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## ABSTRACT

This paper takes an efficiency analysis perspective to analyze, on the basis of the data of the 2009 Organisation for Economic Co-operation and Development Program for International Student Assessment (PISA) survey, the determinants of scholastic performance in five Asian countries (Azerbaijan, Indonesia, Kazakhstan, the Kyrgyz Republic, and Thailand). In the first stage, the huge amount of information available in the PISA survey on the production of education is aggregated via the use of correspondence analysis. To measure efficiency, a stochastic production frontier approach is then adopted and efficiency is estimated at the individual (student) level. Finally, the factors affecting this efficiency are analyzed via an ordinary least squares regression and, using the so-called Shapley decomposition, an attempt is made to determine the exact impact on efficiency of the various explanatory variables that were introduced.



Keywords: Azerbaijan, correspondence analysis, educational production function, Indonesia, Kazakhstan, Kyrgyz Republic, PISA data, Shapley value, Thailand

JEL Classification: A20, O15

## I. INTRODUCTION

Several studies have found that educational quality, when measured by international comparative tests of skills, is quite strongly associated with growth (see, for example, Hanushek and Kimko 2000 and Barro 2001). It then becomes important to understand how scholastic performance in such tests is produced. There is a long tradition in the economics of education literature which considers an educational institution as a firm transforming inputs into outputs. The inputs often refer to the teaching and learning environment while the outputs are defined in terms of test scores. Naturally drawing strong inference from such studies may be problematic because the datasets on which they are based include only information on the contemporaneous family background and treat early childhood inputs as unobservables (for a review of this important issue, see, Todd and Wolpin 2003).[1]

Though aware of the importance of such an issue, this paper, which analyzes data from the 2009 Program for International Student Assessment (PISA) survey, will nevertheless attempt to find ways of determining what the main factors of scholastic achievement are. Its focus is on five Asian countries (Azerbaijan, Indonesia, Kazakhstan, the Kyrgyz Republic, and Thailand) that participated in this survey. It starts by estimating an educational production function but rather than selecting as inputs a few variables among the many that are available in the survey, it includes the maximum amount of available information. Such an approach is made possible because the enormous amount of information available on the production of scholastic achievement is aggregated via the use, not of principal component analysis—a technique that should not be used with qualitative data—but of multiple correspondence analysis. Before estimating the degree of efficiency of the production of scholastic achievement, a distinction will be made between discretionary inputs and factors which are assumed to have an impact on the efficiency of transforming these discretionary inputs into outputs (scholastic achievements). To measure efficiency we use the stochastic production frontier approach but, rather than focusing on schools,[2] we analyze efficiency at the individual (student) level. Once such individual efficiency measures are obtained, we use ordinary least squares (OLS) regressions and then the so-called Shapley decomposition procedure to determine the exact impact on individual efficiency of each of the nondiscretionary variables considered as determinants of such an efficiency.

This paper is organized as follows: Section II describes succinctly the methodology used in the present study. Section III presents the three stages of the empirical investigation while concluding comments are presented in Section IV. The paper has two Appendixes, one which lists the PISA questions that were used and the other presenting results concerning mathematics and science literacy.

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[1] Some micro studies do however include early childhood factors (e.g., Behrman et al., 2008, and Todd and Wolpin, 2007) and found these factors to be important.

[2] See, Deutsch and Silber, 2009 for a survey of studies that applied efficiency analysis to the production of education.

## II. THE METHODOLOGY

### A. The First Stage of the Analysis: Data Sources and Data Reduction Procedure for the Inputs:

#### 1. Data Sources

The estimation of scholastic performance production functions for Azerbaijan, Indonesia, Kazakhstan, the Kyrgyz Republic, and Thailand is based on data collected in the 2009 PISA survey. PISA) is a system of international assessments that focus on 15-year-olds' capabilities in reading literacy, mathematics literacy, and science literacy. PISA[3] emphasizes functional skills that students have acquired as they near the end of mandatory schooling. It began in 2000 and is administered every 3 years. Each administration includes assessments of all three subjects, but assesses one of the subjects in depth. The most recent administration was in 2009 and it focused on reading but also assessed mathematics and science performance.

#### 2. Deciding which PISA Variables Should be Considered as Inputs

The PISA surveys in the five countries examined in this study include mainly two types of questionnaires (besides the tests themselves) that are respectively filled by the school administration and the student. It is not difficult to decide what the outputs will be in the efficiency analysis to be conducted since three test scores are generally available for each student in the PISA survey (scores in mathematics, reading, and science), it is much less simple to select the inputs. At this stage, before any aggregation procedure takes place, the idea is to choose inputs that could be considered as discretionary. Four categories of inputs have been selected

- the educational means available at home
- the pedagogical characteristics of the school
- the physical capital available at school
- the time inputs of the student (time outside school)

Appendix 1 lists all the relevant variables in each of these categories. These variables have been aggregated using Correspondence Analysis (CA).

#### 3. On Correspondence Analysis

CA was introduced by Benzécri (1973) and his French school. It is an exploratory data analytic technique aiming at analyzing simple two-way (or multi-way) tables where some measure of correspondence is assumed to exist between the rows and columns. CA is extremely useful to transform a set of complex data into quite a simple description of almost all the implicit information provided by the data.

A very useful characteristic of correspondence analysis is that it allows one to obtain a graphical display of row and column points in biplots, which helps discovering some structural relationships that may exist between the variables and the observations.

Although CA may be defined as a special case of principal components analysis (PCA) of the rows and columns of a table, one should stress that CA and PCA each have specific

[3] The PISA surveys were launched by the Organisation for Economic Co-operation and Development.

uses. PCA is a useful tool when one has tables consisting of continuous measurement, whereas correspondence analysis is typically applied to the case of contingency tables.

Like principal components analysis, correspondence analysis provides the researcher with principal components which are orthogonal. More specifically each component is a linear combination of the variables on one hand, the observations on the other. We limited ourselves to the first factor[4].

## B. The Second Stage of the Analysis: Using the Stochastic Production Frontier Approach to Determine the Efficiency of Each Student

### 3. Why is such an efficiency analysis important?

While it is certainly most desirable to increase the PISA scores of the students, there may also be reasons to increase their relative score, that is, to improve the efficiency with which students transform the inputs at their disposal into PISA scores. Assume, for example, that students belonging to a given subpopulation achieved quite a high score on the PISA tests. It might be very difficult to improve the scores of such a subpopulation. What is possible is to improve the efficiency with which these students obtained their high levels of achievement and hence to free resources that can be transferred to other subpopulations or purposes. Such a transfer would be valuable not only for students with high scores but even for students who had low scores. The idea is if some student had a low score in one of the PISA tests (in mathematics, reading, or science) by improving the efficiency with which such a low achiever transforms inputs into scores, we may free resources that would allow him to improve his results in another PISA test.

Another reason for emphasizing the efficiency with which individual students transform their inputs into test scores is related to the relative cost of improving a test score beyond threshold. There may well be decreasing returns (in terms of test scores) to some types of investments in education. If this is the case, attempting to improve the score per resource unit might be more cost effective. This is thus another justification for stressing the concept of individual student efficiency.

### 2. The Stochastic Production Frontier Approach

On the basis of the four inputs previously mentioned and of the three outputs provided by the PISA survey (scores in mathematics, reading, and science), an efficiency analysis was implemented and an efficiency score attributed to each student.

We first considered the three test scores as the outcomes of a latent variable reflecting the cognitive ability of the student (for a similar point of view see, Heckman, Stixrud, and Urzua 2006, and Urzua, 2007). This latent variable is evidently not observed and to implement a stochastic production frontier analysis, we used a technique originally proposed by Lovell et al. (1994). Deutsch and Silber (2009) applied it to the 1966 Latin America PISA data.[5]

Let $x = (x_1, x_2, x_3, x_4)$ denote the vector of the four aggregated inputs derived from "correspondence analysis." Similarly, let $y = (y_1, y_2, y_3)$ refer to the three educational achievement scores obtained by the individual on the three tests (mathematics ability, reading

[4] For more details on correspondence analysis, see Deutsch and Silber (2009).
[5] See, Deutsch and Silber (2009) for a detailed presentation of this technique.

ability, and science ability). Lovell et al.'s approach (see, Lovell et al. 1994, for more details on the procedure) amounts to estimating a translog output distance function expressed, for example, as

$$\ln(1/y_3) = a_0 + \sum_{j=1}^{4} a_j \ln x_j + (1/2)\sum_{j=1}^{4}\sum_{k=1}^{4} a_{jk} \ln x_j \ln x_k + \sum_{i=1}^{2} b_i \ln y_i + (1/2)\sum_{i=1}^{2}\sum_{h=1}^{2} b_{ih} \ln y_i \ln y_h + \sum_{i=1}^{2}\sum_{j=1}^{4} c_{ij} \ln y_i \ln x_j + \varepsilon \quad (1)$$

(see, Lovell et al., 1994, for more details on the procedure)

Note that the value of the four inputs, derived from correspondence analysis, were negative for some of the individuals. In order to be able to use a translog production function we transformed these inputs as follows

$$x'_{jk} = \frac{[x_j - Min\{x_{jk},...,x_{jK}\}]}{[Max\{x_{jk},...,x_{jK}\} - Min\{x_{jk},...,x_{jK}\}]} \quad (2)$$

where $x_{jk}$ is the value of input $j\,(j = 1$ to 4) for individual $k\,(k = 1$ to $K)$ and $x'_{jk}$ is the value of the "transformed input".

The technique of COLS (corrected least squares) was then used to obtain estimates of the various coefficients. The modified residuals which were then derived provided output distance functions for each individual by means of the transformation

$$d(k) = e^{[(\max imum \;\; negative \;\; residual) - (residual \;\; for \;\; individual \;\; k)]}$$

Such a distance is by definition smaller than one (since its logarithm will be negative or at most equal to zero) so that all individual input and output vectors lie on or beneath the frontier.

These output distance functions measure the efficiency with which individuals convert their inputs into "educational achievements." Since the maximum observed output distance function is unity by construction, the individual distance divided by the maximum output distance may be considered as a kind of relative productivity index (it is called the Malmquist Productivity Index in the literature; for more details, see, Deutsch et al., 2003).

However, we also estimated the individual efficiency of each student separately for each of the three types of test. In such a case, the relevant test score (in mathematics, reading, or science) was considered as an output produced by the four inputs previously mentioned and the estimation was done using the stochastic production function approach.

## C. The Third Stage of the Analysis: The Determinants of Individual Efficiency

### 1. Deciding which PISA variables should be considered as determinants of individual efficiency and aggregating these variables using CA

The following set of variables was considered as determining the level of individual efficiency. First, separately for each of the following categories, we aggregated, again via correspondence analysis, the variables listed in the Appendix 1 under the following categories:

- the human capital of the parents
- the material wealth of the parents
- the autonomy of the school funding
- the school management
- the transparency of information at school
- the homogeneity of the school

Second we also included the following dummy variables:

- the gender of the student
- did the student repeat a grade in primary school (ISCED1)
- was the student and his/her parents born in the country where the test took place
- is the school privately funded
- four dummy variables describing the location of the school

### 2. Analyzing the Determinants of Individual Efficiency

We then considered the individual efficiency score which had been previously derived via the stochastic production frontier approach, the dependent variable of an OLS regression whose explanatory variables were the aggregated and dummy variables which have just been mentioned.

### 3. Finding Out Which Determinants of the Test Scores Play a Key Role

In the final stage, we applied what is known as the Shapley decomposition procedure. This is a technique which allows one finding out which determinants contribute most to the variance of the individual test scores.[6] In a certain way the Shapley decomposition procedure can be considered as measuring the contribution of a given explanatory variable to the R-square of a regression when implementing a stepwise regression procedure where all possible orders of introduction of the explanatory variables are taken into account, including the cases where some of them are not introduced as explanatory variables.

[6] See Deutsch and Silber (2009) for more details on this procedure.

## III. RESULTS OF THE EMPIRICAL INVESTIGATION

Before analyzing the results of our empirical investigation we give some background on the educational system in the five countries whose data were analyzed.

### A. Educational System in the Five Countries Examined

#### Azerbaijan

According to Johnson (2004), "Azerbaijan is unique, especially in comparison to the Central Asian states, in several ways. First, it experienced rapid economic development, industrialization and the consequent emergence of a vigorous national movement much earlier, as a direct initial result of the oil boom of the 1890s. This created significant legacies in the development of a modern vernacular language based on a Latin script, and of a modernizing Islam, especially around the *Jadidist* or “new education” movement. Azerbaijan is also in an advantageous position because of its significant energy resources, and thus has at least the potential to fund comprehensive educational reform, although there has seemingly been little official willingness to make or even to think through the hard choices required, at least until recently."

The Constitution of Azerbaijan guarantees the right to free compulsory primary and secondary education for all citizens so that education is compulsory between the age of 6 and 15. Primary school takes 4 years (from age 6 to 10), basic school education takes 5 years (from age 10 to 15), and secondary school education takes two additional years (ages 16 and 17) and ends with the final achievement of the Certificate of Complete Secondary Education. Instead of a regular secondary school, students may also attend a technical secondary school lasts 3 years until the age of 18, in which case the students receive a Certificate of Complete Secondary Specialized Education.

According to the UNDP (2007), women make up 71% of the educators employed in the educational system but men form the overwhelming majority (83%) of secondary school principals. It should also be stressed that the conflict in and around Nagorno-Karabakh region had very serious consequences since more than a thousand educational institutions were destroyed. Given the common material difficulties parents have to face, they often seem to give the preference to the education of boys. The 2007 Human Development Report (HDR) thus indicates that in a survey conducted for this report, 0.9% of the respondents considered secondary education sufficient for boys while the corresponding percentage for girls was 8.4%. Respondents also considered secondary special education as well as vocational education more acceptable for girls than boys.

In 2004 a 3-year state program was launched, aiming at providing general secondary schools with access to information and communication technology (ICT). It turns out that at that time only 4.5% of the respondents had personal computers so that computers and internet centers at school were the only way for students to learn to use computers.

The World Bank also made great efforts to improve the quality and relevance of general education. It thus recommended changes in the curriculum of schools, the development of national standards, and the printing of new textbooks. It also encouraged the education of teachers and attempted to improve the financial efficiency and transparency of the schooling system.

Azerbaijan has in fact participated in the PISA survey since 2006. In the survey that was conducted in 2006 in 57 countries, the ranking of Azerbaijan was as follows: 54 in reading and learning, 4 in mathematics, and 32 as a whole.

Despite the fact that in mathematics Azerbaijan ranked among the best countries, in a conference co-organized by the Ministry of Education of Azerbaijan and UNESCO (see, Azerbaijan Ministry of Education and UNESCO, 2005) the following problems were listed as far as secondary education is concerned:
insufficient financial and technical resource basis

- 76% of schools located in non-standard buildings
- 500 school buildings in unsatisfactory condition
- unavailable heating system in 85% of schools
- 74% of the schools are working in 23 shifts with 32.5 % of the students attending second or third shifts
- overload of schools by three to four times in comparison with the projected capacity
- high density of students in classrooms (4050 students per classroom).
- low rate of computers per student (an average of 1,047 students per computer)
- only 4.4 % of schools have access to internet
- shortage of teaching staff for different subjects in rural areas
- no foreign language teaching in 10.3 % of the schools
- outdated system of assessment of students' learning achievement
- inadequate curriculum to meet modern requirements
- insufficient teachers' professional skills
- inefficient funding mechanisms

The results of the 2009 PISA survey in Azerbaijan need to be analyzed based on these observations, even though the latter were made more than 5 years before.

**Kazakhstan**

The Educational Law of the Republic of Kazakhstan (1999) is the legal framework for the introduction and implementation of innovations in education, such as creating a national system of providing education quality on the basis of a monitoring of the test results and making great efforts to connect the schools in Kazakhstan to the global telecommunications network and Internet.

If one however takes a look at the various stages of schooling, one will observe that since the beginning of the 1990s the condition of the pre-school system was in a serious state of deterioration. More than 80% of preschools closed down because the transfer to the market economy profoundly modified the system of financing such preschools. Thus in 2004, the enrollment of children of age 1–7 in preschools was only 19% on average, the corresponding percentage in rural areas being 2.4%.

The secondary school system underwent also very important changes. Starting in 1993–1994 out-migration and the reduction in fertility led to a drastic reduction in the number of daily secondary schools, specially in rural areas. The growing number of urban pupils resulted in the introduction of two-shift studies. There was also a growth in the number of private schools. Ethnic schools are also developing and they provide training in the national language. The proportions of boys and girls attending primary school are quite similar. The number of vocational and technical schools declined between 1994 and 2000 (by 31%). The low share of

teachers with higher education has certainly an impact on the quality of preparation provided in primary schools while in rural areas the key problem is the lack of staff. The share of females among teachers is very high since in 2004 women accounted for 80.6% of the total number of teachers (see, Human Development Report for Kazakhstan, 2004).

According to Johnson (2004) the situation in Kazakhstan has been quite similar to that in Azerbaijan. "The country has been plagued by neglect and inertia in educational policy, endemic corruption and declining instructional quality, and tensions over bilingual education and the use of Russian as a second (or first) language. While Kazakhstan should have solid economic prospects due to its vast energy resources, the country faces similar potential problems as Azerbaijan."

Similar observations have been made by Briller (2004) who emphasized the depth of the systemic problems faced by the educational system in Kazakhstan. Briller thus stressed the relative strength of private education in the country, whether in the form of private secondary schools or Turkish lyceums (both state-sponsored and private schools). In addition, according to Briller (2004), the secular educational system has tended to ignore or marginalize religious instruction, which has presumably contributed to the growth of mosque-based and private Islamic education, especially in the south of the country.

Note also that helped by the World Bank, Kazakhstan has been aiming at shifting the system away from the Soviet type of educational system and emphasizing more learning outcomes. Kazakhstan thus participated in 2006 in the OECD's Program for International Student Assessment (PISA).

**Kyrgyz Republic**

The population of the Kyrgyz Republic, though mainly ethnically Kyrgyz, includes also Russian, Uzbek, Tajik, and Turkish minorities. After the Kyrgyz Republic became independent, the share of the Russian population decreased drastically from 21.5% in 1989 to 12.4% 20 years later. Although fertility is lower than what it used to be, the population of the Kyrgyz Republic is still growing by about 1.1% per year (see, Kyrgyz Republic HDR, 2009). One of the main problems faced by the educational system in the Kyrgyz Republic is the very high proportion (65%) of the population living in rural areas. This clearly raises the educational costs since class and school sizes tend to be smaller. In addition, since rural areas are poorer, many families cannot rent textbooks or afford school supplies and for the same reason local government is unable to finance school inputs so that rural schools are less well-equipped than urban schools.

The system of schooling in the Kyrgyz Republic includes preschool for children of age 1–6, primary education (four first grades), lower secondary education (fifth to ninth grade), and upper secondary education (tenth and eleventh grade).

Because of the extremely difficult financial situation of the country during the period of transition, the government had to reduce compulsory education from 11 to 9 years and transferred most of the responsibility for financing education to local governments and to parents. It also encouraged the private provision of education. The result of these transformations is that the quality of education declined seriously, except in a few urban schools benefiting from parental or community contributions. In 2002 however the government decided to extend to 12 years the total duration of primary and secondary education. But consequences of the difficult transition years are still felt, whether one refers to the widespread lack of educational materials, the decline of teachers' salaries (and the arrears in the payment of these

salaries), the increasing inequality in the quality of education, the cessation of new school construction or the development of parental contributions as a source of school finance (see, Kyrgyz Republic 2009 HDR). In addition, this decline in the capacity and quality of the secular educational system is driving a move toward private Islamic and boarding schools, at least in the rural and southern regions (see, Johnson, 2004).

The Asian Development Bank (ADB) made several significant loans in the Kyrgyz Republic (most notably a loan of $31.3 million for 2000–2005) for educational policy development, administrative reform, and the reform of vocational and educational training. The ADB attempted also to help introduce textbook rental schemes and quality monitoring while the World Bank helped the Kyrgyz Republic so that it could participate in the 2006 PISA survey.

**Thailand**

Formal education in Thailand (excluding higher education) includes the following stages: pre-primary education, primary education (6 years), lower secondary education (3 years) and upper secondary education (3 years). Special education provided to children with physical impairment is provided either in special schools or in regular schools, the curriculum being adjusted to the special needs of the physically impaired children.

The 1999 National Education Act (NEA) and the 2002–2016 National Education Plan raised compulsory education to 6 and then to 9 years. The main focus of the Thai government during the 1980s was the expansion of primary education and indeed near universal primary education has been achieved, whatever the socioeconomic background, geographical location, or gender of the pupil. During this same period, however, secondary education enrollment remained deficient. It improved only in the 1990s. Whereas in 1997 only 17% of the labor force had received secondary education, it was the case of 40% in 2004 and the goal of the Thai government is to reach universal upper secondary education by 2015 (see, Thailand Human Development Report, 2009).

Access to secondary education has also improved from an equity point of view since participation rates in secondary education increased for all strata of the population, for boys as well as for girls and whatever the region in which the student lives or whether he/she is located in an urban or rural area. Differences by income remain however serious, as there are important gaps in secondary school enrollments between the poorest and richest population subgroups. In fact, the main reason why some children do not attend or stay in schools is the absence of financial support. This is why the Thai government developed schemes such as loan and lunch programs or scholarships.

The results of the 2006 PISA tests are nevertheless reasonable, given its per capita income level: 40% of the students performed at or below the PISA level one in literacy and 50% at or below the PISA level one in mathematics (see, Thailand Social Monitor Series, 2006).

**Indonesia**

The number of primary and junior secondary schools more than doubled in Indonesia during the 1970s and 1980s. In 2002 net enrollment in primary schools was up to 93% while the gross enrollment ratio was about 112% (see, Indonesia, HDR, 2004). This enrollment was spread quite evenly because there are no important differences between income groups, boys and girls, or urban and rural areas. But there were serious geographical differences.

As far as secondary education is concerned, enrollment in junior secondary level reached 62% in 2002, with no significant gap between girls and boys. Enrollment was, however, much higher in urban areas (72%) than in rural areas (54%). Similarly, while 72% of the children belonging to the highest income quintile enrolled, the corresponding percentage for the lowest quintile was only 50%.

In 2002, half of the children completed 9 years of education but 18% dropped before completing primary school, because of financial pressures (cost of uniforms and books as well as opportunity cost of the time of children). Quality was also an important concern since many school buildings were in bad state, textbooks were scarce, teachers often under-qualified (especially in primary schools). This was reflected in the results of the 2006 PISA survey since Indonesia 's rank in the test was 32 (out of 34 countries).

## B. Results of the Correspondence Analysis

Although we do not present detailed results, we list in Table 1 each category of variables, the variables that generally play a dominant role. It should be stressed that what this means is that, for each category of variables, any variable which is listed plays a discriminating role in so far as it has an important impact on the dispersion of the data. Table 1 thus indicates that the variables which play an important role in every country examined are the number of books available at home, the presence at home of a computer that can be used for school work, the number of computers per student available at the school, the presence at home of rooms with a shower or bath, whether achievement data are posted publicly by the school and whether, when admitting students at school, the fact that family members attend or attended the school in the past, plays a role.

**Table 1: Variables Playing a Major Role for Each Category of Variables**
(results based on correspondence analysis)

| Category of Variables | Variables |
|---|---|
| Educational means available at home | – Number of books<br>– Is there a computer you can use for school work |
| Pedagogical Characteristics of the School | It depends on the country |
| Physical capital available at school | – Number of computers per student |
| Learning time outside school | – Does the student borrow books to read for pleasure? |
| Human capital of the parents | – What is the language spoken at home? (important in Azerbaijan, Indonesia, and Thailand) |
| Material wealth of the parents | Are there rooms with a bath and/or a shower? |
| Autonomy of the school | Do parents' or students' groups exert a role in staffing decisions (important in Azerbaijan, Indonesia, and thethe Kyrgyz Republic)<br>Does the school governing board or the national education authority have responsibility for selecting teachers for hire? (important in Indonesia, the Kyrgyz Republic, and Thailand)<br>Does the regional or local authority have a considerable responsibility as far as students' admission is concerned? |
| School management | Does the director of the school take over lessons from teachers who are uneexpectedly absent? (important in Indonesia, the Kyrgyz Republic, and Thailand) |
| Transparency of information | Are achievement data posted publicly? |
| Homogeneity of the school | When students are admitted to school is the attendance of other family members at school in the past or present taken into account? |

## C. Results of the Efficiency Analysis

In Table 2 we give the results of the OLS regressions where the dependent variable is the efficiency value for each individual and the explanatory variables the determinants mentioned previously. This table refers to the case where a latent variable is assumed to represent the value of the output which is the consequence of the three test scores taken by the students.[7]

It appears that the following variables have, in most (four out five) of the countries analyzed, a significant impact on the efficiency with which the students transforms inputs into output (test scores):

– whether the student ever repeated a grade in primary school (ISCED1)whether the school is a private schoolthe location of the school (country side, town, city, or large city).

The degree of autonomy of the school, the school management, and the transparency of information at school had also a significant impact in four out of five countries, but the sign of the impact was not always the same so that, since these variables are aggregated variables, it is somehow difficult to draw clear-cut conclusions. What happens is that some variables which are positively correlated with the first factor in a given country may be negatively correlated with this factor in another country. This does not necessarily mean that the impact of this variable is different in the two countries.

It may simply mean that the factor is defined differently in the two countries: for example, in one country the factor would refer to the degree of autonomy of the school, in another to the degree of non-autonomy of the school.

[7] Results of the efficiency analysis implemented separately for each test score (in mathematics, reading, and science) may be obtained upon request from the authors.

## Table 2: The Determinants of Individual Efficiency in the Multiple Output Case

| | Azerbaijan | | Kazakhstan | | Kyrgyz Republic | | Thailand | | Indonesia | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Explanatory Variables** | **coefficients** | **t-values** | **coefficients** | **t-values** | **coefficients** | **t-values** | **coefficients** | **t-values** | **coefficients** | **t-values** |
| | | | | | | | | | | |
| constant | 0.6349 | 16.50 | 0.4342 | 20.93 | 0.6206 | 16.91 | 0.6071 | 12.65 | 0.5103 | 18.16 |
| Human capital of parents | 0.0073 | 0.39 | 0.0556 | 7.47 | 0.0127 | 0.70 | 0.0112 | 2.15 | 0.0103 | 0.97 |
| Material wealth of parents | 0.0256 | 2.71 | 0.0277 | 2.59 | –0.0136 | –0.72 | 0.0050 | 0.50 | –0.0303 | –2.87 |
| Autonomy of school | –0.0068 | –0.54 | –0.0446 | –4.85 | 0.0918 | 5.75 | –0.0502 | –5.18 | 0.0269 | 1.76 |
| School management | 0.0207 | 0.84 | 0.0208 | 2.95 | –0.0284 | –2.11 | 0.0316 | 3.93 | –0.0928 | –9.86 |
| Transparency of information in school | 0.0175 | 1.43 | 0.0163 | 2.13 | –0.0297 | –2.14 | –0.0185 | –1.65 | 0.0245 | 4.17 |
| Homogeneity of school | –0.0295 | –2.85 | –0.0398 | –4.03 | 0.0116 | 0.63 | 0.0001 | 0.01 | 0.0741 | 8.67 |
| Gender of the student | 0.0002 | 0.05 | 0.0001 | 0.03 | –0.0052 | –0.91 | 0.0290 | 9.40 | 0.0326 | 9.81 |
| Has the student ever repeated a grade in primary school (ISCED1)? | 0.0639 | 2.30 | 0.0678 | 4.45 | 0.0283 | 1.31 | 0.0448 | 4.51 | 0.0397 | 8.32 |
| Were you born in the country where the test took place? | 0.0126 | 0.66 | 0.0409 | 5.51 | –0.0413 | –1.70 | –0.0241 | –0.54 | 0.0470 | 1.81 |
| Is the school a private school? | 0.0834 | 4.11 | 0.0123 | 1.13 | 0.0391 | 2.56 | –0.0198 | –4.00 | –0.0263 | –2.93 |
| Location of school: small town | –0.0354 | –4.97 | –0.0120 | –2.55 | 0.0308 | 3.58 | 0.0024 | 0.45 | 0.0009 | 0.19 |
| Location of school: town | –0.0145 | –1.67 | 0.0256 | 4.63 | –0.0057 | –0.66 | 0.0169 | 3.29 | 0.0225 | 4.00 |
| Location of school: city | –0.0466 | –5.35 | 0.0371 | 8.57 | 0.0573 | 5.54 | 0.0491 | 8.66 | 0.0494 | 8.23 |
| Location of school: large city | –0.0319 | –4.78 | 0.0481 | 5.47 | 0.1043 | 7.89 | 0.0707 | 11.05 | 0.0548 | 7.74 |
| | | | | | | | | | | |
| $R^2$ | 0.0702 | | 0.1049 | | 0.1491 | | 0.1267 | | 0.2232 | |
| $\bar{R}^2$ | 0.0595 | | 0.1007 | | 0.1378 | | 0.1232 | | 0.2183 | |
| F-value | 6.5377 | | 25.0302 | | 13.2393 | | 37.0231 | | 45.6209 | |
| Number of observations | 1,227 | | 3,006 | | 1,073 | | 3,589 | | 2,238 | |

## IV. WHICH DETERMINANTS OF THE TEST SCORES PLAY A KEY ROLE? RESULTS OF THE SHAPLEY DECOMPOSITION

The results of this Shapley decomposition are given in Table 3. This table indicates clearly that the impact of the different variables on the R-square of the regressions whose results were presented in Table 2, depends often on the country examined. Nevertheless some features seem to be shared by most of the countries.

First in all the countries the location of the school (whether it is in the country side, a town, a city or a large city) has the highest contribution to the R-square of the efficiency regression. In fact in Azerbaijan, the Kyrgyz Republic, and Thailand, the contribution of this variable is higher than 50%. It is even close to 60% in the Kyrgyz Republic and almost 50% in Kazakhstan. Only in Indonesia is the contribution of this variable significantly smaller (23%).

The second most important contribution varies from one country to the other. In Azerbaijan whether the school is private and the homogeneity of the school contribute 14.5% and 13.4%, respectively to the R-square while in Kazakhstan the human capital of the parents is the second most important contribution (14.4%). In the Kyrgyz Republic the second most important variable is the autonomy of the school (15.3%) while in Thailand and Indonesia it is the gender of the student (a contribution of 17.8% in Thailand and 18.7% in Indonesia). In Indonesia, school management plays also an important role (18.1%).

The Shapley contributions for the math and science tests are quite similar to those given for the overall PISA score as can be observed in the two tables of Appendix 2. For the test in reading, the contributions are however quite different, as indicated in Table 4. It appears that in three countries (Azerbaijan, Indonesia and Kazakhstan) the variable contributing most to the R-square of the efficiency in reading regression is the gender of the student.[8] The second most important variable is the location of the school, which contributes in fact the most to the R-square in the Kyrgyz Republic and Thailand. Other quite important contributions are the degree of homogeneity of the school in Azerbaijan, the autonomy of the school in the Kyrgyz Republic, and school management in Indonesia.

The policy implications of the differences between the determinants of the student's efficiency in math and science tests and his/her efficiency in reading tests is quite clear: in the former case, differences between the quality of the schools in urban and rural areas as well as between sizes of cities should be taken care of, while in the latter case the most urgent priority is to decrease the gender gap.

[8] The results of this regression may be obtained upon request from the author.

## Table 3: Results of the Shapley Decomposition in the Multiple Output Case[9]

| Factor | Azerbaijan | Kazakhstan | Kyrgyz Republic | Thailand | Indonesia |
|---|---|---|---|---|---|
| | | | | | |
| Human capital of parents | 0.1 | 14.4 | 0.6 | 6.0 | 1.5 |
| Material wealth of parents | 7.6 | 8.2 | 2.5 | 1.7 | 1.5 |
| Autonomy of school | 0.6 | 6.6 | 15.3 | 7.0 | 2.2 |
| School management | 2.8 | 3.4 | 6.1 | 3.0 | 18.1 |
| Transparency of information in school | 4.6 | 1.5 | 2.3 | 2.4 | 4.3 |
| Homogeneity of school | 13.4 | 5.5 | 1.6 | 0.5 | 11.9 |
| Gender of the student | 0.1 | 0.1 | 0.5 | 17.8 | 18.7 |
| Has the student ever repeated a grade in primary school (ISCED1)? | 4.6 | 5.6 | 1.2 | 5.3 | 15.6 |
| Were you born in the country where the test took place? | 0.6 | 5.0 | 2.4 | 0.1 | 0.7 |
| Is the school a private school? | 14.5 | 1.6 | 8.1 | 3.4 | 2.5 |
| Location of school | 51.3 | 48.3 | 59.5 | 52.9 | 23.1 |
| $R^2$ | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

## Table 4: Results of the Shapley Decomposition for the Reading Test[10]

| Factor | Azerbaijan | Kazakhstan | Kyrgyz Republic | Thailand | Indonesia |
|---|---|---|---|---|---|
| | | | | | |
| Human capital of parents | 0.0 | 1.9 | 0.6 | 5.4 | 1.5 |
| Material wealth of parents | 3.9 | 7.7 | 2.0 | 1.9 | 1.8 |
| Autonomy of school | 0.5 | 2.5 | 10.2 | 6.3 | 2.0 |
| School management | 5.7 | 0.7 | 0.5 | 3.0 | 15.6 |
| Transparency of information in school | 6.3 | 3.3 | 1.1 | 2.2 | 3.2 |
| Homogeneity of school | 12.1 | 4.8 | 1.7 | 0.3 | 8.4 |
| Gender of the student | 41.6 | 43.7 | 36.5 | 29.7 | 29.2 |
| Has the student ever repeated a grade in primary school (ISCED1)? | 3.3 | 3.3 | 1.5 | 5.8 | 17.2 |
| Were you born in the country where the test took place? | 0.1 | 1.2 | 0.8 | 0.0 | 0.8 |
| Is the school a private school? | 7.2 | 1.0 | 3.4 | 1.6 | 1.5 |
| Location of school | 19.3 | 30.1 | 41.7 | 43.6 | 18.8 |
| $R^2$ | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

[9] The data of the table give the percentage contribution of each factor to the R-square. The data refer to the multiple output case where a latent variable is estimated on the basis of the results on the tests in mathematics, reading and science.

[10] The data of the table give the percentage contribution of each factor to the R-square.

## V. CONCLUDING COMMENTS

Several important conclusions may be derived from the previous analysis as far as the math and science tests are concerned. First, the location of the school (classified by size of the area of residence) turns out to be the main determinant of efficiency, except for Indonesia. Second, the impact of the other factors varies from one country to the other. Thus, the homogeneity of the school is an important factor for Azerbaijan and Indonesia. The material wealth of the parents plays a role in Azerbaijan and Kazakhstan whereas the fact that the school is a private school does not play a role in Azerbaijan and the Kyrgyz Republic. The human capital of the parents (which refers mainly to the language spoken at home and the place of birth of the parents) contributes significantly to the R-square of the efficiency regressions in Kazakhstan and Thailand, whereas the degree of autonomy of the school is an important determinant in Kazakhstan, the Kyrgyz Republic, and Thailand. The fact that the student repeated a grade during his/her primary education (what is called ISCED1) plays a role in Azerbaijan, Kazakhstan, and Thailand and even more in Indonesia. Finally, the transparency of information plays some role in Azerbaijan. All these conclusions have evidently important policy implications, in particular as far as the central role played by the location of the school is concerned. The latter findings should clearly induce the educational authorities in each country to allocate more resources to rural areas and smaller cities.

On the other hand in order to improve the students' efficiency in reading, the highest priority should be given to policies aiming at reducing the gender gap. The second most important implication, as far as reading is concerned, is to decrease differences in the quality of the school between urban and rural areas and between sizes of the cities.

## Appendix 1: Detailed Classification of the Educational Inputs that Have been Defined on the Basis of the Questions Formulated in the 2009 PISA survey

**Notations:** School questionnaire: B ; Student questionnaire: S

### List of the educational inputs and of their components

**1. Educational Means Available at Home**

| Symbol of variable | The variable | Value taken by the variable |
|---|---|---|
| S4 | a desk to study at | 1=yes |
| S5 | a room of your own | 1=yes |
| S6 | a quiet place to study | 1=yes |
| S7 | a computer you can use for school work | 1=yes |
| S8 | classic literature | 1=yes |
| S9 | books of poetry | 1=yes |
| S10 | works of art | 1=yes |
| S11 | books to help with school work | 1=yes |
| S12 | a dictionary | 1=yes |
| S13 | a DVD player | 1=yes |
| S14.1 | number of books in home: 0–25 | 1=yes |
| S14.2 | number of books in home: 26–100 | 1=yes |
| S14.2 | number of books in home: $\geq$ 100 | 1=yes |

**2. Pedagogical Characteristics of School**

Grades existing in school (from first to thirteenth grade)

| | | |
|---|---|---|
| B3 | Grade 1 | 1=yes |
| ⋮ | ⋮ | 1=yes |
| B13 | Grade 11 | 1=yes |

Total school enrollment (number of students) of school

| | | |
|---|---|---|
| B14 | Number of students | 1 = if number of students >1000 |

Which of the following activities does the school offer to students?

| | | |
|---|---|---|
| B16 | volunteering or service activities | 1=yes |
| B17 | school club or school competition for foreign language, math or science | 1=yes |
| B18 | sporting team or sporting activities | 1=yes |
| B19 | collaboration with local libraries | 1=yes |

Generally in your school how often are students assessed using the following methods

| | | |
|---|---|---|
| B20 | standardised tests | 1=yes |
| B21 | teacher-developed tests | 1=yes |
| B22 | student assignments/projects/homework | 1=yes |

In your school are assessments of students used for any of the following purposes?

| | | |
|---|---|---|
| B23 | to inform parents about their child's progerss | 1=yes |
| B24 | to make decisions about students' retention or promotion | 1=yes |
| B25 | to group students for instructional purposes | 1=yes |
| B26 | to compare the school to district/national performance | 1=yes |
| B27 | to monitor the school's progress from year to year | 1=yes |
| B28 | to make judgments about teachers' effectiveness | 1=yes |
| B29 | to identify aspects of instruction or the curriculum that could be improved | 1=yes |
| B30 | to compare the school with other schools | 1=yes |

In your school, to what extent is the learning of students hindered by the following phenomena?

| | | |
|---|---|---|
| B31 | student absenteeism | 1=none or little |
| B32 | poor student-teacher relations | 1=none or little |
| B33 | disruption of classes by students | 1=none or little |
| B34 | teachers not meeting individual students' needs | 1=none or little |
| B35 | teacher absenteeism | 1=none or little |
| B36 | students skipping classes | 1=none or little |
| B37 | students lacking respect for teachers | 1=none or little |
| B38 | staff resisting change | 1=none or little |
| B39 | teachers being too strict with students | 1=none or little |
| B40 | students intimidating or bullying other students | 1=none or little |

Language of the students

| | | |
|---|---|---|
| B41 | Which percentage of the students in your school have as first language a language which is not the language of the test | 1 if percentage $\leq$ 20% |

**3. Physical Capital Available at School:**

| | | |
|---|---|---|
| B42 | About how many computers are available in the school for educational purposes | 1 if the number of computers per student is greater than the mean |

Is your school's capacity to provide instruction hindered by

| | | |
|---|---|---|
| B43 | a shortage or inadequacy of science laboratory equipment | 1=none or little |
| B44 | a shortage or inadequacy of instructional materials | 1=none or little |
| B45 | a shortage or inadequacy of computers for instruction | 1=none or little |
| B46 | a lack or inadequacy of Internet connectivity | 1=none or little |
| B47 | a shortage or inadequacy of computer software for instruction | 1=none or little |
| B48 | a shortage or inadequacy of audio-visual resources | 1=none or little |

**4. Time Inputs of the Student: Learning Time Outside School**

What type of out-of-school-time lessons do you attend

| | | |
|---|---|---|
| S24 | enrichment lessons in language | 1=yes |
| S25 | enrichment lessons in mathematics | 1=yes |
| S26 | enrichment lessons in science | 1=yes |

How often do you visit a library for the following activities?

| | | |
|---|---|---|
| B48 | Borrow books to read for pleasure | 1=at least once a month |

**5. General Characteristics of the Student**

| | | |
|---|---|---|
| S28 | Gender of the student | 1=female |
| S29 | Age of the student | Numeric |
| S31 | In what grade is the student? | Numeric |
| S32 | Did the student attend pre-primary education (ISCED0 in the International Standard Classification of Education**)** | 1=at least one year |
| S33 | How old was the student when he started primary education (ISCED1 in the International Standard Classification of Education**)** | Numeric |
| S34 | Has the student ever repeated a grade in primary school (ISCED1) | 1=no |
| S35 | In what country were you and your parents born? | 1=country of test |

**6. Human Capital of the Parents**

| | | |
|---|---|---|
| S36 | Language spoken at home most of the time | 1=country of test |
| S37 | In what country was your mother born? | 1=country of test |
| S38 | In what country was your father born? | 1=country of test |

**7. Material Wealth of Parents**

How many of the following items are at home ?

| | | |
|---|---|---|
| S36 | cellular phones | 1=at least one |
| S37 | televisions | 1=at least one |
| S38 | rooms with a bath or shower | 1=at least one |

**8. Information on School Governance: School Funding**

| | | |
|---|---|---|
| B49 | Is the school a private or a public school? | 1=private |

**9. Information on School Governance: Autonomy of School**

Regarding your school, which of the following bodies exert a direct influence on decision making about (1=tick):

| | **Staffing** | **Budgeting** | **Instructional Content** | **Assessment Practices** |
|---|---|---|---|---|
| regional or national educational authorities (inspectorates) | B50 | B51 | B52 | B53 |
| the school's governing board | B54 | B55 | B56 | B57 |
| Parent groups | B58 | B59 | B60 | B61 |
| Teacher groups | B62 | B63 | B64 | B65 |
| Student groups | B66 | B67 | B68 | B69 |
| External examination board | B70 | B71 | B72 | B73 |

Regarding your school which of the following categories has a considerable responsibility for (1=tick):

| | Principal | Teachers | School Governing Board | Regional or Local Education Authority | National Education Authority |
|---|---|---|---|---|---|
| selecting teachers for hire | B74 | B75 | B76 | B77 | B78 |
| firing teachers | B79 | B80 | B81 | B82 | B83 |
| establishing teachers' starting salaries | B84 | B85 | B86 | B87 | B88 |
| determining teachers' salary increases | B89 | B90 | B91 | B92 | B93 |
| formulating the school's budget | B94 | B95 | B96 | B97 | B98 |
| deciding on budget allocations within the school | B99 | B100 | B101 | B102 | B103 |
| establishing student disciplinary policies | B104 | B105 | B106 | B107 | B108 |
| establishing student assessment policies | B109 | B110 | B111 | B112 | B113 |
| approving students for admission to the school | B114 | B115 | B116 | B117 | B118 |
| choosing which textbooks are used | B119 | B120 | B121 | B122 | B123 |
| determining course content | B124 | B125 | B126 | B127 | B128 |
| deciding which courses are offered | B129 | B130 | B131 | B132 | B133 |

**10. Information on School Governance: School Management**

Below are statements about your management of this school. Indicate the frequency of the following activities and behaviors in your school during the last school year.

| | | |
|---|---|---|
| B134 | I make sure the professional development activities of the teachers are in accordance with the teaching goals of the school | 1=often or very often |
| B135 | I ensure that teachers work according to the school's educational goals | 1=often or very often |
| B136 | I observe instruction in classrooms | 1=often or very often |
| B137 | I use student performance results to develop the school's educational goals | 1=often or very often |
| B138 | I give teachers suggestions as to how they can improve their teaching | 1=often or very often |
| B139 | I monitor students' work | 1=often or very often |
| B140 | When a teacher has problems in his/her classroom, I take the intitiative to discuss matters | 1=often or very often |
| B141 | I inform teachers about possibilities for updating their knowledge and skills | 1=often or very often |
| B142 | I check to see whether classroom activities are in keeping with our educational goals | 1=often or very often |
| B143 | I take exam results into account in decisions regarding curriculum development | 1=often or very often |
| B144 | I ensure that there is clarity concerning the responsibility for coordinating the curriculum | 1=often or very often |
| B145 | When a teacher brings up a classroom problem, we solve the problem together | 1=often or very often |
| B146 | I pay attention to disruptive behavior in classrooms | 1=often or very often |
| B147 | I take over lessons from teachers who are unexpectedly absent | 1=often or very often |

During the past year, have any of the following methods been used to monitor the practice of language teachers at your school?

| | | |
|---|---|---|
| B148 | Tests or assessments of student achievement | 1=yes |
| B149 | Teacher peer review (of lesson plans, assessment instruments, lessons) | 1=yes |
| B150 | Principal or senior staff observations of lessons | 1=yes |
| B151 | Observation of classes by inspectors or other persons external top school | 1=yes |
| B152 | Does your school provide information to parents of students on their child academic performance relative to other students of similar grade in your school? | 1=yes |
| B153 | Does your school provide information to parents of students on their child academic performance relative to other students of similar grade at the national or regional level? | 1=yes |

**11. Information on school governance: Transparency of information**

Are achievement data in your school

| | | |
|---|---|---|
| B154 | posted publicly (e.g. in the media) | 1=yes |
| B155 | used in evaluating the principal's performance | 1=yes |
| B156 | used in evaluating the teachers' performance | 1=yes |
| B157 | used in decisions about instructional resource allocation to the school | 1=yes |
| B158 | tracked over time by an administrative authority | 1=yes |

**12. Information on school governance: Homogeneity of school:**

How much consideration is given to the following factors when students are admitted to school (the possible answers are: prerequisite, high priority, considered, not considered)

| | | |
|---|---|---|
| B159 | residence in a particular area | 1=sometimes or always |
| B160 | student's academic record | 1=sometimes or always |
| B161 | parents' endorsement of instructional or religious philosophy of school | 1=sometimes, always |
| B162 | student's need or desire for a special program | 1=sometimes, always |
| B163 | attendence of other family members at the school (in the past or present) | 1=sometimes or always |

**13. Information on school governance: Location of school**

Community size:

| | | |
|---|---|---|
| B164 | Which of the following best describes the community in which your school is located | 1=village/hamlet/rural area (less than 3,000)<br>2=small town (from 3,000 to 15,000 people)<br>3=town (15,000 to 100,000 people)<br>4=city (100,000 to 1000,000 people)<br>5=large city (more than a million) |

## Appendix 2: Results of the Shapley Decomposition for the Math and Science Tests

### Table A-2.1: Results of the Shapley Decomposition for the Math Test[11]

| Factor | Azerbaijan | Kazakhstan | Kyrgyz Republic | Thailand | Indonesia |
|---|---|---|---|---|---|
| | | | | | |
| Human capital of parents | 0.9 | 14.4 | 0.7 | 2.8 | 2.8 |
| Material wealth of parents | 5.7 | 12.4 | 3.4 | 4.5 | 1.0 |
| Autonomy of school | 1.1 | 4.9 | 16.6 | 9.5 | 3.1 |
| School management | 1.4 | 3.5 | 4.0 | 0.6 | 22.9 |
| Transparency of information in school | 1.2 | 1.9 | 5.0 | 1.2 | 3.2 |
| Homogeneity of school | 8.0 | 6.0 | 1.3 | 0.7 | 10.9 |
| Gender of the student | 5.6 | 0.1 | 0.1 | 5.6 | 0.2 |
| Has the student ever repeated a grade in primary school (ISCED1)? | 6.8 | 3.7 | 2.5 | 3.8 | 17.3 |
| Were you born in the country where the test took place? | 2.7 | 3.2 | 0.5 | 0.5 | 0.4 |
| Is the school a private school? | 14.3 | 1.6 | 6.6 | 6.7 | 3.7 |
| Location of school | 52.2 | 48.3 | 59.4 | 64.1 | 34.5 |
| $R^2$ | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

### Table A-2.2: Results of the Shapley Decomposition for the Science Test[12]

| Factor | Azerbaijan | Kazakhstan | Kyrgyz Republic | Thailand | Indonesia |
|---|---|---|---|---|---|
| | | | | | |
| Human capital of parents | 2.2 | 7.5 | 0.4 | 5.0 | 1.0 |
| Material wealth of parents | 3.6 | 5.9 | 2.8 | 2.9 | 1.1 |
| Autonomy of school | 5.0 | 7.8 | 18.2 | 12.6 | 2.8 |
| School management | 7.0 | 2.3 | 1.0 | 1.7 | 23.9 |
| Transparency of information in school | 7.5 | 2.1 | 1.6 | 2.4 | 4.1 |
| Homogeneity of school | 11.7 | 4.5 | 4.7 | 1.0 | 16.4 |
| Gender of the student | 0.1 | 2.0 | 6.3 | 1.4 | 1.7 |
| Has the student ever repeated a grade in primary school (ISCED1)? | 0.1 | 11.7 | 1.7 | 5.7 | 18.7 |
| Were you born in the country where the test took place? | 1.1 | 7.0 | 2.6 | 0.2 | 0.6 |
| Is the school a private school? | 11.0 | 1.1 | 6.4 | 6.2 | 4.3 |
| Location of school | 50.8 | 48.2 | 54.4 | 60.9 | 25.4 |
| $R^2$ | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

[11] The data of the table give the percentage contribution of each factor to the R-square.
[12] The data of the table give the percentage contribution of each factor to the R-square.

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**On the Determinants of Scholastic Performance in Five Asian Countries**

This paper takes an efficiency analysis perspective to analyze the determinants of scholastic performance in Azerbaijan, Indonesia, Kazakhstan, the Kyrgyz Republic, and Thailand. Information on the production of education is first aggregated through correspondence analysis. A stochastic production frontier approach is then adopted and efficiency is estimated at the student level. Finally, factors affecting efficiency are analyzed via a regression and, using the Shapley decomposition, the exact impact on efficiency of the various explanatory variables is determined. Among other findings, it finds that location is a key factor influencing learning efficiency, pointing to the need to reduce differences between rural and urban schools.

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