resource	p-Value	None	Pedagogic	Financial	Human Resource	p-Value
Argentina	3.354	3.176	3.082	2.082	17%	0.851	0.886	0.890	0.909	2%
Brazil	1.553	1.853	1.709	1.693	29%	0.815	0.811	0.812	0.849	25%
Chile	1.424	1.583	1.565	1.422	6%	0.877	0.876	0.892	0.920	10%
Mexico	1.489	1.524	1.558	1.367	32%	0.888	0.863	0.893	0.949	0%
Peru	2.253	1.950	1.950	2.267	3%	0.857	0.859	0.856	0.910	2%
Hong Kong		1.962	1.896	1.991	61%		0.899	0.913	0.909	37%
Indonesia	2.835	2.436	2.411	2.326	32%	0.824	0.844	0.847	0.841	82%
Korea	1.903	1.811	1.913	2.138	48%	0.897	0.919	0.913	0.914	39%
Thailand	2.144	1.984	2.043	2.186	60%	0.839	0.848	0.862	0.878	6%

Source: Authors´ calculation from efficiency data calculated by Wilson(2005).

The results are not highly significant due to the reduced number of schools in many of the categories for some countries, which reduces the power of one way Analysis of Variance. Only one pattern appears visible: human resource autonomy is related with high output efficiency in Latin America but not in East Asia. Indeed the only cases for which the differences are significant at 5% or more are output efficiency for Brazil, Mexico, and Peru and input efficiency for Peru.

FIGURE 5

Output Efficiency According to School Autonomy



Source: Authors´ calculation from efficiency data calculated by Wilson(2005).

Figure 5 above clearly shows that one type of autonomy – human resource autonomy – is responsible for these differences. The visual impact is quite striking in that schools with human resource autonomy do much better than those without it in all Latin American countries, but there appears to be no pattern in East Asian ones. Even in Brazil and Chile, where the p-values that all cases are drawn from the same distribution are as high as 25% and 10%, the difference between human resource autonomy and the rest is quite striking.

Given that private schools are much more human resource autonomous than public ones – 60% against 6% in our sample – it is likely that the human resource autonomy question is picking up the private vs. public dimension already explored. This strongly suggests that multivariate analysis is warranted to complement the bi-variate approach here explored.

RESULTS – TEACHER TURNOVER AND ABSENTEEISM

Given that the only relevant result from the previous section is that human resource autonomy is associated with higher output efficiency in Latin America, it makes sense to ask what practices are important. If specific ways in which more human resource autonomy translates into greater efficiency can be pinpointed, then perhaps we can recommend improvements in these specific practices.

The PISA database provides two questions on how better teacher management could improve student results. Question 19 asks the school director whether learning is hindered "not at all", "very little", "to some extent", or "a lot" by teacher turnover and teacher absenteeism. The question is imperfect since the answers may well be endogenous – school directors who

judge that something is more detrimental to learning may simply have higher expectations. If higher expectations lead to more action, the data may even show a false positive correlation between teacher turnover and teacher absenteeism and learning. Nevertheless, since there are no "objective" variables that measure either turnover or absenteeism, these are the ones we will use.

TABLE 4

Input and Output Efficiency by Teacher Turnover and Absenteeism

	Extent to which learning is hampered					Extent to which learning is hampered				
	Not at All	Very Little	To Some Extent	A Lot	p-Value	Not at All	Very Little	To Some Extent	A Lot	p-Value
Turnover										
Argentina	2.856	3.247	3.575	3.806	**1%**	0.880	0.899	0.885	0.879	**24%**
Brazil	1.617	1.771	1.726	1.557	**52%**	0.830	0.793	0.824	0.839	**4%**
Chile	1.511	1.450	1.831	1.761	**2%**	0.891	0.901	0.869	0.749	**20%**
Mexico	1.469	1.505	1.571	1.331	**57%**	0.906	0.906	0.876	0.900	**38%**
Peru	2.051	2.051	2.181	2.384	**77%**	0.871	0.875	0.833	0.727	**2%**
Hong Kong	1.902	2.021	1.787	1.910	**41%**	0.912	0.908	0.918	0.910	**90%**
Indonesia	2.498	2.298	2.333	2.333	**24%**	0.833	0.852	0.845	0.840	**32%**
Korea	1.889	2.128	1.773	1.996	**18%**	0.914	0.912	0.903	0.912	**70%**
Thailand	2.141	2.067	1.929	2.019	**49%**	0.873	0.853	0.859	0.843	**10%**
Absenteeism										
Argentina	2.854	3.073	3.497	3.415	**3%**	0.880	0.890	0.896	0.883	**69%**
Brazil	1.613	1.806	1.606	1.534	**31%**	0.827	0.809	0.819	0.821	**64%**
Chile	1.529	1.471	1.595	1.458	**42%**	0.884	0.902	0.874	0.904	**43%**
Mexico	1.352	1.500	1.537	1.641	**21%**	0.913	0.901	0.891	0.894	**76%**
Peru	2.141	2.053	1.958	2.337	**57%**	0.873	0.866	0.858	0.842	**81%**
Hong Kong	1.842	2.001	1.945	1.473	**4%**	0.916	0.906	0.912	0.943	**17%**
Indonesia	2.370	2.407	2.302	2.388	**87%**	0.834	0.843	0.868	0.833	**6%**
Korea	1.915	1.910	1.732	1.793	**87%**	0.915	0.906	0.923	0.920	**29%**
Thailand	2.246	2.008	2.016	1.640	**13%**	0.854	0.864	0.854	0.889	**54%**

Source: Authors´ calculation from efficiency data calculated by Wilson(2005).

The results show almost nothing. Only in Brazil and in Peru are teacher turnover significantly negative influences on output efficiency, and in Brazil, the most output efficient categories are "to some extent" and "a lot". In teacher absenteeism, there are no Latin American countries in which schools unhampered by this are more output efficient. Once again, these disappointing results may be due to endogenous response to the wording of the question.

RESULTS – USE OF EVALUATION

Much as in the case of autonomy, it is difficult to define exactly what is meant by use of evaluation as a pedagogic and management tool. Different from autonomy, there are only six questions on the use of evaluation (providing only 64 possible combinations) and five on the form of evaluation. We grouped these into two categories: (i) schools using external evaluation for purposes of grouping students into grades, decisions on retention and promotion, and for informing parents and (ii) schools using external evaluation on the school for purposes of comparison with other schools, tracking progress over time, and making judgments about the effectiveness of teachers. Finally, if a school either does not use external evaluation or uses it for neither of the two purposes above, it is classified as not using evaluation.

TABLE 5

Input and Output Efficiency by Use of Evaluation

	Use of Evaluation				Use of Evaluation			
	None	Pupil	School	p-Value	None	Pupil	School	p-Value
Argentina	3.225	3.276	3.123	**75%**	0.891	0.879	0.896	**34%**
Brazil	1.748	1.627	1.617	**50%**	0.798	0.818	0.840	**2%**
Chile	1.503	1.531	1.485	**88%**	0.916	0.879	0.846	**0%**
Mexico	1.523	1.465	1.505	**90%**	0.899	0.885	0.901	**69%**
Peru	2.058	2.161	2.129	**82%**	0.868	0.823	0.863	**49%**
Hong Kong	1.912	1.743	1.992	**6%**	0.912	0.927	0.904	**3%**
Indonesia	2.486	2.227	2.365	**61%**	0.860	0.863	0.842	**32%**
Korea	1.906	1.963	1.776	**37%**	0.915	0.910	0.916	**50%**
Thailand	2.021	1.985	2.105	**58%**	0.855	0.884	0.856	**2%**

Source: Authors´ calculation from efficiency data calculated by Wilson(2005).

The results are shown in Table 3 and they are little more conclusive than those for autonomy. In Brazil, output efficiency appears to be associated to evaluation in schools, and in Chile, the two appear inversely related. Hong Kong and Thailand student evaluation appears related to output efficiency and no other significant relations are visible in the data.

RESULTS – SORTING AND SELECTION

One of the harshest facts uncovered and many times reaffirmed in the four decades of the study of the determinants of educational success since the Coleman Report is the overwhelming influence of family background in education. Not only is family background individually important, but it is also also collectively important. This means that having classmates of high socio-economic status increases one's educational attainment and achievement more than any other variable, apart from one's own socio-economic status. Schools have long been aware of this fact, successful schools often practice selection and sorting as a means to improve school outcomes. In other words, one of the easiest ways of having very good graduates is to allow only the best to graduate, and if possible, to allow only the best into the school.

The fact that successful schools sort and select is perhaps responsible for more difficulties in uncovering what works and what does not work in education than any other single difficulty. The difficulties of unveiling sorting and selection begin with measuring them. Since individual educational trajectories depend heavily upon family background, student socio-economic mix is an endogenous variable. This means that merely observing socio-economic means and variances of efficient schools will say little about their sorting and selection practices. In addition, since socio-economic background was used as one of the input variables from which efficiency was estimated, this approach would use an input variable of the efficiency estimates as an explanatory variable, which goes against the spirit of the methodology.

Another approach is to classify according to self-declared sorting and selection behaviour. This approach is also not free of criticism as often sorting and selection are considered ethically unacceptable pedagogical approaches. In many countries, they fall into the category of things which many happen, but few admit to. Nevertheless, this is the approach that will be used now.

PISA asks about sorting and selection in three different questions – one on how students are admitted into the school, one on how they are internally tracked into study programs, and

another on how they are transferred away. Table 4 shows the unweighted answers to these questions for all the schools in the Latin America and East Asia sample.

TABLE 4

Sorting and Selection Indicators

Admittance into School

Freq.	Residence	Academic performance	Feeder schools	Philosophy / Religion	Special programs	Family preference	Other
Never	48%	37%	46%	54%	37%	43%	44%
Sometimes	24%	23%	31%	20%	34%	35%	34%
Always	29%	40%	24%	26%	28%	22%	23%
Total	100%	100%	100%	100%	100%	100%	100%

Internal Tracking

	Student's choice	Academic record	Placement exams	Teacher recommend	Parents' request
Never	14%	11%	32%	21%	23%
Sometimes	44%	51%	46%	54%	58%
Always	42%	38%	22%	25%	19%
Total	100%	100%	100%	100%	100%

Transfer to Another School

	Low achievement	High achievement	Behaviour	Special needs	Parents' request	Others
Never	65%	80%	29%	45%	13%	42%
Sometimes	30%	17%	51%	44%	54%	44%
Always	5%	3%	19%	11%	34%	14%
Total	100%	100%	100%	100%	100%	100%

Source: Authors´ calculation from efficiency data calculated by Wilson(2005).

Once again, it is difficult to know when a given answer implies in sorting and selection and when it does not. For example, in the United States, entry by residence is strongly related to selection due to the high residential segregation in that country, except, of course, in periods during which bussing was prevalent. Some of the questions, however, are unambiguous – school entry by academic performance unambiguously denotes selection due to school achievement, internal tracking by placement exams unambiguously denotes internal sorting, and transfer due to low or high achievement unambiguously denotes selective exit from the school.

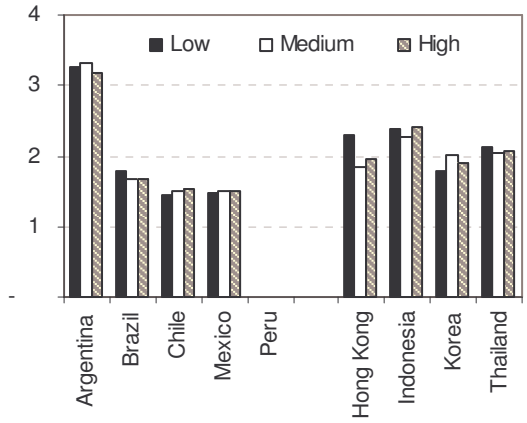
In this line, two variables were constructed to represent selection and sorting, respectively. The selection variable was constructed by adding entry by academic performance and exit by high or low achievement. For each of these variables, “never” was given value zero, and “sometimes” and “always” were given value one so that the final selection variable had three values: 0, 1, and 2.

The sorting variable was constructed by adding tracking by academic record to tracking by placement exams, with “never” equalling zero and “sometimes” and “always” equalling one so that again the sorting index took values 0, 1 and 2. Mean input and output efficiencies were calculated by sorting and selection levels and the results are in Tables and Figures 6 and 7.

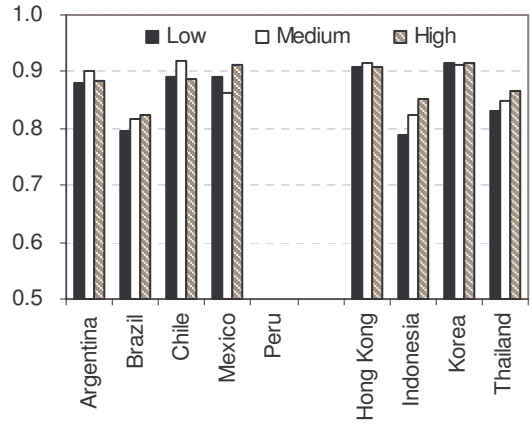
FIGURE 6

Efficiency by Sorting

Panel 1 – Input Efficiency



Panel 2 – Output Efficiency



Source: Authors´ calculation from efficiency data calculated by Wilson(2005).

TABLE 6

Efficiency by Sorting

Panel 1 – Input Efficiency

Country	Sorting Level			p-Value
	Low	Medium	High	
Argentina	3.270	3.318	3.188	**86%**
Brazil	1.792	1.662	1.671	**79%**
Chile	1.459	1.514	1.543	**45%**
Mexico	1.471	1.500	1.514	**96%**
Peru				
Hong Kong	2.309	1.845	1.968	**3%**
Indonesia	2.395	2.266	2.409	**44%**
Korea	1.791	2.003	1.904	**21%**
Thailand	2.121	2.048	2.057	**95%**

Panel 2 – Output Efficiency

Sorting Level			p-Value
Low	Medium	High	
0.879	0.901	0.886	**51%**
0.795	0.815	0.823	**41%**
0.890	0.917	0.886	**24%**
0.891	0.864	0.913	**1%**
0.909	0.916	0.908	**28%**
0.789	0.823	0.851	**0%**
0.915	0.910	0.915	**63%**
0.830	0.848	0.866	**3%**

Source: Authors´ calculation from efficiency data calculated by Wilson(2005).

Table 6 and Figure 5 do not show much in terms of pattern. In Hong Kong, there are significant differences in input efficiency with low sorting being least efficient. In Indonesia and Thailand, sorters are significantly more output efficient. In Brazil, they are also more output efficient, but the p-value for the analysis of variance is only 41%. In other countries, there is no pattern. The conclusion appears to be that internal sorting bears little influence on efficiency.

Selection is a different story. The data show clear patterns similar to those seen for private and public schools. In Latin America, no significant differences appear in input efficiency, except in the case of Argentina. In all countries but Argentina, schools that select are significantly more output efficient than those that do not. In other words, by selecting students, schools become more like the Koreas in Figure 2. In East Asia, the same pattern for output efficiency is visible for Indonesia and Korea, and no pattern is visible for input efficiency.

TABLE 7

Efficiency by Selection

Panel 1 – Input Efficiency

Country	Selection Level			
	Low	Medium	High	p-Value
Argentina	3.536	3.247	2.784	**0%**
Brazil	1.664	1.862	1.579	**25%**
Chile	1.488	1.508	1.509	**95%**
Mexico	1.642	1.604	1.492	**57%**
Peru	2.161	2.014	1.967	**52%**
Hong Kong		1.862	1.952	**22%**
Indonesia	2.224	2.472	2.390	**26%**
Korea	1.868	1.992	1.781	**6%**
Thailand	2.066	1.966	2.160	**16%**

Panel 2 – Output Efficiency

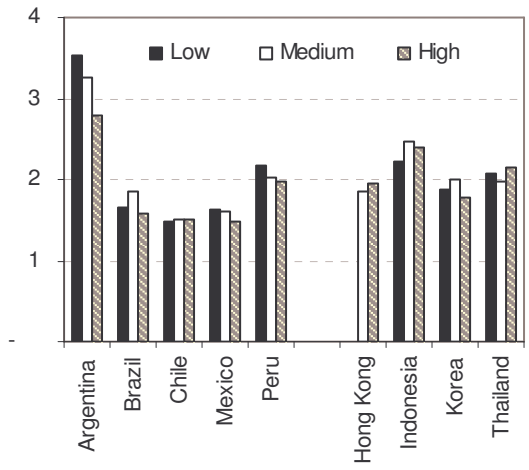
Selection Level			
Low	Medium	High	p-Value
0.884	0.900	0.892	**40%**
0.807	0.818	0.875	**2%**
0.867	0.896	0.917	**3%**
0.883	0.893	0.923	**14%**
0.841	0.863	0.894	**5%**
	0.915	0.909	**31%**
0.823	0.849	0.851	**10%**
0.897	0.914	0.923	**0%**
0.850	0.861	0.860	**68%**

Source: Authors´ calculation from efficiency data calculated by Wilson(2005).

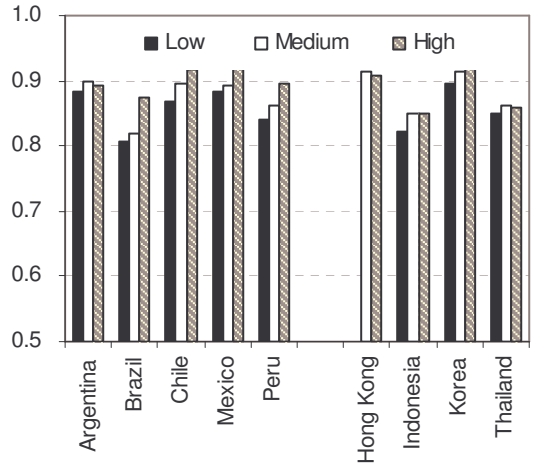
FIGURE 7

Efficiency by Selection

Panel 1 – Input Efficiency



Panel 2 – Output Efficiency



Source: Authors´ calculation from efficiency data calculated by Wilson(2005).

The conclusion appears to be that while internal sorting does little to improve any kind of efficiency, external selection significantly increases output efficiency. Much as in the case of private or public management, the differences are stronger in Latin America than in the Pacific Rim. It is important to note that we are not stating that selection increases outcomes – that is obvious – but that it increases efficiency. In other words, schools that select students are better able to use their inputs to produce higher outcomes than those that do not. While no direct policy suggestions follow from this finding – telling schools to select their students is an offense against egalitarianism – it does suggest that the issue of student body composition deserves much more study.

RESULTS – MULTIVARIATE REGRESSION

Given the high correlation coefficients between indicator variables examined thus far and suspicions that some observed effects may be picking up the effects of other variables, a multivariate regression becomes desirable.

An un-weighted OLS regression was run on input and another on output efficiency with all the variables used in this paper thus far, as well as on country control dummies. Given that the dependent variables are either left (input) or right (output) truncated, an argument may be made that a Tobit would be better than OLS in estimating the impacts of each variable upon DEA efficiency measures. In order to dissipate doubts, both models were run.

The results are in Table 8 below. Remember that a negative coefficient means a variable improves input efficiency and hampers output efficiency.

TABLE 8

Multivariate Results

	Ordinary Least Squares				Tobit			
Variable	**Input Efficiency**	**p-Value**	**Output Efficiency**	**p-Value**	**Input Efficiency**	**p-Value**	**Output Efficiency**	**p-Value**
Sorting								
Low	Base		Base		Base		Base	
Medium	0.049	55%	0.008	34%	0.049	55%	0.008	35%
High	0.090	24%	0.010	18%	0.095	22%	0.010	20%
Selection								
None	Base		Base		Base		Base	
Low	0.032	57%	**0.013**	**2%**	0.038	0.51	**0.013**	**2%**
Medium	-0.051	43%	**0.019**	**0%**	-0.054	41%	**0.019**	**0%**
High	-0.020	81%	**0.017**	**4%**	-0.013	88%	**0.017**	**5%**
Management								
Public	Base		Base		Base		Base	
Private	**-0.308**	**0%**	**0.020**	**0%**	**-0.321**	**0%**	**0.020**	**0%**
Use of Evaluation								
None	Base		Base		Base		Base	
Pupil	-0.079	17%	0.004	49%	-0.088	13%	0.004	43%
School	-0.035	50%	-0.003	53%	-0.044	40%	-0.003	60%
Autonomy								
None	Base		Base		Base		Base	
Pedagogic	0.017	83%	0.011	13%	0.008	92%	0.012	11%
Financial	-0.003	97%	**0.016**	**1%**	-0.015	82%	**0.016**	**1%**
Human Resource	0.131	14%	**0.019**	**3%**	0.120	18%	**0.020**	**2%**
Teacher Turnover								
Not at all	Base		Base		Base		Base	
A little	-0.021	68%	0.001	83%	-0.028	58%	0.002	72%
To some extent	-0.003	97%	-0.002	75%	-0.001	99%	-0.002	74%
A lot	-0.122	21%	0.010	32%	-0.127	20%	0.010	31%
Teacher Absenteeism								
Not at all	Base		Base		Base		Base	
A little	0.000	100%	0.004	38%	0.000	100%	0.004	38%
To some extent	-0.003	96%	0.009	19%	0.000	100%	0.009	19%
A lot	-0.043	67%	0.005	63%	-0.036	73%	0.004	67%

Source: Authors´ calculation from efficiency data calculated by Wilson(2005).

The results in the Table below confirm what was seen in the one way Analysis of Variance. The OLS and Tobit results are also in remarkable agreement.

The use of evaluation has no significant effect upon either kind of efficiency. Autonomy, on the other hand, significantly improves output efficiency if it is either financial or human resource. Pedagogical autonomy does not appear to be enough. Specific behaviours affected by human resource autonomy – teacher turnover and absenteeism – show no impacts whatsoever, although this may be due to the way in which the question is formulated.

On the other hand, public schools are both input and output efficient. Perhaps most importantly, while internal sorting does not appear to have any significant results either, schools that select are more output efficient and the more they select, the more output efficient they are. Once again, while there are no direct policy conclusions of this result, it does show that the composition of the student body is a fundamental element in learning.

4 CONCLUSION

The results presented here suggest that, with the exception of those schools exactly on the frontier that are perfectly efficient, the volume of resources devoted to education has an important effect upon the direction of inefficiency. This means that efficiency cannot be an absolute concept and will behave differently in the output and input directions. The most important results here:

Use of evaluation appears to have no effect upon efficiency. This is a somewhat surprising result as it says that the accountability that comes from the evaluation of the school and of the teachers is not important in how well resources are utilized. This may be due to the naive measures of evaluation used, but it may also mean that accountability is more of a day-to-day management concept than a once-a-year ranking concept.

Private schools are both more input and more output efficient. That private schools are more output efficient is no surprise since they serve children of rich parents who will not stand for poor results, but are quite willing to pay for more educational inputs than strictly needed. Input efficiency may be credited to the profit motive. Unfortunately, PISA has no non-profit non-government management category to compare with.

Financial and human resource autonomy have strong impacts upon output efficiency. Pedagogical autonomy has no significant impact upon efficiency. Once again, schools in which parents make decisions means that they would not stand for poor results, but would be willing to put up with wasted inputs, particularly if they do not pay for them. The result suggests that this occurs only with financial and, more importantly, human resource autonomy. Attempts to identify behaviours responsible for this in teacher turnover and absenteeism failed to find any impacts, although this may be due to the way in which the question is formulated.

Finally, one of the most important results is that while internal sorting has no effect upon output efficiency, external selection does. In other words, schools that select use their resources better, and the more they select, the better they use them. This suggests that, in addition to having better results due to selection of inputs, either classroom composition or parental participation effects lead to better use of these same resources.

It is important to state that these results are found both in univariate and multivariate analyses.

Are these results optimistic or pessimistic? Perhaps both. On the one hand, they suggest that socio-economic background, expressed either through private management or public schools with explicit selection procedures, is a force too strong to contend with entirely. Whatever we do, the iron law of education first expressed in the Coleman report will be stronger than our efforts: schools with students from high socio-economic backgrounds will be islands of excellence in a sea of mediocrity composed of schools with low socio-economic background students. The strong influence of selection and private management suggest that governments have a difficult choice between condemning almost all the poor to bad schools by allowing the rich to self-segregate into good private schools, or allowing some of the poor into good schools through the creation of student-selecting islands of excellence with public money.

On the optimistic side, our results do point to practices which lead to better results, at least in output terms. Other than selection and private management, the results show that financial and human resource autonomy lead to significantly more output efficiency. Due to the limited nature of the questions on human resource management, we were not able to pinpoint specific practices responsible for improved efficiency, but for those uncomfortable with selection and privatization as ways to improve efficiency, school autonomy appears to be a promising path.

Is there anything new here? Perhaps the strongest result here is the importance of selection of students by schools on their efficiency. High or medium selection relative to low selection has an impact upon output efficiency as large as human resource autonomy or private management, both of which receive considerable attention. This suggests that policies of sorting students in the school system deserve to be objects of more attention than they have been in the past. The fact that many of these policies are difficult to observe make this even more important.

Finally, can these results be believed? Given the many hypotheses behind these results, any reader would be forgiven for not believing them very strongly. Among the reasons for disbelief would be: (i) the aggregations made in order to reduce the dimensionality of the efficiency frontier estimations – all family background variables are reduced to one, all test scores are reduced to one, and so forth; (ii) the ad hoc creation of the indicator variables such as use of evaluation, autonomy, sorting, and selection; (iii) the estimation of efficiency frontiers in contexts as different as those of Korea and Peru.

On the other hand, there are some positive aspects that point to believability. The first is that the data source is excellent: PISA is the best international evaluation and its results are comparable across time, grade levels, and countries. The second is that the estimation methods are both robust: the efficiency frontiers were estimated correcting for stochastic effects and Analysis of Variance and multivariate regression are among the most robust estimation methods known. Finally, while the indicator variables were ad hoc, they are also simple and this suggests reliability.

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NOTES

1. Since the Coleman report, the overwhelming importance of socioeconomic background in educational results has been a constant in the educational production literature. Parents' educational levels and occupation are the most important causal variables in almost any regression explaining educational results.

2. While FDH and DEA estimates are not identical, the two are highly correlated and, more importantly, yield the same qualitative results.

3. In a perfectly deterministic world without measurement error, whenever input efficiency is equal to unity, output efficiency will also be. In the real world in which the frontier must be estimated from imperfect data, schools will often have unity score on one dimension, but be inefficient on the other.

4. The use of the words under- and over-funded is again poetic license as one of the most important inputs is the socio-economic background of students, which cannot be bought with any budget.

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