PERUVIAN ECONOMIC ASSOCIATION

Measuring Technical Efficiency in Primary Education: Evidences for Peruvian Case

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Abstract

This research article applies an analysis of efficiency in the process of educational outcomes (or "educational efficiency") on Peruvian elementary schools. It evaluates whether there are significant differences in efficiency analysis if educational outcome is considered unidimensional (only considered the educational achievement) or multidimensional (also includes access and retention in the education system). Furthermore, this document investigates the causes of these differences, and their relationship with characteristics of the demand for educational services. For that purpose, parametric and nonparametric methods are used to identify educational efficiency levels, and the Tobit methodology to estimate the effects of non-discretionary factors.

The research points toward the conclusion that Peruvian elementary schools have heterogeneous levels of efficiency. Main aspects that explain this heterogeneity are school experience in generating educational outcomes, the prevalence of students with preschool education, and socioeconomic status of their households.

Keywords: Analysis of Education, Education and Inequality, Parametric and Nonparametric Methods, Government Policy.
JEL Codes: I21, I24, C14, I28.

Resumen

La presente investigación analiza la eficiencia del proceso de generación de resultados educativos («eficiencia educativa») de las escuelas peruanas de nivel primario. Específicamente, este documento se enfoca en evaluar si existen diferencias importantes en un análisis de eficiencia, si es que se considera que el resultado educativo es unidimensional (contemplando solo logros educativos) o multidimensional (incluyendo además, el acceso y la permanencia en el sistema educativo). Asimismo, se indaga sobre las causas de dichas diferencias, y su relación con aspectos ligados a características de la demanda por servicios educativos. Para ello, métodos paramétricos y no paramétricos so aplicados para la identificación del nivel de eficiencia educativa como consecuencia del uso de insumos discrecionales; y se estiman los efectos de factores no discrecionales, mediante la metodología Tobit.

La investigación concluye que las escuelas de educación primaria presentan niveles de eficiencia heterogéneos. En tanto que, los principales aspectos que explican dicha heterogeneidad en la eficiencia educativa son: la experiencia de la escuela en la generación de resultados educativos, la prevalencia de estudiantes con educación preescolar y el nivel socioeconómico de sus hogares.

Palabras clave: Educación, Desigualdad, Métodos paramétricos y no paramétricos, Políticas públicas.
Clasificación JEL: I21, I24, C14, I28.

Measuring Technical Efficiency in Primary Education: Evidence for Peruvian Case♣

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Education is a fundamental aspect for the social and economic development of countries. Educational services are the key element that contributes in obtaining capabilities, develop workforce skills, closing social gaps, among other benefits. For that reason, the role of the government is essential for the provision of educational services (in basic and higher level), and for ensuring its equity and efficiency.

Nowadays, the performance and current structure of the Peruvian educational system is explained by the importance of domestic investment in education, the growing demand for workers with better qualifications, the greater economic dynamism in the country, and the recent design and implementation of sectoral policies. These policies have prioritized the satisfaction of basic requirements of accessibility, retention, and educational progress of students in the system. This occurs with greater emphasis on basic education (EBR, for its acronym in Spanish) of elementary education, which concentrates more than 7.5 million students.

Peru has reached remarkable results in *accessibility* to elementary education between the years 2004 and 2014. According to the Ministry of Education (MINEDU, for its acronym in Spanish), the gross enrolment rates in elementary education have been maintained around of 98.5% (98.8% in urban and 97.8% in rural areas). In addition, gross attendance rates averaged 97.7% (98.2% in urban and 96.7% in rural areas). About the *retention* of students in the system, it has been reported that 20.1% of elementary school students enrolled in a lower grade than the one corresponding to their age (for reasons of repetition or school backwardness) in 2012. Whereas in 2014, this indicator increased to 25.3% at the national level. This is explained by the fact that in urban area the rate increased by 6.1% (to 21.8%), while in rural areas the increase was only by 3.5% (to 33.4%).

In terms of *educational progress*, indicators show that they have improved at national level. However, high disparity was registered. The average percentage of students in the second grade with successfully achieved learning was 43.4% in reading comprehension and 25.9% in math. Nevertheless, in urban areas, the percentages related to reading comprehension and mathematics were 49.7% and 28.9%, respectively; while, in rural areas, they were 16.7% and 13.1%%, respectively. These results are less encouraging if analyzed in a disaggregated.

Overall, the evidence shows opposite results: positive results in access, but negative results in permanence, and ambiguous results in educational progress. In this regard, it is essential to explore what factors explain efficiency levels in schools. Therefore, the main aim of this research is to characterize and explain efficiency in the process of generating educational outcomes –or *educational efficiency*– in elementary schools during the period between 2010 – 2014 period, in the Peruvian educational system.

In this working paper evaluates the hypothesis that there are significant differences in efficiency levels,

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related to the approach applied: one-dimensional or multidimensional. It could consider that the elementary school´s educational outcome is *one-dimensional*, measured as educational achievement, or a *multidimensional* result (access, retention and educational achievement). Moreover, this research article investigates what are the causes of these differences and if these are related to the type of school management (public or private), the school's institutional organization (full-grade or multi-grade schools), or the characteristics of the demand for educational services.

This document is organized as follow. In the first section, there are presented the key concepts and literature linked to the theory of production in education. In section two the main characteristics and regulatory elements of the Peruvian educational context are described. The third section presents the methodological guidelines for the empirical analysis. Finally, the last part discusses the results, limitations and conclusions. It also outlines some considerations and recommendations for the design of sectorial policies.

1) Education and technical efficiency

Education has been considered a key factor in human development. Since seminal studies of late 1950s to the present, a wide range of authors has applied different approaches to analyse this economic phenomenon. The literature derived from the pioneering studies of Mincer (1958) and Becker (1964) emphasized that the education analysis must be seem from an aggregate approach. In those cases, they consider that the role of education involves the promotion of labour productivity and the generation of economic growth (Checci, 2006).

In this section, main contributions of the literature associated to the production function approach, the conceptualization of «educational outcome» and its inputs are reviewed. In addition, the concept of technical efficiency is explained.

a) «Production» of educational services

The theory dedicated to understanding the productive processes finds its basis in the paper of Cobb & Douglas (1928)[2]. Since this study the literature has made further progress in two lines of research: i) on the deepening of mathematical formalization[3] and associated concepts useful for modelling the complexities of economic sectors; and ii) on the implementation of theoretical advances in different sectors, such as educational sector.

In the literature, there has been a debate about the proper ways to apply economic concepts in the educational provision. Usually, the concept of production function analyses the interaction between the different inputs and outcomes in a given productive process. However, this application is valid due to the fulfilment of certain assumptions, which are not fulfilled accurately in the provision of educational services[4]. Still, authors like Glewwe & Muralidharan (2015), Todd & Wolpin (2003) and Hanushek (1986) state that these concepts are applicable in education because they enable greater comprehension of the system and the design of effective policies.

[2] The authors made the first mathematical formalization of the theory of production, by analysing interactions of inputs and final goods generated by the US manufacturing sector. See Cobb & Douglas (1928)

[3] At this point, the contributions of Bailey & Friedlaender (1982), Caves et al (1980), and Christensen et al (1973; 1971) are fundamental to the development of Transcendental Logarithmic function or "*Translog*" function.

[4] For example, the modelling of a production function assumes substitutability between production inputs, measurability and variability of their endowments, and determinisms between inputs and outputs. However, the product of the generation of educational outcomes and some inputs they are not directly measurable, some inputs are not interchangeable, and not are always possible changes in the magnitudes of the allocations.

One of the first studies to analyse the educational system under this approach was «*Equality of Educational Opportunity*», known as the *Coleman Report* (1966). In this report, the author used information from more than half million American students enrolled in more than three thousand elementary and secondary schools, in order to emphasize the efficiency aspects between inputs and outcomes in the education field.

Furthermore, Polachek et al (1978) made one of the first applications of the concept of a production function for the educational outcomes. Not only did they applied a generalized form of Cobb & Douglas proposal[5], but also the authors considered that the main goal was to improve the cognitive abilities of the students. Likewise, they proposed a set of attributes associated with the academic achievement of students, from various sources such as student characteristics, their environment, and the time spent on academic activities. Hanushek (1979) also synthesizes that provision of educational services can be defined as a process that transforms original qualities of a defined set of individuals or students, with a set of inputs. The author remarks that education provision is a school responsibility (i. e. its administrative role and pedagogical management); therefore, these institutions could be considered as decision units that optimize the educational outcomes[6].

In this regard, two questions arise: what should be understood as educational outcome? Moreover, what inputs affect the process of generating these educational outcomes? Authors such as Hanushek (1986) and Boissiere (2004), more recently, explain that there is no consensus in the definition of the educational outcome. While most studies find that educational outcome is linked to the student's cognitive abilities (named as *learning achievement*); it is also possible to consider other aspects of the educational process such as access and retention in the educational system. For instance, De Witte et al (2012) and Worthington (2001) explain that the concept depends on the observability of each stage in the educational process, and its relevance in each society. If the society has accomplished universal education, it is not relevant to include access to education as an aspect of the results. Similarly, if the educational impact (or learning achievements) do not consider all the students of the schools, it would generate an estimation bias of the educational outcomes.

Another key thing to remember is that the literature detail various forms to understand the educational outcome and its determinants. Glewwe & Muralidharan (2015), Boissiere (2004) and Worthington (2001) go on to review previous studies, where they highlight the production function models in education. Therefore, in the next subsection, the recurrently factors considered as determinants in the recent literature will be explained.

b) Educational inputs

i) Schools

As mentioned by Hanushek (1979), schools are responsible for the provision of educational services. Its functionality is subject to the availability of a set of elements and characteristics. Based on the Harbison & Hanushek (1992) proposal, this research article uses a simplified classification on three types of inputs: non-pedagogical support, pedagogical support and teaching staff[7].

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[5] Polachek et al (1978) applied a functional form Cobb - Douglas generalized log-linear:

$$y_i = \gamma \left[\sum_{i=1}^{n} \delta_i x_i^{-\rho} \right]^{-\mu/\rho} + \varepsilon_i$$

Where: y_i is the academic achievement and x_i, the input vector. In addition, they included an elasticity of substitution of inputs (ρ).

[6] Authors like Klitgaard and Hall (1975) and Solmon (1970) had made analysis of factors associated with education, prior to the contributions of Hanushek; but they not considered a defined functional structure.

[7] Authors call these categories as «hardware», «software» and «teacher characteristics», respectively. However, this study extends these definitions to make an adaptation for Peruvian educational system.

First, the non-pedagogical support represents those aspects that allow provision of educational services and the production of educational outcomes. These factors constitute a necessary (but not sufficient) condition for the performance of pedagogical practice. This category includes school characteristics as school infrastructure quality or quality of building school materials, physical spaces sufficiency, availability and quality of school equipment (for example: furniture, equipment for specific educational activities, among others), and access to basic services.

According to compilations of studies presented by Glewwe & Muralidharan (2015) and Boissiere (2004), the relative importance of non-pedagogical support aspects is related to the degree of standardization of them. For example, these authors found that non-pedagogical aspects lose relevance in developed economies, where the quality of infrastructure and availability of educational equipment is uniformly distributed in educational systems. By contrast, other studies applied to developing economies show that non-pedagogical support factors (i.e. quality of materials, access to basic services and adequacy of classrooms) gain importance in these contexts. Among these studies highlights Afonso & St. Aubyn (2005) for case of several developing, and developed countries. Similarly, Alvarez-Parra (2012) compares the cases of Chile and Peru; and Beltran & Seinfeld (2011), Tam (2008) and Miranda (2008) for Peruvian case.

The second category refers to pedagogical support. This type includes those aspects directly associated to the process of generating educational outcomes. Organizational aspects such as management of the school day (duration of classes) or academic calendar (days of school days dedicated to year), curriculum design, educational materials and others are considered in this category[8].

Finally, the third category refers to teaching staff. Hanushek & Rivkin (2006), Hanushek (2006) and Hanushek et al (1996) outlined the importance of teachers in the production function, and they specify some relevant characteristics. In this category, they include aspects such as the adequacy of teachers with respect to the number of enrolled students, teaching academic training, professional experience and pedagogical skills[9].

ii) Household and student´s characteristics

Many studies support the idea that education is a process that occurs at home and is associated with initial development of cognitive skills. For instance, the household characteristics, the student´s abilities and the parent´s perception about the importance of education are aspects that should be considered. About this, Glewwe & Muralidharan (2015) find evidence that households take optimal decisions about investment in education, but sub-optimal at social level. Significantly, household and student characteristics such as the socioeconomical status, the parent's education, the access to educational service, among others define the importance of education factor at home.

De Witte et al (2012), Glewwe & Kremer (2006) and Todd & Wolpin (2003) explain that the educational experience of the parents determine present and future educational valuation within the household; therefore, if parents perceive that education is a positive factor in their children, they could easily promote school enrolment, school attendance, and children´s dedication to educational activities. However, financial

[8] At this point, a problem with computer equipment appears. On one hand, computer equipment can be used for teaching activities, and be considered as part of the non-pedagogical support. On the other hand, if the computer equipment used as a writing element (for example, as a notebook) then it may consider as a pedagogical support aspect. Harbison & Hanushek (1992) do not consider this dilemma, while Beltran & Seinfeld (2011) include these elements as part of the non-pedagogical support. In this research, it considered in both categories.

[9] It is noteworthy that, between these categories, there remains a set of unobservable aspects involved in generating results. These aspects are qualitative; and for this reason, these are not use considered in most quantitative literature. Highlights among these aspects: time dedicated to educational activities, teaching practice, climate in the classroom and climate at school, among others. According to Bruns & Luque (2015) and Jopen et al (2014), few studies collect these type of aspects because these require classroom observations and apply sophisticated instruments. Equally, its importance is recognized.

constraints, household priorities budget and household size can affect investment decisions and income in the educational training of their children (Beltrán & Seinfeld, 2011; Glewwe, 2002). In addition, literature stands out the importance of preschool education, the development of cognitive skills, and alike. These factors positively influence the learning opportunities for students, which improves educational outcomes. According to Glewwe and Kremer (2006), Cueto et al (2015) and Berlinski et al (2008), access to early childhood education and cognitive skills are aspects that generate a better outcome, in terms of education.

iii) Educational community and Educational system

Educational community´s characteristics and institutional framework in which educational activity takes place influences educational outcomes. These physical and institutional aspects interact with households, students and schools (Beltrán & Seinfeld, 2011; Glewwe, 2002). Therefore, they constitute conditional aspects of educational results. For example, if the provision of educational services is given in a highly rural context with low socioeconomic status, presence of native languages or bilingualism, and low average adult education, it is expected that the process to generate optimal educational outcomes is more complex, compared to more favourable context. As a response to these conditions, the education system should count on mechanisms that could compensate those limitations. Specifically, Boissiere (2004) and Pritchett & Filmer (1997) emphasize that the type of school administration, institutional management capacity, and the budget for these topics, will play an important role in overcoming these limitations.

Overall, it is possible to establish a functional relationship between educational outcomes and inputs. On one hand, outcomes are the result of a three-stage process: access, retention and educational achievement; and on the other hand, inputs could be divided into two factors: discretionary aspects, which are under the control of the school; and non-discretionary aspects, that affect the educational process (e.g. characteristics of students, households or communities). Thus, according to Glewwe & Kremer (2006), Todd & Wolpin (2003), Glewwe (2002), Harbison & Hanushek (1992) and Hanushek (1986), it has been possible to establish the equation (1):

$$Y_{it} = f[E_{it}; S_{it}; Y_{it-1}; H_{it}; C_{it}; u_{it}; \varepsilon_{it}] \dots (1)$$

Where educational outcomes (Y_{ij}) school i at time t are related dependently: the results achieved at period $t-1$ (which in turn were a result of inputs at period $t-1$), the characteristics of the school (E_{ij}), the characteristics of each student (S_{ij}), characteristics of their homes (H_{ij}), aspects concerning the educational community (C_{ij}), and unobservable aspects that constitute a disturbance term (ε_{ij}). In addition, it is considered a parameter to each school u_{ij}, which represents the ability of each school to combine inputs and generate optimal results. This will eventually be referred to as technical efficiency.

c) Technical efficiency and educational outcomes

According to Leibenstein (1978), Farrell (1957) and others, the economic efficiency in any decision unit means that this unit: generates an optimal amount of results, given a set of inputs and technology available; and also, it chooses an optimal set of inputs, considering an input system of prices as given. These concepts refer to as technical efficiency and allocative efficiency, respectively. However, the application of economic efficiency concept to the educational case is unique. This occurs because economic efficiency is mainly explained by technical efficiency rather than allocative efficiency. To understand this statement, it is necessary to explain two peculiarities of the process of providing educational services (De Witte et al 2012 and Worthington 2001).

A first reason refers to the existence of discretionary and non-discretionary factors, which influence the generation of educational outcomes. Although the production approach allows us to understand what are the factors involved in the process, not all of these factors are controllable by schools (Tam 2008 y Coelli et al 1997). In other words, on one hand, characteristics of students, their households, and communities determine the educational outcome, and are not under control of the school management (e.g. non-discretionary); and on the other hand, school features are affected by the school management (e.g.

discretionary). As a second reason, not all inputs have a price because some school inputs do not have a market, then the possibility of allocative efficiency is insignificant (Worthington, 2001). Coelli et al (2003) and Hanushek et al (1996) argue that to identify an optimum set of inputs is impossible due: i) exogenous allocation of inputs (such as the case of education managed by the public sector); and ii) inelasticity of demand for inputs (e. g. hire new teachers can be done, but not immediately –so it would intertemporal inefficiency). Therefore, economic efficiency would mean reaching the highest levels of technical efficiency possible.

Therefore, it is possible to apply the concept of (technical) efficiency to the educational case if the researcher understands that this efficiency is related to educational outcomes and discretionary inputs; and that non-discretionary inputs are exogenous, but these affect the educational process. However, how do you identify, and with respect to which criteria the technical efficiency should be observed?

Authors like Coelli et al (2003), Worthington (2001) and Kumbhakar & Lovell (2000) apply the concept of *Efficiency Frontier*. This defined as a set of firms that has reached an optimum production process under certain criteria. In the case of educational outcomes, the optimality criterion is called «*output orientation*». Under this, a frontier is constituted by those schools that have maximized the chances of production of educational outcomes, given a set of available discretionary inputs[10]. Thus, schools allocated in the frontier would be a benchmark for others, and the distance between the measurable levels of educational performance of reference schools and the rest, given a set of inputs, is a measure of relative efficiency or technical efficiency (TE) (Coelli, Estache, Perelman, & Trujillo, 2003).

The identification of a set of reference schools not only allows the measurement of differences between schools; at the same time these would allow to identify changes over time and with respect to the previous efficiency level. Therefore, it is possible to identify changes in relative efficiency (a school compared with other), changes in pure efficiency (a comparative itself school), changes in scale efficiency (existence of scales or sizes of efficient school), or changes in Total Factor Productivity (TFP) (Coelli et al 2003, Kumbhakar & Lovell 2000).

d) Preliminary studies

The implementation of the concept of production function in education is quite usual in international literature. However, in Peru, the application of efficiency analysis in this context is less widespread and highly limited. Glewwe & Muralidharan (2015), Boissiere (2004) and Worthington (2001) provide extensive review of the studies related at international level. Those, and other reviewed studies present three latent ideas.

A first idea is related to the measurement of some types of inputs. International literature recommends to choose the most direct and unbiased indicators as possible with respect to production of educational results. This latent idea is presented as a response to the large number of studies that use efficiency of budgetary magnitudes (for example, amounts or percentages of budget for educational inputs). In those cases, the degree of inefficiency detected may be associated to bureaucratic constraints, problems of governance and other aspects away to school management (Worthington, 2001; Leibenstein, 1978; Klitgaard & Hall, 1975).

Another latent idea has regarding to the comparability between the units of analysis in studies of technical efficiency. This idea implies that schools considered in the analysis should be on similar operating conditions. Therefore, it is recommended that include cohort analyses to identify homogeneous schools for

[10] There is an opposite approach called «*input orientation*». Which means that frontier is formed by a set of firms that manage to minimize the use of inputs available, considering a level of desired results. However, this logic is not appropriate for the case of education (Worthington, 2001).

the realization of unbiased comparisons (De Witte et al 2012).

Finally, although previously mentioned, there are discretionary and non-discretionary inputs for determining educational outcomes. Authors like De Witte et al (2012), Todd & Wolpin (2003) and Worthington (2001) find evidence in several studies that educational public policies are insufficient in themselves. In addition, Boissiere (2004) complemented that it be require additional or multisectoral policies to affect the generation of educational outcomes.

Most studies applied in Peru, and other countries in the region, analyse and define educational outcome from its dimension of impact. These studies measure educational outcome from scores on standardized assessments. For example, Afonso and St. Aubyn (2005) conducted an analysis of the efficiency in the provision of education and health. They included the OECD countries and some others, who participated in the evaluation of the Programme for International Student Assessment (PISA). These authors identified that sociodemographic characteristics, such as population density, influenced academic achievement.

Similarly, other authors applied information from national assessments of learning achievement to their researchs. For example, Iregui et al (2006) and Alvarez-Parra (2012). On one hand, Iregui et al (2006) analyse the Colombian case, as part of a process of fiscal decentralization during 1990s decade. They found that school infrastructure and socio-economic background of students have positive impacts on educational efficiency, and that private schools achieve better levels of efficiency, due to having these schools operating in privileged socio-economic environments. Meanwhile, Alvarez-Parra (2012) analysed the technical efficiency considering the average school performance and the type of school management. He focused on schools in Chile (with information from the National Assessment of Learning Outcomes 2004-2010) and Peru (with information from the Census Student Assessment 2010). This study found that differences in efficiency levels were due to differences in socio-economic background of students, and educational resources available at each school, in both analysed countries.

At the national level, the efficiency analysis to the field of provision of educational services are directly applied in three highlighted studies[11]. First, Pereyra (2002) apply an efficiency analysis to the case of education, and he made it from the side of the efficiency of educational spending, and under a cross-country approach. His study considers a sample of several countries in Latin America; and it evaluates the efficiency in the process of transformation of production factors. The author finds that increased educational spending does not necessarily imply a higher level of efficiency. Second, Tam (2008) analyses the efficiency of educational spending in the Peruvian case, but in a regional and comparative level. This study proposes a comprehensive set of educational outcome variables (educational coverage, timely conclusion and academic achievement of students). The author considers as the main discretionary input: public spending on education per student; and estimates a Tobit model to identify the relevance of non-discretionary inputs in regional efficiency in education. To sum up, she finds that the availability of financial resources and the results do not maintain a significant relationship in the context of low efficiency. Finally, Beltran & Seinfeld (2011) conducted a study based on schools, and identified efficiency levels considered only as an outcome variable learning achievements obtained in the Census Student Assessment in 2008 and 2009. They used non-monetary inputs, and they found results consistent with the Tam (2008) findings. Additionally, Beltran and Seinfeld proposed an analysis of technological change, and identified that there are opportunities for increased efficiency in the generation of educational outcomes.

[11] The analysis of efficiency in the Peruvian case is not confined to the field of educational services provision. Authors like Leon (2009) and Aguilar et al (2005) performed efficiency analysis for the case of financial institutions and microfinance, and Herrera & Francke (2009) analysed the efficiency in municipal spending.

2) Peruvian educational system

Education is a fundamental right for people, therefore, the government is responsible for providing free educational services at all levels and modalities; ensuring the quality of this provision[12]. Public education is complemented with private, which is regulated and supervised by MINEDU. Thus, the Peruvian educational system is a mixed model, facilitating the expansion of coverage, quality and financing[13].

a) Regular Basic Education: Elementary Education

EBR attends children and adolescents whom transit through the educational process in a timely manner, according to their physical, emotional and cognitive development. As shown in **¡Error! No se encuentra el origen de la referencia.**, in 2014, the EBR provides through more than 101 thousand schools (about 95% of all operative schools). The relevance of elementary education lies not only in the nearly 38 thousand schools nationwide that offer this level (about 35.7% of the total), but also at this level, schools concentrate more than 3.5 million students, about 7.5 million students in the EBR.

Table 1. Peru: Number of schools by type and level, according to management type and area (2014)

Schools	Public				Private				Total	
	Urban		Rural		Urban		Rural			
	Nº	%	Nº	%	Nº	%	Nº	%	Nº	%
Basic education	30 266	92,6	47 023	99,8	22 899	90,9	1 041	98,2	101 229	95,5
Initial	*17 852*	*54,6*	*21 345*	*45,3*	*10 050*	*39,9*	*390*	*36,8*	*49 637*	*46,8*
Primary	*7 384*	*22,6*	*22 035*	*46,8*	*8 139*	*32,3*	*330*	*31,1*	*37 888*	*35,7*
Secondary	*5 030*	*15,4*	*3 643*	*7,7*	*4 710*	*18,7*	*321*	*30,3*	*13 704*	*12,9*
Alternative Basic	810	2,5	15	0,0	727	2,9	6	0,6	1 558	1,5
Special Basic	397	1,2	10	0,0	64	0,3	1	0,1	472	0,4
Technical-Productive	740	2,3	29	0,1	1 026	4,1	8	0,8	1 803	1,7
Tertiary Non-Univ.	463	1,4	22	0,0	488	1,9	4	0,4	977	0,9
TOTAL	**32 676**	**100,0**	**47 099**	**100,0**	**25 204**	**100,0**	**1 060**	**100,0**	**106 039**	**100,0**

Note: Includes adult education. Source: MINEDU (2015).

These schools are mainly managed by the public sector (more than 29 thousand schools in 2014) than by the private sector (about eight thousand schools, in the same year)[14]. Similarly, this heterogeneous distribution is replicated in a geographic area analysis. For instance, for every public school in the urban area, three schools are located in rural areas; and for each private school located in rural areas, they are about 25 schools in the urban area[15]. This distribution of administration type in schools is explained by the lack financial incentives for private schools (e.g. fewer school-age students, lack of infrastructure, etc.) to offer educative services in more rural areas. Conversely, public schools must cover an unmet demand by the private sector in rural areas.

Contextual characteristics (as concentration of private schools in urban areas, low demand for educational

[12] These by ensuring the good performance of: general guidelines; curriculum design; investment per student; initial and continuing training of educational authorities; teaching and administration of public teaching career; infrastructure, equipment, services and materials; educational research and innovation; and institutional organization. (*Ley* Nº 28044, *Ley General de Educación*, Arts. 4° and 13°). See Jopen et al (2014).

[13] Also see *Diseño Curricular Nacional* (2009), *Proyecto Estratégico Nacional* (2006), *Reglamento de Educación Básica Regular* (2004) and *Ley* N° 28044, *Ley General de Educación* (July 28, 2003). All these policy documents for Peruvian educational system are currently in force.

[14] MINEDU performed, in some cases, shared management with a civil association, religious congregation, military organization, among others. This type of management is called «management agreement». For simplicity, these schools are considered part of public management schools.

[15] For more details, see Annex 1 (Figure 8)Figure 9. Peru: Distribution of schools of public administration and percentage of students enrolled in public schools by region (2014)**¡Error! No se encuentra el origen de la referencia.¡Error! No se encuentra el origen de la referencia.**

services in rural areas, and logistical difficulties in rural areas) have consequences on educational supply. Thus, elementary education includes different types of organization or attention called «*característica de la escuela*». This classification describes: (i) one-teacher and multi-grade schools (elementary schools with a teacher who is dedicate to manage classes and teach in the six elementary grades), (ii) multi-grade incomplete or only multi-grade schools (elementary schools with some teachers who are dedicate manage classes and teach in the six elementary grades), and (iii) full grade schools (elementary schools with sufficient teachers for each elementary grade level)[16][17].

b) Educational outcome

The educational outcome can be understood as an economic and multidimensional phenomenon, which involves obtaining results in up to three dimensions: access to educational services, permanence in the educational system and the impact of the educational process.

About *access to educational services*, school-age population (between 6 and 11 years) enrolled in elementary level is regionally unevenly distributed. Lima and Callao has more than 533 thousand students enrolled; while in Piura, Cajamarca, Loreto and La Libertad, there are about 173 thousand registered in average per region. On the other side, Pasco, Tacna and Tumbes concentrate about an average of 25 thousand enrolled students per region; and Madre de Dios and Moquegua the 15 thousand enrolled on average is reached by region[18]. At the national level, and as detailed in Figure 1, the indicators of access to elementary education (net enrolment and attendance) have remained high, although with a slight decreasing trend during the period 2010 - 2014. In particular, the reduction in assistance 2012 is explained by a teachers' strike that occurred that year[19].

In *retention*, students from rural areas recorded significant improvements, while those who live in urban areas are slightly worse. For example, the percentage of students enrolled for at least the second time in the same grade of elementary education has been reduced significantly in rural areas (12.2% in 2010 to 6.8% in 2014), but in urban areas it has increased slightly from 4% in 2010 to 5.4% in 2014. Similar interpretation is in terms of the rate of school backwardness and cumulative dropout levels (see Figure 2)[20].

In relation to the third dimension of educational outcome, the *educational achievement*, are mixed results. MINEDU applies a standardized evaluation of basic learning to students of second grade of elementary education, called Census Student Assessment (ECE, for its acronym in Spanish). According to the report of results of this evaluation, improvements were recorded in the subject areas of reading comprehension and math. Still, the percentage of students achieving a satisfactory level in the area of mathematics does not exceed 30%. If these results are analyzed in detail, the differences are accentuated[21]. For example, in 2014, urban students scored up to three times better than the rural counterparts in math and reading comprehension. Overall, only ten regions had a 40% rate of students achieving a satisfactory level in reading comprehension, and only nine had 30% of students achieving a satisfactory level in mathematics.

In general, there are signs of substantial improvements in terms of access and retention in the educational

[16] This information refers to the *Reglamento de Educación Básica Regular* N° 013 - 2014-ED, Chapter 2, Articles 62-64.
[17] With this classification, primary educational system adapts to the availability of teachers and demand for educational services in each area. Therefore, one-teacher and multi-grade and multi-grade primary schools are commonly found in rural areas; while in the city, one in four elementary level are the full grade primary schools type, and the remaining (about 23 thousand schools, by 2014) are one-teacher and multi-grade and multi-grade primary schools.
[18] For more details, see Annex 1 (Table 2)
[19] Those teachers who disagreed with the implementation of an evaluation teacher knowledges policy carried out the teachers' strike. Despite of that, the information is up to date.
[20] For more details, see Annex 1 (Table 3).
[21] For more details, see Annex 1 (Table 4).

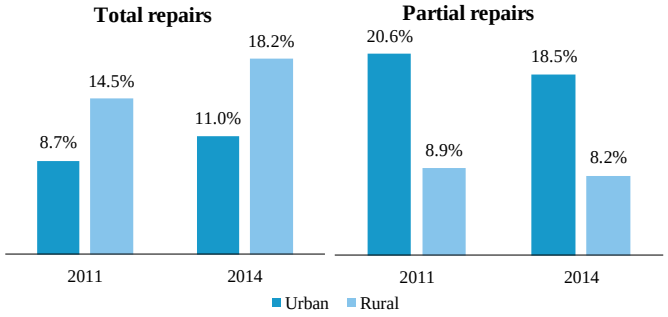
system. However, the evolution of indicators of educational achievement has not followed the same trend, and differences deepen if we consider both. This evidence validates the proposal from the international literature on the multidimensionality of educational outcome. A multidimensional approach will provide an unbiased identification of efficient educational processes in the use of educational inputs to generate optimal outcomes.

c) Discretionary factors: Educational inputs

In literature, proliferate relevant aspects in determining educational outcomes, and whose uses are controlled by same schools, as a provider of educational services. Based on the classification proposed by Harbison & Hanushek (1992), then a categorization made by non-teaching support aspects, aspects of pedagogical support and aspects of teaching staff is proposed.

Aspects of *non-pedagogical support* facilitate the production of educational outcomes, but are not involved directly in teaching practice. In Peru, it is possible to have detailed information on the quality of the infrastructure of school facilities, access to basic services in the same, quality educational furniture, among other indicators. As shown in Figure 1, the quality of infrastructure of school facilities has changed slightly between 2011 and 2014. The percentage of school buildings requiring partial repairs has decreased slightly in both urban and rural areas. Unfortunately, school facilities that require complete repair have increased, which reflects the lack of attention from the government.

Figure 1. Peru: Proportion of school buildings that require full or partial repair (2011 and 2014)



Note: The requirement to repair is the proportion of public school facilities at all (total repair) or some (partial repair) classrooms in use have walls, or ceilings have leaks or cracks, according to the principal's report. Source: MINEDU (2015).

Access to basic services like potable water, sewer and electricity is another aspect considered as a part of non-pedagogical support. Between 2010 and 2014, the proportion of school buildings dedicated to elementary education with access to the these three basic services increased, especially in rural areas (Figure 2), despite a slight reduction between 2013 and 2014; years in which the number of elementary schools marginal urban areas of coastal regions increased (MINEDU 2015).

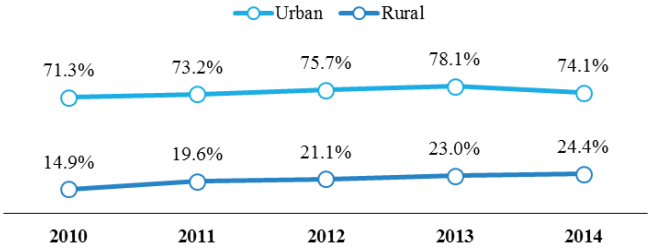
The availability of equipment in good condition and use is another aspect of non-pedagogical support. In this regard, 43% of public management schools are equipped with furniture in good condition; while the privately run schools, only 31% achieved this benchmark in 2014. Under the same scheme, full-grade schools mostly have better equipment compared to other types (MINEDU 2015). On the other hand, there are *pedagogical support aspects*. These aspects include the factors directly involved in the production of educational outcomes, as directly part of pedagogical practice. In this regard, it stands out as a relevant indicator, compliance with the academic calendar by the elementary schools.

Most of elementary schools meet the planned academic calendar (Figure 3Figure 3). However, rural schools face greater difficulties to comply with this planning, which is likely associated with climatic aspects, travel times from home to school, etc.

Finally, there are *teaching staff aspects*; and specifically, the availability of teachers in schools per students enrolled. In Peru, time dedicated to to administrative and institutional activities is an important element;

especially in multi-grade schools. It is noteworthy that the availability of personnel with exclusive dedication to administrative activities, allows teachers fully engage in educational activities. Thus, private schools have mainly this type of staff (about 88% of private schools in 2014). Schools full grade type also has this type of personnel.

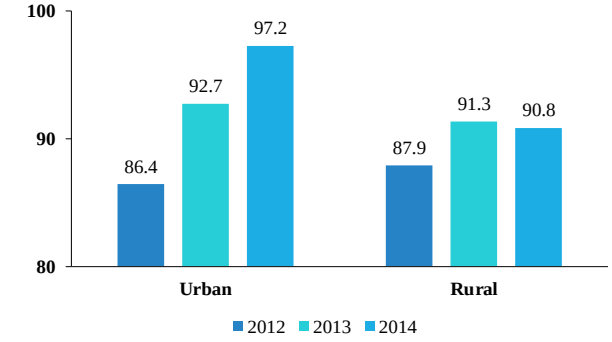
Figure 2. Peru: Educational facilities of public management with access to the three basic services (2010 – 2014)



Note: Percentage of educational facilities of public management that provide complimentary water system and drainage directly from the public network within the local, and have electric lighting by public network, according to the statement of school principals. Source: MINEDU (2015).

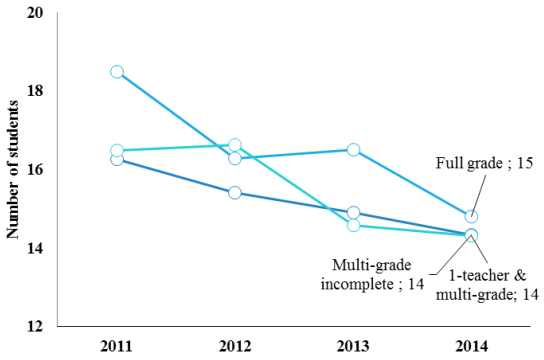
In connection with this, over recent years the number of students per teacher has fallen sharply. The full grade schools reduced their average of about 19 (in 2011) to 15 students per teacher (in 2014), while other types of schools reduced their average about 16 to 14 students per teacher (2011 2014) (see Figure 4).

Figure 3. Proportion of elementary schools that meet the academic calendar by geographical area (2012 - 2014)



Note: Source: MINEDU (2015).

Figure 4. Peru: Number of students per teacher by type of school (2011 - 2014)



Note: Source: ESCALE, 2015 (MINEDU).

d) Non-discretionary factors

As in the previous case, the literature highlights the importance of non-discretionary factors: aspects related to the student, his household and their community. These aspects are also known as demand factors, and are relevant in the process of generating educational outcomes. These factors include the educational level of parents as a determining factor in the student's family and public investment in the education sector.

Years of schooling or years of accumulated education of adults are related to positive valuation that their parents gave to education. Therefore, parents who accumulate more years of education tend to give greater importance to the educational process and its conditioning factors. For example, parents can promote school attendance and dedication to the educational activities of children (Beltrán & Seinfeld, 2011; Glewwe, 2002).

In Peru, average adult schooling years (between 25 and 64 years of age) remained statistically constant between 2010 and 2014. This is due to the indicator's invariability in short term, and there are only significant changes in long term. Likewise, there are significant differences when comparing the results for different geographical areas differences. On average, adults in rural areas reached 6.7 and 6.2 years of education (in men and women, respectively); whereas, in urban areas, the average years of education attained is 11.1 in men and 10.9 in women.

Finally, in relation to the evolution of public spending, the share of investment in the education sector has a strong positive trend in recent years. Pereyra (2002) finds that this trend has a positive relationship with the generation of educational outcomes as Pritchett & Filmer (1997) did. However, this association is due to the existence of bureaucratic obstacles and government management capacity.

3) Methodological strategy

This paper evaluates the hypothesis that there are significant differences in efficiency analysis among schools, which depends on the approach applied: one-dimensional or multidimensional. Likewise, it explores key drivers of differences in educational efficiency, and if these are related to the type of management (public and private), organizational type, or demand characteristics. Furthermore, this research contrasts secondary hypotheses. Firstly, asymmetries, in terms of management capacity of schools, have consequences on the possibility of obtaining better results; and generates different efficiency levels. Secondly, given the dispersion in educational outcomes and efficiency, schools can still improve their educational efficiency. Lastly, the set of non-discretionary aspects, such as pre-school education and previous educational outcomes have more relevance than other variables.

a) Methodological tools

In this research, we must consider four assumptions. Firstly, educational outcomes have a multidimensional and observable nature. Secondly, schools are the decision-making units that create educational outcomes with a set of (discretionary) inputs. Thirdly, they may be categorized as efficient if they generate the maximum educational results, given their set of inputs. Finally, inputs from each student, their families or their community also influence the results, but are exogenous to the school they attend.

This section details two methodological stages. Efficiency analysis methodologies are applied to identify the educational efficiency level generated by each school as a first stage. Secondly, Tobit methodology will also be applied in order to identify non-discretionary factors that affect school's efficiency. Below are listed each of these methodologies.

i) Efficiency analysis

The estimation of efficiency levels in an industry can generate tools for policymaking through the identification of those firms that generate the maximum quantity of production, given a set of inputs

(LoveII, 1993). Farrel (1957) mentioned this dynamic as «output orientation»[22], and the optimal set of units as «efficient frontier» or simply frontier. Thus, the relative distance between production levels of frontier firms and other firms constitute an efficiency (or inefficiency) measure.

In the literature, there are different approaches to the estimation of efficiency levels[23]. This can be divided into two major categories: nonparametric and parametric methodologies. First, *nonparametric methods* use mathematical tools to analyse the efficiency of decision-making units. Some assumptions in this method are too flexible or less restrictive (Coelli et al 2003, Kumbhakar & Lovell 2000, Coelli et al 1997, Lovell 1993). As Kumbhakar & Lovell (2000) and Coelli et al (1997) mention, these techniques have several benefits, because they not require assumptions about the functional form of the efficient frontier. No assumptions about the technology production is useful in cases where the technology production is not known. However, there is a disadvantage because it does not consider stochastic components; in other words, it is not possible to establish a form of error distribution, nor analyse reliability of the results, due to the absence of a functional form.

One of the most widespread nonparametric methods is the *Data Envelopment Analysis (DEA)*. This method implicates the identification of an efficient frontier by mathematical programming. The nonparametric method DEA, initially proposed by Charnes et al (1978), considers that the decision-making units can change their outcome levels to generate changes in the use of available inputs. Additionally, it assumes that these proportional changes can be constant (constant returns to scale) or variable (variable returns to scale) according to the scale (Banker et al 1984).

This distinction also has implications in the number of decision-making units (schools) that are within the efficient frontier. On one hand, under the assumption of constant returns to scale, only one school will be identified as the most efficient. In the case of variable returns to scale, it will be a greater number of effective schools (according to the dispersion of cases with different levels of inputs available). In other words, the scheme of constant returns is sufficient to capture efficiency differences between decision units, if schools are very similar from each other (in its main features, at least). While, the scheme of variable returns is sufficient to estimate efficiency differences between decision units, if schools are very different from each other as in the Peruvian case.

As shown in mathematical form (2), the methodology assumes that given a set of n schools, each one obtains a certain level of educational outcomes (Y_i) using k different types of inputs. In this regard, each school seeks to minimize the relatively $\theta < 1$ distance between their level of educational outcomes and the maximum observed level of such results (Y_{Max}, with $\theta = 1$) in schools with similar levels of inputs.

$$\begin{cases} \min\limits_{\theta\lambda} & \theta \\ s.t.: & Y_{Max}\lambda \geq Y_{it} \dots\dots (i) \\ & \theta x_i \geq X_{Max}\lambda. \dots (ii) \\ & \lambda \geq 0 \dots\dots\dots\dots (iii) \\ & n1'\lambda = 1 \dots\dots\dots (iv) \end{cases} \dots (2)$$

According to Coelli et al (2003) and Kumbhakar & Lovell (2000), each school compares with others that: (i) have a higher level of educational outcome than itself, and (ii) that have lower levels of inputs available

[22] The opposite proposal would also be valid (an observable set of optimal decision units that generate a certain number of products, minimizing the use of inputs available, or orientation to inputs). Although, as mentioned, this scheme is not appropriate for the case of the provision of educational services.

[23] The identification of Efficiency Frontiers and measuring the relative distances (or levels of efficiency) are not the only methodology for this type of analysis. As Tam (2008) mentions, an alternative is the technique of Artificial Neural Networks (a method not widespread in the literature that requires calibration and contrasts of "guess and verify" following information criteria. However, it would not apply for production approach as proposed.

than itself. Also, the authors assume that every school have the same production scale (iii). Finally, (iv) DEA method added a scale parameter multiplier like λ for each school.

About the methodological adequacy, authors argue that this type of analysis is subject to the existence of anomalous behaviour. In this case, it is worthwhile to ensure the quality of information to use, in order to guarantee that there is no presence of anomalous cases. They also recommend including control variables, which allow efficiency comparisons between similar schools.

Parametric methods are techniques that require a functional structure (relative with decision units and their process of transformation discretionary inputs in outcomes efficiently) linked to the productive structure or other characteristics of the industry analysed. These methods are advantageous, compared with nonparametric, due to the possibility of having stochastic terms, and therefore levels of reliability relative to estimates of efficiency. However, they are also techniques criticized by the imprecision of their estimates; and even more, if applied in high heterogeneity contexts between decision units.

The principal methodologies in this category are the estimates of deterministic and stochastic frontiers[24]. Deterministic Frontier Analysis (DFA acronym) assumes that any deviation of the individual behaviour towards the border amounts to a measure of inefficiency, given a functional structure (Worthington, 2001). However, Meeusen & Van Der Broeck (1977) mention that such assumption could generate estimation bias. According to the related literature, the DFA ignores that may exist exogenous factors that may explain these deviations and non-inefficiencies (e.g. aspects not related to the availability of inputs) (LoveII, 1993).

An alternative methodology is the *Stochastic Frontiers Analysis (SFA)*, developed by Aigner et al (1977) and Meeusen & van den Broeck (1977). This proposal is a response to potential weaknesses that could present the results under the DFA. In this case, SFA also assumes a functional structure that explains how each school generates educational outcomes (Y_{it}), given a collection of inputs school (X_{it}). However, this method includes an error term decomposed into two sections. The first component of the error would be stochastic and independent and identically distributed, such that $v_{it} \sim N(0, \sigma_v^2)$; and the second component would be the level of inefficiency of the decision unit, which particularly are assumed independent and identically distributed with $u_{it} \sim |N(0, \sigma_v^2)|$. As shown in Equation (3) (Kumbhakar & Lovell, 2000; Battese & Coelli, 1995).

$$Y_{it} = X_{it}\beta - \mu_{it}$$

$$\begin{aligned} &Y_{it} = X_{it}\beta + (v_{it} - u_{it}) \\ &con: \;\; v_{it} \sim N(0, \sigma_v^2) \;\; \wedge \;\; u_{it} \sim |N(0, \sigma_v^2)| \end{aligned} \quad \ldots (3)$$

DFA and SFA methodologies have the distinction of adapting by the imposition of assumptions about functional form and the form of distribution of the term u_{it} (LoveII, 1993). The literature not shows consensus about the assumptions applying in every case. Battese & Coelli (1995) applied suitable assumptions for the education system (i. e. functional *Traslog*[25]; normal distribution of the error term, and the semi-normal distribution of the inefficiency term). Thus, this study applies the DEA methods with variable returns to scale and SFA for two main reasons: i) both methods are comparable in their assumptions (except for cases of production technology); and ii) both are adequate to describe the provision of public

[24] Another non-parametric methodology is *Free Disposal Hull* (FDH). However, this research does not apply this method because it is not compatible with inputs considered and functioning of the educational system. See Coelli et al (2003) and Charnes et al (1978).
[25] The literature presents other functional forms. According to De Witte et al (2012), *Generalized Translog* form, originated based on the assumptions of Cobb & Douglas (1928) -symmetry, homogeneity, among others. While some functional forms alternatives would form *Generalized Leontief* (characterized by low substitutability of factors of production), and *Fourier - Flexible* form (enabling better identify contexts where units are less homogenous one another). However, such schemes would not be the most appropriate for the case of the provision of educational services (Todd & Wolpin, 2003).

goods and services.

This type of analysis of efficiency and availability of longitudinal data allow us to analyse the changes that occur in the relationship between production levels (educational outcomes) and inputs (educational inputs). These changes allow us to measure the productivity levels of a decision unit time (LoveII, 1993). In particular, a change or technological progress is related to an improvement in the way in which inputs are used in a particular process. Moreover, for purposes of this study, technological change involves learning or improvement in teaching practice or institutional or school management processes.

Considering the information for each school i and efficiency measure for each period, such that the Malmquist index (M_i) would be as shown in equation (4):

$$M_i = \left[\frac{D_{i,t}(y_{i,t+1}; x_{i,t+1})}{D_{i,t}(y_{i,t}; x_{i,t})} \frac{D_{i,t+1}(y_{i,t+1}; x_{i,t+1})}{D_{i,t+1}(y_{i,t}; x_{i,t})}\right]^{1/2} \dots (4)$$

Where, $D_{i,t}(y_{i,t}; x_{i,t})$ and $D_{i,t+1}(y_{i,t+1}; x_{i,t+1})$ refer to the level of efficiency of the ith school (distance between the educational outcomes of the school and the efficient frontier corresponding), both for the period t to $t+1$, respectively. While other factors relate to the corresponding levels of cross efficiency (for example, the distance between the educational outcomes of a period with respect to the frontier of another period).

According to Coelli et al (2003) and Lovell (1993), if $M_i > 1$, it means that a school has increased its production capacity from one period to another. Also, it is possible to identify whether this change in production capacity or change in total factor productivity (ΔPTF) is due to: a change in technical efficiency (ΔEF), a change in pure technical efficiency (ΔEFP), a technological change (ΔCT), or a change in scale efficiency (ΔCEE).

ii) Tobit methodology

On a second stage, Tobit methodology is applied to estimate non-discretionary factors that affect school's efficiency. It must be considered this approach due to the nature of the endogenous variable. In the first methodological step, we suggested the application of a method that estimes using a linear relationship, these methods could produce inconsistent estimations if the endogenous variable has some type of bias. To define the censored nature of the efficiency variable, we need to consider which values are assigned to efficient schools. Those schools that produces the maximum observed educational outcome, given a proportion of educational inputs, acquire a value equivalent to one. Conversely, schools that get lower values (in the range of zero to one) are in a technical inefficiency level[26].

The Tobit methodology applies a first estimate by iterations with Maximum Likelihood, under assumptions of normality and homoscedasticity, which overcomes the problems of censorship: Then, the method makes an estimation by ordinary least squares. As set forth in Equation (5):

$$\theta_{it} = \begin{cases} \alpha_i + Z_{it}\gamma + \varepsilon_{it}, & si\ \theta_{it}^* < 1 \\ 1, & si\ \theta_{it}^* \geq 1 \end{cases} \dots (5)$$

Where the level of efficiency achieved by the school i in period t (θ_{it}) is linked directly to a set of variables that characterizes students, their households and the community's education (non-discretionary variables,

[26] Note that $score_{it} = 0$ is not a censorship to the down side. If a school has a zero level of efficiency does not mean it is not producing educational results, but has the largest gap between the results of the most efficient school and own results.

Z_{it}). Additionally, if it is required to consider longitudinal data, the parameter of average behaviour α is the characteristic effect of each school over time, with distribution $\alpha_i \sim N(0, \sigma_\alpha^2)$, whose estimation is done via Maximum Likelihood with random effects.

b) Variables

This research uses available information from the *Censo Escolar* (CE), the *Evaluación Censal de Estudiantes* (ECE) and the *Encuesta Nacional de Hogares* (ENAHO)[27]. In order to avoid creating bias in the analysis, it was useful to consider three assumptions. Firstly, only those elementary schools that have been in operation (operational and enrolled students) during the period analysed were included in the database. Second, we only considered multigrade complete and polidocente grade schools. However, it has been omitted multigrade teacher schools because they were not evaluated in the ECE. Lastly, there has been a special treatment for missing data in databases.

It was necessary to construct two databases obtained from mentioned national registers (called *Registro Nacional de Instituciones Educativas*). The first dataset includes longitudinal level information schools (13,038 schools with original longitudinal information, and 1,748 schools with longitudinal information retrieved by imputation) with 14 786 schools representing about 53% of all schools in the registry. The second database includes annual information unbalanced (due to attrition problem by closing and opening schools). This second database has 23,647 schools, after imputation process (about 86.8% of census information), and nationally representative, by type of management and type of organization of schools.

i) Educational outcome variables

The provision of educational services is a multidimensional process, and as such, the educational outcome is the result of the dimensions of this process: access, permanence, and educational impact. A variety of studies has prioritized only the last stage mentioned. These studies have been using average score of students per school in a standardized assessment as learning achievement measure. In this sense, these studies assume that a school would get better results if their students, on average, achieve higher scores on these assessments. However, this kind of one-dimensional interpretations could be biased[28]. To overcome measurement problems and biases, a multidimensional approach should be considered.

It is important to clarify that school analysis is quite different from a multiproduct firm that advantages sunk costs of installation and develops several products simultaneously. In this case, the learning process depends on three dimensions whose results interact sequentially. Thus, if a school gets better results in access and permanence, it will probably improve outcomes in educational impact. Therefore, it is useful to develop an indicator that takes into account all dimensions. The proposal of an *Educational Outcome Index* ($IREdu$, for its initials in Spanish), is beneficial for two reasons. Firstly, it suggests that elementary schools are economic decision units, which simplifies the analysis. Secondly, it helps to avoid double counting or

[27] CE (MINEDU) containing information about inputs used for the provision of educational services nationwide. ECE (MINEDU), like other standardized tests, has information about academic achievement of students in the second grade of primary schools in the EBR mode (omits one-teacher schools) in the areas of reading comprehension (in Spanish) and mathematics. In addition, ENAHO (INEI) provides representative information at regional level about socioeconomic levels and household characteristics. In all three cases, it has annual information for all years included in the study: period 2010 - 2014. Information was included until 2014 given the availability of information on the closing date of the study.

[28] One of these biases is associated with the thematic scope of evaluations, as standardized tests (such as ECE) evaluate only some minimal thematic areas (Reading and Mathematics); because it does not have the possibility of having, a comprehensive evaluation that includes all subject areas taught (p. e. natural sciences, social sciences, etc.) (OMCA, 2009). Another bias is generated due to standardized assessments require narrow evaluable population (for example, to second grade of primary level, and full-grade and multi-grade schools –but ECE omits one-teacher and multi-grade schools).

endogeneity[29].

It is considered the following indicators: attendance rate as a proxy for access to education, repetition rates and promotion as identifiers permanence in the educational system, and results in the ECE (both Reading and Mathematics) as an approximation of the impact educational. Thus every methodological approach is applied to each of the proposed indicators ($IREdu$, Learning achievements in Reading and Mathematics). Then, the construction of the $IREdu$ implies Factorial Analysis application between the proposed indicators for each dimension, under the fulfillment of the relationship expressed in Equation (6):

$$IREdu_{it} = \alpha_1 acc\_enro_{it} + \alpha_2(\beta_1 per\_rep_{it} + \beta_2 per\_pro_{it}) + \alpha_3(\gamma_1 imp\_achvc_{it} + \gamma_2 imp\_achvm_{it}) \dots (6)$$

Where the parameters reflect weights or factor loadings (α_{kt}, β_{kt} and γ_{kt}) generated by the Factorial Analysis[30]. Thus, a synthetic index that reflects the educational outcome of each elementary school and for each period is obtained.

With estimates made for the period 2010 - 2014, the analysis finds that private schools generated higher results (average 0.78) compared with public schools (0.74). Also, private schools' homogeneous results are shown among themselves; while public schools have on average more scattered results. It also found that full-grade schools report higher and more consistent levels of education result (0.77). While multi-grade schools show average levels of 0.74, with high dispersion.

If the same results at every educational jurisdiction are reviewed, it is found that jurisdictions of Moquegua, Tacna, Tumbes, Ica and Arequipa are, on average, have schools that generate higher educational outcomes in the country. Meanwhile, jurisdictions located in the area of the jungle (Loreto and Ucayali) are those with lower levels of IREDU (see **Figure 5**).

ii) Discretionary inputs

As described in the previous sections, this study considers the classification of three types of discretionary inputs or school inputs: aspects of non-pedagogical support, aspects of pedagogical support, and aspects of teaching staff.

About aspects of non- pedagogical support, they were considered those that enable the provision of educational services and the creation of educational outcomes, but do not participate directly in the performance of pedagogical practice. In this group five variables were calculated:

- *Quality of school infrastructure.* The local school is the physical space in which school activities are performed. For the calculation has used the report to the principals about the status of the predominant material walls, ceilings and floors[31] of the building. From this information, an index

[29] *Factorial Analysis* methodology reduces a number of indicators in one or more factors. This method studies the interdependence that can exist in a set of observables, and assumes the existence of a common underlying factor all variables. This factor is a latent variable, and needs to be inferred from a set of observables. This latent variable contains the information of the observable variables. Alternatively, it is possible that a set of observables two or more are common factors underlying. So algebraically, the set of variables the method estimates a parameter matrix or Factor Loading Matrix, which identifies residual values or not explained by the latent variable. About this Kaiser (1974) explains that it should select the set of factors whose eigenvalues are greater than one. This situation would reflect a context in which each variable to include individually contributes (or maintains a degree of "community") to other variables; whereby a common construct is generated or common factors are identified.

[30] For more details on the Factor Analysis and Factor Loadings Matrices, see Annex 2 (Table 6).

[31] Information about the predominant material in the walls is reported under the following categories: mat, cardboard or plastic; Eternit fibre or concrete; wood; stone clay, lime or cement; *quincha* or barking clay reinforced with cane; adobe or mud; brick or concrete; and other. Information about the predominant material in the ceilings is reported under the following categories: straw, palm leaf or the like; mat, cardboard or plastic; tin or brass; cane with mud; calamine; fibre cement; roof tile; wood; reinforced concrete; and

that takes values from zero (lowest quality infrastructure of the sample) and one (highest quality of infrastructure in the sample) is constructed[32].

- *Access to basic services*. These services include: access to electricity, clean water and sewage services[33]) in the school building. As in the previous case, use of the information reported by school principals is done. With this information an index that takes values between zero (no access to any of the three services) and one (with good quality access to all three services) is constructed[34].
- *Availability of physical spaces.* The most common physical spaces in the Peruvian education system (workshops, computer rooms, science laboratories, slabs and sports areas and classroom libraries) are considered. School principals also report this information[35].
- *Sufficiency of furniture per student*. This indicator was also built on the basis of the report of the directors of schools and comprises the adequacy of folders, tables and chairs on school building[36].
- *Sufficiency of classrooms sections*. To do this, the number of classrooms available downplayed and enabled on school premises regarding the number of sections (regardless of what degree or degrees such sections engaged). This indicator was normalized between values of zero and one taking the maximum and minimum values observed in the sample in each year[37].

Concerning variables pedagogical support, they include those aspects directly involved in the process of generating educational outcomes, because they form part of the teaching practices. In this case, three variables were considered.

- *Length of school calendar and duration of the school day*. Both consist of standard variables indices reflecting the extent of calendar days, and the time in hours.
- *Availability of operating computers*. It is included as an aspect of pedagogical support, because it was considered computers that are used ex professedly for that purpose. In this regard, we proceeded to normalize the indicator as in the previous cases.

Finally, the third category includes teachers of the school. In particular, it has built a number associated with the number of teachers per student or *Teacher per student sufficiency indicator*. This particular variable has been considered because of the teacher is the key player of the educational process, and availability facilitates the generation of educational outcomes[38]. Thus, as shown in Table 16, normalized for each of the discretionary inputs values were obtained.

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others. Information about the predominant material on the floors is reported under the following categories: land; wood (boarding); cement; tile, ceramic or the like; vinyl or the like; polished wood or similar; and other. This report allows categorization under a quality scale of these materials (1 for low quality, 2 for medium quality; and 3, for high quality materials used).

[32] For more details on the factor analysis and factor loadings matrices see Annex 2 (Table 7).

[33] Information about access to electricity services is reported under the following categories: access to the public network (a power distribution company); by a generator or motor municipality; by a generator or motor school building; or simply do not have access. Information about access to drinking water is reported under the following categories: access to the public network (drinking water); a pylon for public use; a tanker or the like; a pit; through rivers, canals, springs or the like; or simply do not have access. Information about access to sewer is reported under the following categories: access to public sewage network; by some well receiving treatment with lime, ash or other waste disintegrating, a pit that receives no treatment to disintegrate waste; rivers, ditches or canals; or simply do not have access. Overall, for the three cases it is categorized under the following scale, according to the quality of access to each of the basic services: 0, no access; 1 access of poor quality; and 2 access of acceptable quality.

[34] For more details on the factor analysis and factor loadings matrices see Annex 2 (Table 8).

[35] For more details on the factor analysis and factor loadings matrices see Annex 2 (Table 9).

[36] For more details on the factor analysis and factor loadings matrices see Annex 2 (Table 10).

[37] The construction of the normalization of the variable x_{it} and follows the form: $z_{it} = \frac{Max(x_{it}) - x_{it}}{Max(x_{it}) - min(x_{it})}$.

[38] It is possible to detail on some other aspects related to teaching quality; however, in this study such specifications are not made for various reasons. For example, it is not detailed on the pedagogical training of teachers, because no variability was found; and on issues such as employment status and/or wage levels, it has not publicly available information.

Figure 5. Peru: Index of Educational Result of elementary schools by educational jurisdiction (2010 - 2014)

Education jurisdiction	Average	Standard deviation	Number of schools
Tacna	0.7864	0.0834	1,209
Moquegua	0.7818	0.0759	984
Ica	0.7364	0.0708	3,211
Arequipa	0.7302	0.0870	6,301
Tumbes	0.7202	0.0840	887
Callao	0.7061	0.0958	2,696
Lambayeque	0.6959	0.0687	5,268
Huancavelica	0.6874	0.0718	6,001
Pasco	0.6801	0.0951	3,453
Lima (Metropolitan area)	0.6740	0.0695	22,475
Cajamarca	0.6692	0.0786	18,430
La Libertad	0.6675	0.0791	10,042
Piura	0.6601	0.0840	11,492
Madre de Dios	0.6561	0.0720	989
Ancash	0.6548	0.0914	9,331
Lima 1/	0.6500	0.0816	5,038
San Martín	0.6480	0.0781	6,614
Puno	0.6453	0.1118	9,575
Cusco	0.6281	0.0928	9,081
Junín	0.6237	0.0902	10,905
Amazonas	0.6191	0.0805	6,087
Huánuco	0.6163	0.0970	8,598
Ayacucho	0.6106	0.0997	7,065
Apurimac	0.6040	0.1053	4,411
Ucayali	0.4744	0.1143	3,995
Loreto	0.4612	0.0925	11,544

Note. 1 / Excludes Metropolitan area. The number of elementary schools that had students enrolled in each year analysed was considered. In total, there are up to 26 educational jurisdictions in the educational system (one for each political region, and in the case of Lima is sub-divided into the Regional Directorate of Education in Metropolitan Lima and the Regional Directorate of Education of Lima Province). Source: MINEDU (2010 and 2014) and INEI (2010-2014).

iii) Non-discretionary inputs

In particular, the variables shown below are the explanatory variables that characterize the students, their households and their communities.

- *Proportion of students with early childhood education*. Based on students at each school, they reported being enrolled in at least one year of preschool or early childhood education. According to authors like Benavides et al (2014), Beltrán & Seinfeld (2011) y Miranda (2008), students who have attended preschool have a greater predisposition and early cognitive skills that facilitate the development of learning achievement.
- *Accumulated educational result.* This variable pre-analysis period or cumulative cognitive skill. As Boissiere (2004) suggest, and Todd & Wolpin (2003), this variable is positively related to obtaining educational outcomes in the present.
- *Years of schooling of the adult population*. Allow to analyse the educational experience that has an average adult, since it is assumed that this experience can influence the importance that is given to the schooling of minors (Glewwe & Muralidharan, 2015; Miranda, 2008).
- *Average household spending on health and related issues*. This variable describes not only the socioeconomic status of households, as referred on budgetary availability of households, but also describe the degree of prioritization of spending on health issues relative to other budget options. Given the information, this variable has been calculated average level of jurisdiction (Tam, 2008; Todd & Wolpin, 2003; Worthington, 2001).
- *Presence of indigenous languages*. It is an aspect that limits the generation of educational outcomes, because in these contexts requires the application of a pedagogical practice adapted and intensive (i.e.: a curriculum adapted, availability of suitable materials, and teachers with specific training).
- *Proportion of households in overcrowded dwellings*. It is a variable that is one of the unsatisfied basic needs of households in each educational jurisdiction. According to Cueto et al (2015) and Pritchett & Filmer (1997) this variable is inversely related to the generation of educational outcomes because, if households living in inadequate or live in overcrowded homes, then learning opportunities will be lower. conducting activities to reinforce learning at home is difficult.

- *Regional spending on education*. Budget availability is a facilitator in generating educational outcomes because it implies a greater availability of usable inputs in the medium term. Pereyra (2002) had already found evidence of the importance of this factor, but also identified its importance can be reduced due to the existence of bureaucratic obstacles that limit the efficiency of public expenditure, as this author found.
- *Geographic area.* The effect on efficiency is uncertain because the location of the school in a given geographical area can facilitate access to information, generate greater social interaction and increase access to communications. But also, the geographic area may be a limiting of educational efficiency because for school's educational efficiency is increased at decreasing rates (Miranda, 2008) and in the urban area is more difficult to obtain educational efficiency, given the size of demand for educational services.
- *Type of management or organization of schools*. Aspects such as the type of educational management (public management or private management), or as school organization (full-grade or multi-grade schools), different possibilities of administrative, institutional and/or pedagogical management of these schools. For this reason, that control aspects considered in the estimates.

4) Results

a) Analysis of educational efficiency: Discretionary inputs

According with the discussion in the previous sections, the analysis of educational efficiency means that the efficiency (technical) complies with the following considerations:

- There is no consensus on how to measure the results. Therefore, the efficiency analysis was performed by measuring three options: i) average score of each school, obtained in the ECE - Reading comprehension; ii) average score of each school, obtained in the ECE - Mathematics; and iii) Education Index Score. The first two are normalized and dimensional character variables representing educational outcomes; while the third is estimated according to the guidelines mentioned previously multidimensional variable.
- School inputs are standardized discretionary inputs. It has nine inputs: quality of infrastructure, access to basic services, availability of spaces, school furniture for students, classrooms by section, duration of the academic calendar and the school day, computers for educational use by students and teachers per student.
- The study has been applied nonparametric methods (DEA) and parametric (SFA) in parallel. All this in order to compare the results.

The estimation of efficiency levels under the above considerations, allowed us to find that the three options for measuring the educational outcome generate a similar hierarchization. A first comprehensive analysis of all sample schools per year suggests that the level of efficiency of schools has increased over the period 2010 - 2014. These efficiency indicator values are statistically similar across the three variable type's analysed result.

As shown in Figure 6, the numerical differences between levels of efficiency estimates are related the methodology applied. The results obtained by the DEA methodology are more spreaded and higher than those obtained by the SFA. However, both methods have a hierarchical order, or similar to each other. This has a methodological justification, because the DEA method applies a flexible scheme, (by not having a functional form) that identifies a few effective schools in a context of high heterogeneity, and that generates greater distances between effective schools and the rest. On the other hand, the SFA method is less flexible, (by imposing a functional form) which includes many effective schools in a context of high heterogeneity, and generates much shorter distances. In other words, observed heterogeneity between schools creates overestimations of the differences between levels of efficiency with DEA method, while the SFA method underestimates the same distances.

A second result is associated with the suitability of Educational Outcome Index as a variable comprising

the multidimensionality of educational outcomes. According to the results of efficiency analysis, three alternative measurement of educational results show similar systems (among the most efficient to least efficient schools). However, cases in which the outcome variable considered are the scores in the ECE Reading and Mathematics in ECE have much more similar to each other jurisdictions. Meanwhile, the case in which educational outcomes are measured through the synthetic index IREDU not only creates slight variations in the order of efficient and inefficient schools, but also considers the conceptual multidimensionality of educational outcomes.

In particular, levels of efficiency achieved (under both methodologies) can be compared across two cohorts of analysis: type of management and type of organization of schools. With regard to the type of school management, results show that public schools have increased their level of educational efficiency over recent years. Private schools have maintained, on average, the same level of efficiency, which could explain the heterogeneity among schools. Regarding the type of organization of schools, the results obtained show that full-grade schools get high levels of educational efficiency regarding multi-grade schools. Full-grades generate homogeneous levels of efficiency to each other; unlike results from multi-grade schools (see Annex 2).

Figure 7 shows the average efficiency levels in each region of the country (in 2014). In this case, it is found that the regions with the highest and lowest levels of educational efficiency are always the same, independently of the applied educational outcome variable. Moquegua, Tacna and Tumbes are educational jurisdictions with the most efficient schools. Under both methodologies, Loreto and Ucayali jurisdictions are those with most schools less efficient in the sense of generating educational outcomes.

As shown in Table 17 (Annex 2), the observed increase educational efficiency levels in 2011 and 2012 related to the increase in access to basic services, the quality of educational infrastructure and availability of classrooms per section. These school supplies have increased just in the years 2011 and 2012, which created variations on the school´s efficiency levels. Subsequently, in 2013 and 2014, access to basic services and the availability of classrooms per section are the factors that have kept closer relationship with the results obtained by the schools.

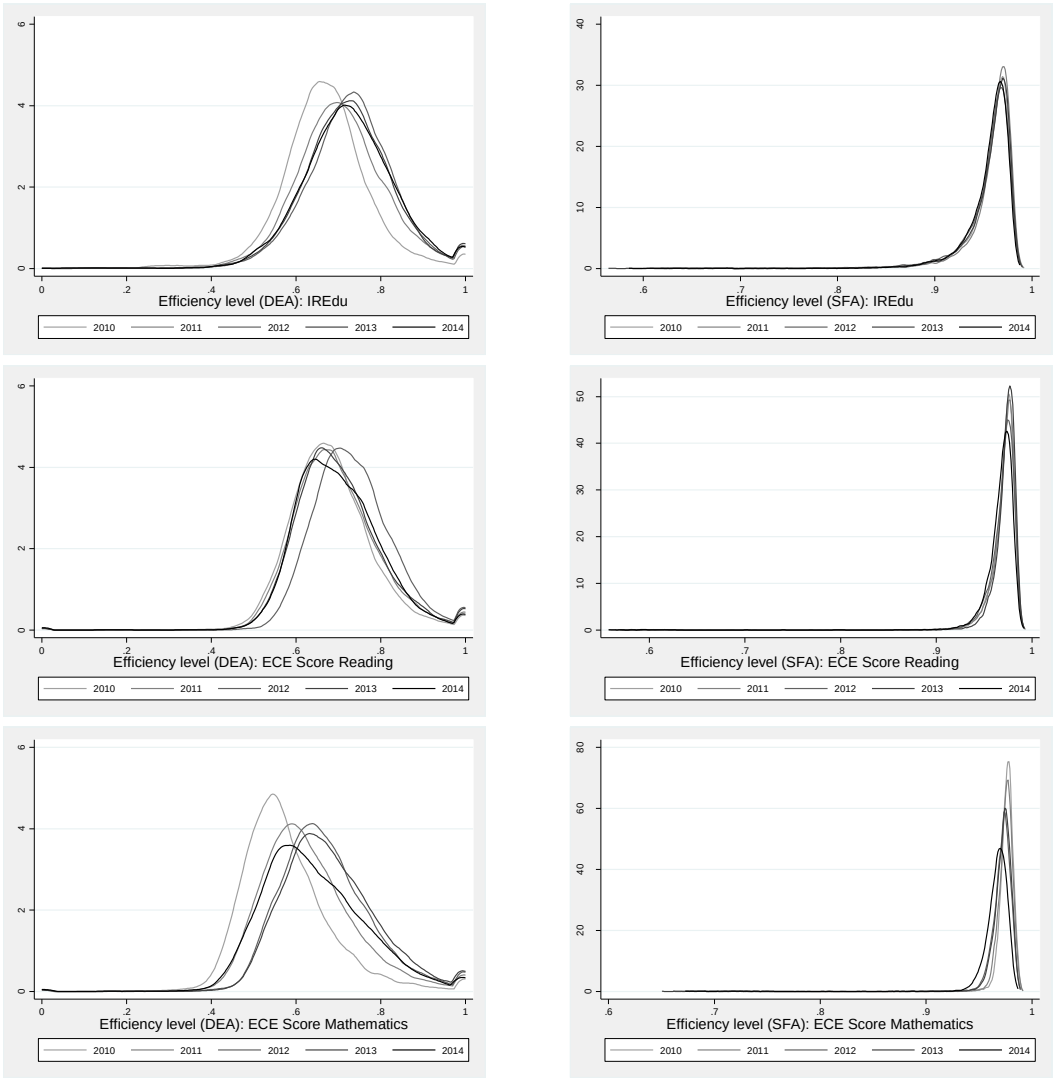
Educational efficiency is the result of proper management of school or discretionary inputs, while that proper management is reflected in the generation of a maximum proportion of educational outcomes (in its multiple dimensions of analysis). Thus, the efficiency analysis identifies what discretionary inputs intervened with greater emphasis on generating results were.

An additional issue that allows the (non-parametric) efficiency analysis with longitudinal information is the application of the method of Malmquist decomposition (Coelli et al 2003). With this calculation, it is possible to observe changes in the levels of efficiency over time and identify whether these changes are changes TFP, and what are the sources of variability are. This method suggests that, if the TFP indicator shows change values greater than unity, then there has been an increase in production capacity from one period to another. However, as shown in Figure 10, over the period 2010 to 2014 the indicator has remained below the unit ($M_i < 1$) in most schools analyzed. This would reflect a loss in the productive capacity of schools.

To sum up, the loss in the capacity to create educational attainment in schools can be directly associated to a loss in the management capabilities of educational inputs (observed by the average indicator of technological change). Indicators of change in technical efficiency of school (ΔEF), change in pure technical efficiency (ΔEFP), and change in scale efficiency (ΔCEE) have remained on average around the unit. With this, it is possible to infer that the loss of capacity management, rather than an absolute loss, is a relative downturn based mainly on the effective increase in most school supplies available at school and in the low increase has generated over educational outcomes observed.

Figure 6. Peru: Distribution of levels of efficiency DEA and SFA by type of educational outcome (2010 - 2014)

(a) DEA Methodology *(b) SFA Methodology*



Note. Own elaboration. For more details, check Annex 3 (Table 14). N = 23,647 schools (originals and imputed).

b) Non-discretionary determinants of educational efficiency

The estimate of determinants of school efficiency levels of non-discretionary factors was considering the efficiency levels estimated by parametric (SFA) or non-parametric (DEA) methods; and three options for measuring educational outcomes. Specifically, the results shown in Table 2 reported separately by type of school management and by type of school organization[39].

It is noteworthy that control variables included in the study to avoid the generation of bias in the estimates. Of these variables, highlight the type of school management (public schools and private schools), type of school organization (full-grade schools and multi-grade schools), regional effects and temporary effects. In

[39] Details of the estimates with longitudinal data (Table 18) and annual (Table 19, Table 20, Table 21 and Table 22) are reviewed in Annex 5.

all these cases are consistent and significative results. Among the main results, it was found that public schools receive educational efficiency levels lower than in the case of private schools. Meanwhile, the full grade schools recorded higher levels of educational efficiency, those multi-grade schools.

Figure 7. Peru: Average efficiency estimated by DEA, by type of educational outcome and region (2014)

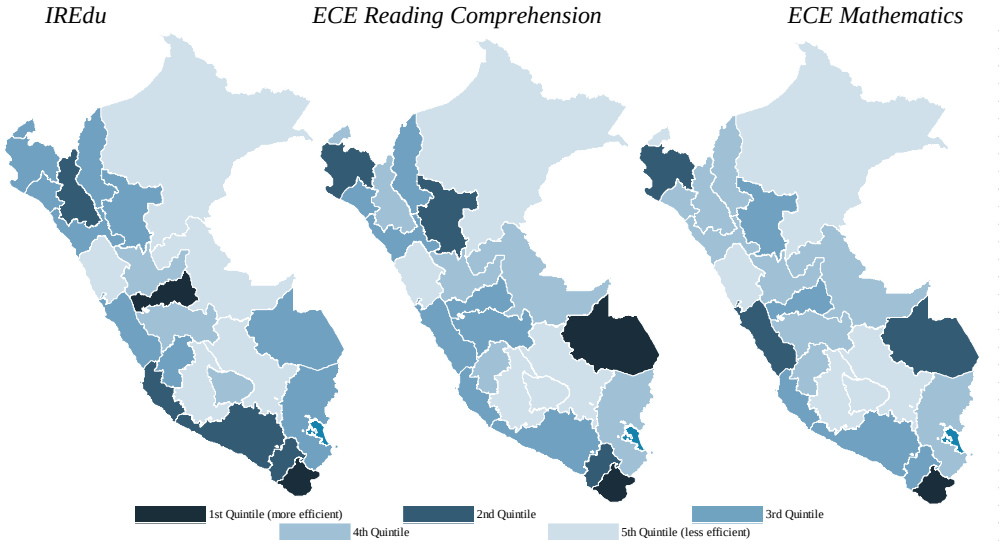
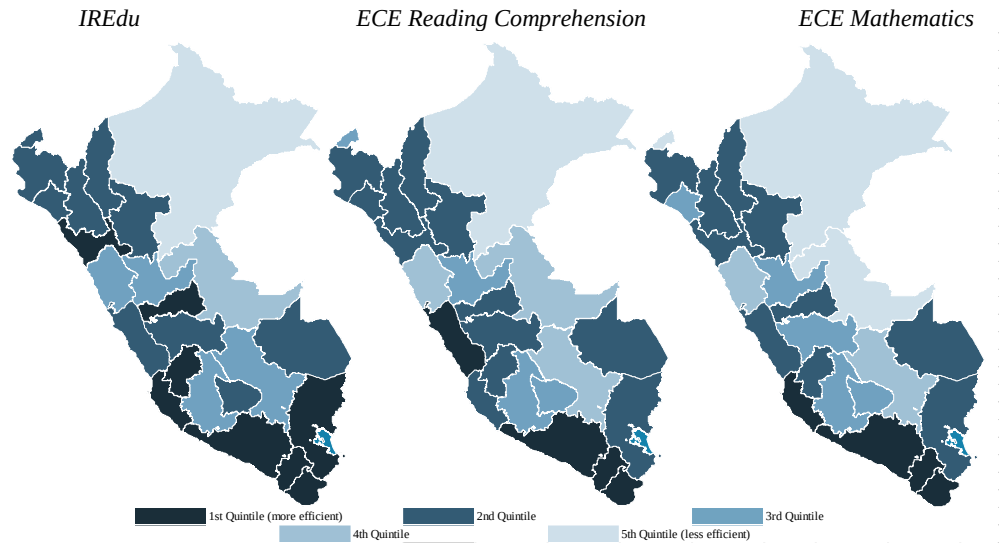


Figure 8. Peru: Average efficiency estimated by SFA, by type of educational outcome and region (2014)



Note. Own elaboration. For more details, check Annex 3 (Table 14). N = 23,647 schools (originals and imputed).

As shown in Table 2, the analysis of determinants of educational efficiency approaches corroborates shown evidence by Boissiere (2004) and Todd & Wolpin (2003) about the lag in educational outcomes. This variable measures cognitive skills accumulated by the students of each school (on dimensional analysis), and educational results achieved in the previous period by each school (under multidimensional analysis). In all cases, this variable provides the level of efficiency in schools because they facilitate the generation of contemporary educational outcomes.

A second aspect showing consistent results across cohort analysis is the proportion of students with early education at school. This variable shows significant and positive results regarding the efficiency of (public and particularly full-grade) schools. These results suggest that schools, where a higher proportion of students with preschool education are, have a greater facility for the generation of educational outcomes. It is noteworthy that, in the case of private schools, the significance is much lower than in the rest cohort

analysis. This finding confirms the results previously identified by Benavides et al (2014), Beltran & Seinfeld (2011), Tam (2008), Berlinski et al (2008) and Cueto et al (2015).

Another interesting result is the statistical importance of the household budget on health and average years of education of household heads. Both aspects have a positive relationship with educational efficiency, and particularly in the case of public schools. This result makes sense for two reasons. The higher educational level of household heads increases the subjective assessment of education, which household financial assets in which it is profitable to invest resources. On the other hand, the household investment in health, not only reflects the importance that is given access to intangible services such as education and health, but also facilitates the educational process since the state of health of students affected in attention span and the development of cognitive skills of students (Cueto et al 2015; Boissiere 2004).

Table 2. Peru: Estimation Tobit - Results by type of school and methodology of technical efficiency (2010 – 2014)

	Public Schools		***Private Schools***		***Full-grade Schools***		***Multi-grade Schools***	
	Non-parametric	**Parametric**	**Non-parametric**	**Parametric**	**Non-parametric**	**Parametric**	**Non-parametric**	**Parametric**
Home & Student								
Students with Initial Education	0.0116 ***	0.0056 ***	0.0235 *	0.0151	0.0162 ***	0.0115 ***	0.0129 ***	0.0058 ***
	7.38	4.79	1.68	0.60	5.64	2.61	7.22	4.44
Educational Outcome (Period t-1)	0.1180 ***	0.0411 ***	0.1388 ***	0.4178 ***	0.1219 ***	0.1160 ***	0.1184 ***	0.0418 ***
	39.30	13.94	8.41	12.68	28.03	13.81	30.94	11.69
Schooling of head of household (Average)	0.0192 ***	0.0040 **	0.0614 **	0.0355	0.0148 ***	-0.0072	0.0117 ***	0.0038
	7.08	2.35	2.28	0.66	4.17	-1.61	3.12	1.63
Annual household spending: In health and related (Average)	-0.0360 ***	-0.0258 ***	0.0403	-0.1958 *	-0.0221 ***	-0.0076	-0.0273 ***	-0.0324 ***
	-5.71	-5.06	0.79	-1.86	-2.73	-0.66	-3.19	-5.04
Community								
% Households in overcrowded dwellings	-0.4386 ***	-0.2786 ***	0.0077	1.1774	-0.2655 ***	-0.3206 ***	-0.6426 ***	-0.3121 ***
	-9.15	-7.52	0.02	1.27	-3.88	-3.31	-10.54	-7.15
Presence of indigenous languages [Indigenous languages = 1]	-0.0557 ***	-0.0260 ***	0.0003	0.0203	-0.0552 ***	-0.0223 ***	-0.0468 ***	-0.0227 ***
	-33.00	-28.70	0.02	0.65	-19.09	-9.54	-22.37	-21.38
Geographic area [Rural area = 1]	-0.0093 ***	0.0005	-0.0017	0.0695 **	-0.0143 ***	-0.0008	-0.0020	0.0039 **
	-7.58	0.44	-0.11	2.38	-9.59	-0.46	-1.01	2.46
Government and Education System								
Public expenditure in the Education Sector	0.0325 ***	0.0184 ***	-0.0306	-0.1664 **	0.0282 ***	0.0029	0.0094	0.0204 ***
	6.10	4.57	-1.08	-2.41	4.91	0.34	1.06	3.45
Distance between school and UGEL	0.0005 ***	-0.0001 **	0.0008	0.0005	0.0000	-0.0003 **	0.0005 ***	0.0000
	10.36	-2.18	1.30	0.51	-0.23	-2.05	9.50	-1.28
Type of school organization [Full-grade schools = 1]	0.0266 ***	0.0011	0.0263 ***	0.0348 **				
	23.01	1.04	2.95	2.18				
Type of school management [Public Management = 1]					-0.0243 ***	0.1788 ***	-0.0374 ***	0.1880 ***
					-8.18	22.68	-4.70	11.84
Temporal effects	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Regional effects	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Intercept [c]	0.6028 ***	1.0448 ***	0.1051	2.9410 ***	0.5646 ***	0.8890 ***	0.8224 ***	0.8944 ***
	10.12	21.41	0.23	3.07	7.65	8.40	9.48	13.54
Estimated overall error [sigma - e]	0.1197 ***	0.0879 ***	0.1222 ***	0.3001 ***	0.0933 ***	0.1343 ***	0.1324 ***	0.0942 ***
	314.42	55.41	50.69	59.18	171.88	62.41	271.91	51.51
AIC Criterion	-97,400	-147,500	-2,580	1,246	-52,980	-34,290	-52,090	-87,480
BIC Criterion	-97,030	-147,100	-2,353	1,482	-52,650	-33,960	-51,740	-87,130
Likelihood value (Log)	48,740	73,768	1,330	-583	26,530	17,184	26,085	43,782

Note. These results consider the original information in accordance with the procedure outlined in the methodology section. This table reports coefficients and t-statistics estimates. Significance levels are reported each coefficient levels of 90% (*), 95% (**) and 99% (***). The estimate includes controls for temporal and regional effects through dummy variables.

Furthermore, there are factors that characterize home to students and limit the development of higher levels of educational efficiency. A variable describing this situation linked to the space and comfort of the house. These findings corroborate those of Pritchett & Filmer (1997), who found that the proportion of households living in overcrowded limited educational efficiency. This in all schools, except in private schools (perhaps because the socioeconomic status of the homes of students attending these schools is particularly higher than in other cases). Similarly, the presence of indigenous languages in the community is significant through the models considered. This aspect would serve as limiting the level of educational efficiency; it is a situation that requires the application of a teaching practice adapted and intensive, which it not offered under the scheme of the EBR (Miranda, 2008).

About characteristics of the operation of the educational system, it is that the public budget for the Education Sector maintains a positive and significant relationship in public schools. Notably, in the case of private schools, this variable has no significance, probably because such schools do not benefit from public investment in the sector. Similarly, the distance between the school and the corresponding educational management authorities (Local Educational Management Units or UGELs, in the Peruvian educational system) is a variable that measures the difficulty of making representations institutional functioning of schools. In this case, contrary to the findings of Tam (2008), this aspect lacks statistical significance in the more disaggregated levels; and maintains a positive relationship in the longitudinal analysis. The latter may have association with the importance of independence in educational management and capacity management of school supplies for generation of educational outcomes[40].

5) Conclusions

The key objective of this research article has been to characterize and explain the efficiency in the process to create educational outcomes of elementary schools that were operating during the period between 2010 and 2014 in the Peruvian educational system. The main conclusion is that elementary schools have differences in efficiency. These differences are more appropriately described if education is not considered as a one-dimensional outcome (if only considering the dimension of educational achievement) as the literature suggests. Indeed, education should be described as a multidimensional result, which includes access, retention and educational achievement.

The aspects that explain differences in levels of educational efficiency are twofold: discretionary and non-discretionary aspects. First, discretionary aspects are part of the set of inputs available to schools, and consequently are manageable by the school itself. On the other hand, non-discretionary aspects are exogenous aspects that influence the decisions of school management, and are associated with the characteristics of the demand for educational services.

I have applied parametric (SFA) and non-parametric (DEA) approaches that generate an efficiency measure as the relative distance between schools with greater results and less use of inputs available, and other schools. It has been found that independently of the methodology applied, there is a wide dispersion in terms of efficiency levels achieved at the national level. Differences are highlighted by comparing public elementary schools with private; and between schools full-grade and multigrade type. This situation has direct consequences for the design and implement sectoral policies. For that reason, it is necessary to apply adapted policies for each context. And it would be a way to ensure that all primary schools to attain the expected levels and quality of desired education.

Latent heterogeneity among elementary schools is explained by the fact that private schools and full-grade schools are concentrated in urban areas, which in turn, has increased availability and facilities for the provision of educational services: better quality of infrastructure, greater access to educational materials and furniture and greater availability of teaching staff. By contrast, in rural areas they are concentrated multi-grade schools and public schools, which in turn have a lower availability of educational inputs.

Over recent years there has been extensive government efforts to provide necessary school inputs, mainly in rural schools, and for multi-grade schools. This circumstances can explain the recent increase of the educational efficiency level of these school types. But, these efforts are not sufficient to close tha gaps respect to full-grade schools and urban schools.

[40] Institutional management independence refers to the possibility that a school is managed and adapted own way, without resorting to impositions generated by instances of governmental organization, as UGELs. Although this aspect would be expected to influence only in public schools, the results also prove to be inconsistent and insignificant (Tam 2008).

One of the main findings about educational efficiency is that there is a lack in the capacity to create educational attainment in schools. Specifically, school inefficiencies are related to the ability to use inputs such as access to basic services, and the adequacy of classrooms sections. However, this does not imply that other school supplies are not relevant. In fact, the size of teaching staff, the quality of educational infrastructure, and other aspects have lost relevance, affording to the evidence, because these can be founded in standarized and homogeneous way in the education system. This, through the efforts of recent education policy.

As for the analysis of the relationship between non-discretionary aspects and levels of educational efficiency, this research has successfully demonstrated that both pre-school education and educational outcomes stragglers are particularly relevant, compared with the other aspects that have a determining character of contemporary educational outcomes.

Demand characteristics play a key role and generates heterogeneity. It is likely that historical reasons that lead to this situation, and this aspect support the fact that educational policies should not be only educational. On the contrary, the process of improving the quality of educational provision, as a channel for increasing efficiency, necessarily implies designing policies in a broad spectrum that not only involve the educational sector. It is fundamenta considering other aspects such as infrastructure improvements, health and reducing levels of poverty and inequality.

Although the latter idea demonstrates a recurring conclusion in the literature for more than a decade (Cueto et al 2015, Benavides et al 2014, Beltran & Seinfeld 2011, Tam 2008, and Pereyra 2002, had identified similar findings), this study meets the aim of providing support and tools for designing policies to overcome these heterogeneities and promote welfare in society.

Finally, it is important to note that this research is still limited. Since it has tried to analyse a wide field of study (elementary schools), a suitable efficiency analysis should be carried out much more specifically and cautiously. It has used information available, but better information may allow us to include other aspects as teacher quality, infrastructure improvements, distribution of educational materials, and information on sub-national efforts in education. Also, a pendent task is related to improve methodological aspects, and to include better quality information, to assess the consistency of these results.

6) References

Afonso, A., & St. Aubyn, M. (2005). Non-Parametric Approaches to Education and Health Efficiency in OECD Countries. Journal of Applied Economics, VIII (2), 227 - 246 pp.

Aguilar, G., Camargo, G., Morales, R., & Diaz, R. (2005). ¿Son más eficientes las instituciones microfinancieras que los bancos? Instituto de Estudios Peruanos, 83 pp.

Aigner, D., Lovell, C., & Schmidt, P. (1977). Formulation and Estimation of Stochastic Frontier Production Function Models. Journal of Econometrics, 6, 21 - 37 pp.

Álvarez-Parra, F. (2012). Diferencias en la Calidad de la Educación e Ineficiencia: Un Análisis Basado en el Método de Frontera Estocástica. Working Papers CAF (2012/12), 25 pp.

Bailey, E., & Friedlaender, A. (1982). Market Structure and Multiproduct Industries. Journal of Economic Literature, 20(3), 1024 - 1048 pp.

Banker, R., Charnes, A., & Cooper, W. (1984). Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis. Management Science, 30 (9), 1078 - 1092 pp.

Battese, G., & Coelli, T. (1995). A Model for Technical Inefficiency Effects in a Stochastic Production Function for Panel Data. Empirical Economics, 20, 325 - 332 pp.

Becker, G. (1964). Human Capital: A Theorical and Empirical Analysis, with Special Reference to Education. Nueva York: Columbia University Press, Pennsylvania State University.

Beltrán, A., & Seinfeld, J. (2011). Hacia una educación de calidad: La importancia de los recursos pedagógicos en el rendimiento escolar. Centro de Investigación de la Universidad del Pacífico (CIUP), 110 pp.

Benavides, M., León, J., & Etesse, M. (2014). Desigualdades educativas y segregación en el sistema educativo peruano: Una mirada comparativa de las pruebas PISA 2000 y 2009. Research Progress (15), 74 pp.

Berlinski, S., Galiani, S., & Manacorda, M. (2008). Giving children a better start: Preschool attendance and school-age profiles. Journal of Public Economics, 92 (5 - 6), 1416-1440 pp.

Boissiere, M. (2004). Determinants of Primary Education Outcomes in Developing Countries. Background Paper for the Evaluation of the World Bank's Support to Primary Education. The World Banck Operations Evaluation Department (OEP), 38 pp.

Bruns, B., & Luque, J. (2015). Great Teachers: How to Raise Student Learning in Latin America and the Caribbean. World Bank Publications, World Bank (20488), 360 pp.

Caves, D., Christensen, L., & Tretheway, M. (1980). Flexible Cost Functions for Multiproduct Firms. The Review of Economics and Statistics, 62(3), 477 - 481 pp.

Charnes, A., Cooper, W., & Rhodes, E. (1978). Measuring the Efficiency of Decision Making Units. European Journal of Operational Research, 2, 429 - 444 pp.

Checci, D. (2006). The Economics of Education: Human Capital, Family Background and Inequality. Nueva York: Cambridge University Press.

Christensen, L., Jorgenson, D., & Lau, L. (1971). Conjugate Duality and the Transcendental Logarithmic Function. Econometrica, 39(4), 251 - 266 pp.

Christensen, L., Jorgenson, D., & Lau, L. (1973). Trascendental Logarithmic Production Frontiers. The Review of Economics and Statistics, 55(1), 28 - 45 pp.

Cobb, C., & Douglas, P. (1928). A Theory of Production. The American Economic Review, Suplement. Papers and Proceedings of the Fortieth Annual Meeting of the American Economic Association, 18 (1), 139 - 165 pp.

Coelli, T., Estache, A., Perelman, S., & Trujillo, L. (2003). Una Introducción a las Medidas de Eficiencia: Para Reguladores de Servicios Públicos y de Transporte. Washington D. C.: World Bank - Alfaomega Colombiana S. A.

Coelli, T., Rao, D. S., O'Donnell, C., & Battese, G. (1997). An Introduction to Efficiency and Productivity Analysis. Boston: Kluwer Academic Publishers.

Coleman, J. (1966). Equality of Educational Opportunity. Washington DC: U. S. GPO.

Cueto, S., León, J., & Miranda, A. (2015). Características socioeconómicas y rendimiento de los estudiantes en el Perú. Análisis & Propuestas, Grupo de Análisis para el Desarrollo (GRADE) y Niños del Milenio (28).

Cueto, S., León, J., Miranda, A., Dearden, K., Crookston, B. T., & Behrman, J. R. (2015). Does pre-school improve cognitive abilities among children with early-life stunting? A longitudinal study for Peru. International Journal of Educational Research, 75, 102 - 114 pp.

De Witte, K., Maassen van den Brink, H., & Groot, W. (2012). The efficiency of education in generating literacy: A stochastic frontier approach. Review of Economics & Finance, Better Advances Press, 2(Febrero), 25 - 37 pp.

Färe, R., Grosskopf, S., Lindgren, B., & Roos, P. (1995). Productivity and quality changes in Swedish pharmacies. International Journal of Production Economics, 39(1), 137 - 144 pp. Obtenido de http://dx.doi.org/10.1016/0925-5273(94)00063

Farrell, M. J. (1957). The Measurement of Productive Efficiency. Journal of the Royal Statistical Society. Series A (General), 120(3), pp. 253 - 290.

Glewwe, P. (2002). Schools and Skills in Developing Countries: Education Policies and Socioeconomic Outcomes. Journal of Economic Literature, XL (Junio 2002), 436 - 482 pp.

Glewwe, P., & Kremer, M. (2006). Schools, Teachers, and Education Outcomes in Developing Countries. En E. Hanushek, & F. Welch, Handbook of the Economics of Education (Vol. 2, págs. 945 - 1017 pp.). Amsterdam: Elsevier.

Glewwe, P., & Muralidharan, K. (2015). Improving School Education Outcomes in Developing Countries: Evidence, Knowledge Gaps, and Policy Implications. Working Paper RISE-WP-15/001, Research on Improving Systems of Education (RISE), 112 pp.

Hanushek, E. (1979). Conceptual and Empirical Issues in the Estimation of Educational Production Functions. The Journal of Human Resources, 14(3), 351 - 388 pp.

Hanushek, E. (1986). The Economics of Schooling: Production and Efficiency in Public Schools. Journal of Economic Literature, XXIV (3, Setiembre, 1986), 1141 - 1177 pp.

Hanushek, E. (2003). The Failure of Input-Based Schooling Policies. Economic Jounal - Royal Economic Society, 113(485), F64 - F98 pp.

Hanushek, E. (2006). School Resources. En H. E, & F. Welch, Handbook of the Economics of Education (Vol. 2, págs. 1051-1078 pp.). Amsterdam: Elsevier.

Hanushek, E., & Rivkin, S. (2006). Teacher Quality. En E. Hanushek, F. Welch, E. A. Hanushek, & F. Welch (Edits.), Handbook of the Economics of Education (Vol. 2, págs. 1051-1078 pp.). Amsterdam: Elsevier.

Hanushek, E., Rivkin, S., & Taylor, L. (1996). Aggregation and the Estimated Effects of School Resources. The Review of Economics and Statistics, 78(4), 611 - 627 pp.

Harbison, R., & Hanushek, E. (1992). Educational Performance of the Poor: Lessons from Rural Northeast Brazil. Washington D. C.: Oxford University Press.

Herrera, P., & Francke, P. (2009). Análisis de la Eficiencia del Gasto Municipal y sus Determinantes. Economía, XXXII (63), 113 - 178 pp.

Iregui, A. M., Melo, L., & Ramos, J. (2006). Evaluación y Análisis de Eficiencia de la Educación en Colombia. Borradores de Economía (002645), 105 pp.

Jopen, G., Gómez, W., & Olivera, H. (2014). Sistema Educativo Peruano: Balance y Agenda Pendiente. Documentos de Trabajo, Departamento de Economía - Pontificia Universidad Católica del Perú. (379), 52 pp.

Kaiser, H. (1974). An index of factor simplicity. Psychometrika (39), 31 - 36 pp.

Klitgaard, R., & Hall, G. (1975). Are There Unusually Effective Schools? The Journal of Human Resources, 10(1), 90 - 106 pp.

Kumbhakar, S., & Lovell, C. (2000). Stochastic Frontier Analysis. Cambridge: Cambridge University Press.

Leibenstein, H. (1978). X-Inefficiency Xists: Reply to an Xorcist. The American Economic Review, 68(1), 203 - 211 pp.

León, J. (2009). An Empirical Analysis of Peruvian Municipal Banks Using Cost-Efficiency Frontier Approaches. Canadian Journal of Development Studies, 29(1-2), 161 - 182 pp.

LoveII, K. (1993). Production Frontiers and Productive Efficiency. En H. Fried, K. LoveII, & S. Schmidt, The Measurement of Productive Efficiency: Techniques and Applications (págs. 3 - 67 pp.). Nueva York: Oxford University Press.

Malmquist, S. (1953). Index Numbers and Indifference Surfaces. Trabajos en Estadística 4, 209 - 242 pp.

Meeusen, W., & Van Der Broeck, J. (1977). Efficiency Estimation from Cobb-Douglas Production Functions with Composed Error. Internarional Economic Review, 18(2), 435 - 444 pp.

Mincer, J. (1958). Investment in Human Capital and Personal Income Distribution. Journal of Political Economy, University of Chicago Press, LXVI (4), 281 - 302 pp.

Miranda, L. (2008). Factores asociados al rendimiento escolar y sus implicancias para la política educativa del Perú. En M. Benavides, & M. Benavides (Ed.), Análisis de programas, procesos y resultados educativos en el Perú. Contribuciones empíricas para el debate (pág. 29 pp.). Lima: GRADE.

OMCA. (2009). Evaluación Censal de Estudiantes (ECE) Segundo grado de primaria y Cuarto grado de primaria de IE EIB - Marco de Trabajo. Lima: Oficina de Medición de la Calidad de los Aprendizajes - Ministerio de Educación del Perú.

Pereyra, J. (2002). Una medida de la Eficiencia del Gasto Público en Educación: Análisis FDH para América Latina. Estudios Económicos - Banco Central de Reserva del Perú (BCRP), 14 pp.

Polachek, S., Kniesner, T., & Harwood, H. (1978). Educational Production Functions. Journal of Educational Statistics, 3(3), 209 - 231 pp.

Pritchett, L., & Filmer, D. (1997). What educational production functions really show: A positive theory of education spending. Policy Research Working Paper Series 1795, The World Bank, 54 pp.

Solmon, L. (1970). A Note on Equality of Educational Opportunity. The American Economic Review, 60(4), 768 - 771 pp.

Tam, M. (2008). Una aproximación a la eficiencia técnica del Gasto Público en Educación en las regiones del Perú. Lima: Consorcio de Investigación Económica y Social (CIES).

Todd, P., & Wolpin, K. (2003). On The Specification and Estimation of the Production Function for Cognitive Achievement. The Economic Journal, 113 (Febrero), F3 - F33 pp.

UNESCO. (2014a). Enseñanza y Aprendizaje: Lograr la Calidad para Todos. París: Organización de las Naciones Unidas para la Educación, la Ciencia y la Cultura.

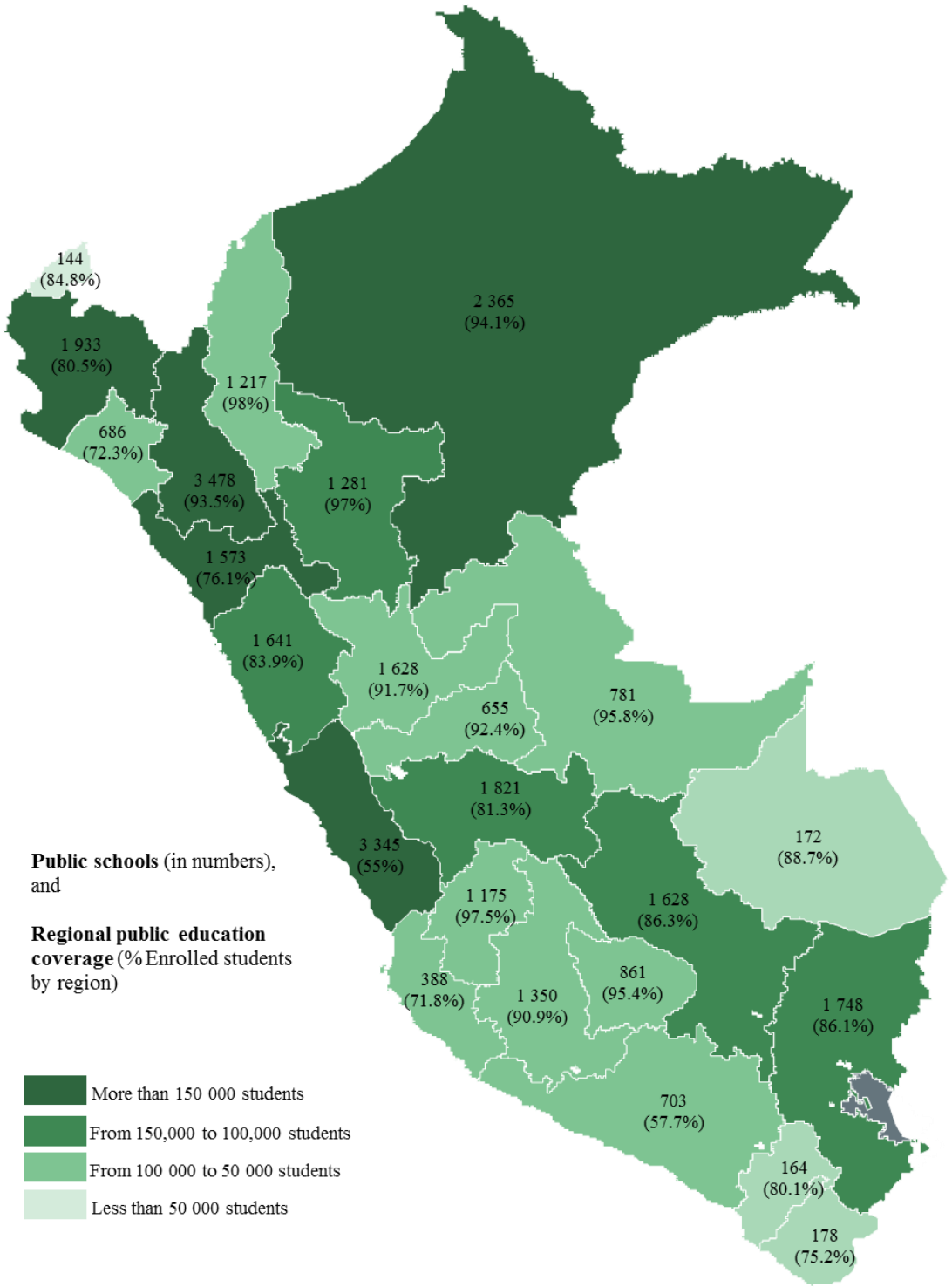
UNESCO. (2014b). Enseñanza y Aprendizaje: Lograr la Calidad para Todos. Una mirada sobre América Latina y el Caribe. Santiago de Chile: Organización de las Naciones Unidas para la Educación, la Ciencia y la Cultura.

Worthington, A. (2001). An Empirical Survey of Frontier Efficiency Measurement Techniques in Education. Education Economics, 9(3), 245 - 268 pp.

7) Annex

Annex 1. Descriptive statistics complementary

Figure 9. Peru: Distribution of schools of public administration and percentage of students enrolled in public schools by region (2014)



Note: Source: *Registro Nacional de Instituciones Educativas* (MINEDU 2015), and the ENAHO (INEI 2014). Regional coverage rate considers the percentage of the population between 6 and 11 years, who live in the region and is enrolled in the educational system, regardless of grade, cycle, level or mode. Own elaboration.

Table 3. Peru: Access to primary education by geographic area, according natural region and political region (2010 – 2014)

	Net enrolment ratio					*Net attendance ratio*				
Year	**2010**	**2011**	**2012**	**2013**	**2014**	**2010**	**2011**	**2012**	**2013**	**2014**
National	93.8	93.6	92.9	92.7	92.1	93.3	93.0	91.6	92.4	91.9
Geographic area										
Urban	93.7	93.1	92.7	92.2	92.2	93.3	92.7	91.4	92.0	91.9
Rural	93.9	94.6	93.3	93.8	92.1	93.2	93.7	92.0	93.4	91.7
Natural region										
Coast 1/	93.7	93.1	92.6	92.8	92.1	93.3	92.8	91.3	92.5	91.8
Lima and Callao 2	92.9	93.0	91.3	92.4	91.3	92.7	92.8	90.0	92.1	91.0
Coast (Rest) 3/	94.6	93.1	94.1	93.3	93.0	94.1	92.7	92.7	92.9	92.2
Highland	93.9	94.5	93.2	92.9	92.3	93.5	94.2	92.5	92.7	92.2
Jungle	94.0	92.9	93.0	91.9	91.9	92.5	90.8	90.4	91.4	91.4
Region										
Amazonas	95.0	90.8	94.7	93.6	91.2	94.5	90.6	94.3	92.8	91.0
Áncash	95.3	95.8	95.2	94.0	91.7	94.7	95.2	91.4	93.8	91.7
Apurímac	92.3	96.7	91.8	91.2	93.4	92.0	96.7	83.6	91.2	93.4
Arequipa	94.4	95.2	93.9	93.7	91.9	94.4	95.2	93.4	93.7	91.9
Ayacucho	92.6	93.9	94.3	94.5	88.1	92.2	93.9	93.8	94.1	87.0
Cajamarca	93.7	95.3	96.0	93.2	93.4	93.0	94.8	96.0	93.0	93.4
Callao	95.7	95.0	92.0	93.0	88.6	95.7	94.6	90.9	93.0	88.3
Cusco	95.5	94.7	93.8	91.8	91.5	95.5	94.5	93.8	91.6	91.1
Huancavelica	95.9	96.0	92.7	94.1	94.6	95.9	95.5	92.7	94.1	94.3
Huánuco	94.0	94.3	93.6	95.4	93.1	93.1	94.0	92.3	95.1	92.3
Ica	92.4	94.1	93.6	93.5	93.8	92.4	94.1	93.6	93.1	93.0
Junín	94.7	91.0	91.0	90.7	93.3	94.7	91.0	90.7	90.4	93.3
La Libertad	95.4	90.9	92.8	91.2	95.1	95.1	90.3	92.1	91.2	94.8
Lambayeque	95.9	95.6	93.9	94.3	91.6	95.3	95.6	92.9	94.0	91.6
Lima	93.0	92.9	91.7	92.6	92.0	92.6	92.6	90.4	92.3	91.7
Loreto	93.8	93.3	91.2	91.3	91.9	90.1	87.2	84.9	90.5	91.9
Madre de Dios	94.4	92.6	93.6	93.9	91.9	93.6	92.2	92.4	93.6	91.1
Moquegua	95.5	94.4	95.4	95.7	91.1	95.5	94.4	95.4	95.7	91.1
Pasco	92.6	92.8	94.4	93.7	94.5	92.6	92.4	93.8	93.1	94.5
Piura	91.8	91.6	93.2	93.6	91.1	91.4	91.6	93.0	93.0	90.7
Puno	90.3	94.9	91.0	91.1	91.8	89.2	94.0	90.4	91.1	91.8
San Martín	96.2	93.9	93.8	93.0	93.4	96.2	93.7	91.4	93.0	92.0
Tacna	96.4	94.3	94.8	94.3	93.0	95.9	93.5	94.8	92.3	93.0
Tumbes	94.7	95.5	96.5	93.6	91.6	94.7	93.1	96.1	92.7	91.4
Ucayali	93.6	93.2	91.9	87.3	88.4	92.4	90.1	88.8	87.2	87.9

Note. The net enrolment rate refers to the percentage of the population in the age group between 6 and 11 years old who is actually enrolled in an elementary school. The net attendance rate also refers to the percentage of the age group between 6 and 11 years old attending an elementary school. 1 / Includes entire coastal area. 2 / Includes provinces of Lima and Callao. 3 / Excludes Metropolitan Lima. Source: ENAHO (INEI 2010 - 2014).

Table 4. Peru: Permanence in elementary education, by geographic area and region (2010 – 2014)

	Repetition rate					*Backwardness rate*					*Cumulative dropout rate*				
	2010	**2011**	**2012**	**2013**	**2014**	**2010**	**2011**	**2012**	**2013**	**2014**	**2010**	**2011**	**2012**	**2013**	**2014**
National	6.2	5.5	4.9	4.8	4.2	12.3	10.8	9.9	8.8	8.0	1.5	1.3	1.2	1.1	1.0
Geográfica área															
Urban	4.0	3.5	3.1	3.1	5.4	7.8	6.9	6.1	5.4	5.4	1.4	1.1	1.1	0.9	0.8
Rural	12.2	11.1	10.1	9.7	6.8	24.0	21.8	20.3	18.9	18.0	1.6	1.7	1.5	1.3	1.4
Region															
Amazonas	10.4	10.8	10.0	8.0	8.1	20.4	19.9	18.7	16.3	15.4	2.9	2.2	1.8	1.4	1.0
Ancash	9.4	7.7	6.5	6.5	5.9	17.2	14.8	13.3	11.4	10.0	0.3	0.3	-	-	1.0
Apurímac	8.7	7.6	6.5	6.1	5.3	15.4	12.5	10.7	9.4	8.2	0.3	0.6	0.4	0.7	-
Arequipa	2.4	2.5	1.9	2.0	1.7	4.9	4.7	4.2	3.4	3.0	0.0	0.4	-	0.2	-
Ayacucho	10.3	9.4	7.7	6.7	6.0	19.5	17.3	16.1	13.0	11.6	0.9	0.7	0.5	0.6	1.1
Cajamarca	9.5	8.0	7.9	7.4	6.7	17.3	14.9	14.4	12.8	11.5	1.4	1.9	1.1	1.5	1.1
Callao	3.0	2.5	2.1	2.9	2.3	6.0	5.2	5.5	4.7	4.3	1.1	0.9	0.5	0.4	0.7
Cusco	7.9	6.4	5.0	5.6	5.0	14.6	12.8	11.6	9.9	9.2	0.4	-	1.0	-	0.2
Huancavelica	10.1	8.8	7.9	8.4	7.5	19.6	18.1	17.0	15.4	13.5	0.3	0.5	-	0.2	-
Huánuco	11.8	10.7	9.7	9.1	8.4	26.7	23.4	21.6	19.4	17.2	0.6	2.9	2.1	1.6	2.1
Ica	3.5	3.1	2.7	2.8	2.6	7.0	5.8	4.7	5.3	4.3	1.5	0.7	0.8	-	0.4
Junín	5.3	5.0	4.6	4.7	4.0	12.3	11.6	10.7	9.8	9.1	1.3	-	0.9	0.4	1.6
La Libertad	6.8	6.3	5.5	5.2	4.5	14.0	12.7	11.5	9.8	8.8	1.4	3.3	1.9	0.9	0.9
Lambayeque	5.3	4.7	4.1	4.1	3.7	10.4	9.6	9.0	7.4	7.3	1.5	1.0	0.6	1.1	1.1
Lima Metropolitana	2.2	1.9	1.7	1.8	1.5	4.6	4.0	3.6	3.2	2.9	2.0	1.0	1.3	1.0	0.9
Lima Provincias	4.0	3.6	2.8	2.7	2.3	7.1	6.5	5.5	4.9	4.4	1.5	2.7	-	0.8	0.4
Loreto	12.1	12.2	13.0	12.5	10.9	24.9	22.6	22.6	21.6	21.7	3.6	4.1	5.1	3.3	3.1
Madre de Dios	4.9	4.3	2.7	3.0	3.0	10.4	9.2	5.7	5.4	6.2	1.7	1.1	1.3	-	0.3
Moquegua	3.0	2.7	1.9	2.2	1.7	4.3	4.2	3.0	3.0	2.5	0.0	-	-	0.5	-
Pasco	7.0	3.9	3.7	4.9	4.0	15.1	13.2	11.3	10.5	10.8	1.4	0.4	0.8	0.9	-
Piura	6.7	6.7	5.8	5.5	4.8	12.9	11.7	10.0	9.3	8.4	2.3	2.1	2.4	2.2	1.1
Puno	4.7	3.5	3.0	2.7	2.3	9.2	7.9	7.2	6.1	4.9	1.1	-	-	-	0.3
San Martín	8.3	7.1	6.5	6.6	5.8	15.4	13.9	12.3	12.1	10.9	3.1	1.8	2.6	1.6	1.3
Tacna	2.6	2.7	2.3	2.2	1.9	3.6	4.3	3.1	3.5	3.2	0.6	-	-	-	-
Tumbes	3.9	3.3	4.1	3.0	2.9	6.8	6.0	5.3	3.9	4.5	0.2	0.5	0.5	1.2	0.7
Ucayali	8.7	8.2	7.3	7.0	6.9	18.9	17.2	18.9	16.5	15.9	0.9	3.5	2.7	6.5	4.5

Note. The cumulative dropout rate considering the number of people aged between 7 and 14 years old who have not completed elementary level and not enrolled in any school, relative to the total of people in the same age group and level. Source: CE and *Registro Nacional de Instituciones Educativas* (MINEDU 2015), and the ENAHO (INEI 2010 - 2014).

Table 5. Peru: Percentage of schools with average students in the satisfactory level, subject area and type of educational management (2010 y 2014)

	Reading comprehension					*Mathematics*				
Year	**2010**	**2011**	**2012**	**2013**	**2014**	**2010**	**2011**	**2012**	**2013**	**2014**
National	28.7	29.8	30.9	33.0	43.5	13.8	13.2	12.8	16.8	25.9
Educational management										
Public schools	22.8	23.0	24.0	27.6	38.1	11.7	11.3	11.5	15.8	25.7
Private schools	48.6	50.3	51.4	47.3	57.4	20.9	18.9	16.5	19.6	26.4
Geographic area										
Urban	35.5	36.3	37.5	38.5	49.7	16.4	15.8	15.2	19.4	28.9
Rural	7.6	5.9	7.0	10.4	16.7	5.8	3.7	4.1	6.5	13.1
Educational jurisdiction										
Amazonas	18.6	19.7	21.1	27.5	39.3	9.8	12.7	12.9	23.8	35.1
Ancash	22.2	22.1	22.4	23.5	34.0	12.9	11.0	7.4	10.9	17.8
Apurímac	16.4	11.6	14.5	19.6	31.1	8.5	5.4	7.7	9.5	20.8
Arequipa	48.1	49.3	50.3	47.4	61.0	25.3	21.2	19.6	21.5	32.9
Ayacucho	-	-	13.7	21.8	34.6	-	-	4.3	10.1	25.6
Cajamarca	-	-	17.0	23.3	31.6	-	-	9.5	13.5	23.4
Callao	37.6	41.2	44.8	41.2	57.6	16.4	15.4	18.0	18.9	31.9
Cusco	24.0	22.9	21.5	25.5	36.4	13.5	11.5	8.9	14.5	24.5
Huancavelica	15.0	10.8	13.6	17.3	28.7	11.8	6.9	7.9	9.7	21.0
Huánuco	12.4	14.6	12.9	17.0	26.4	6.7	6.8	4.9	8.4	16.0
Ica	39.8	37.6	35.7	37.2	49.2	24.4	18.5	16.8	21.3	32.2
Junín	28.6	29.8	29.8	34.4	44.4	13.0	15.5	12.8	19.2	30.1
La Libertad	26.3	27.6	31.2	31.9	38.4	13.2	13.3	13.7	16.0	21.8
Lambayeque	35.0	33.5	31.2	31.4	43.1	16.8	14.8	10.5	11.8	22.7
Lima (Metropolitan area)	42.1	45.3	48.7	46.4	55.8	17.7	18.5	19.3	23.3	31.3
Lima (Rest)	26.4	32.1	31.9	36.2	45.9	11.4	12.8	12.5	18.1	24.6
Loreto	5.0	6.1	6.3	7.6	13.2	1.0	1.4	1.4	1.9	4.8
Madre de Dios	16.3	17.2	19.6	17.7	33.6	6.2	7.7	6.8	5.4	17.1
Moquegua	44.1	51.4	59.4	63.7	69.1	24.5	29.1	37.5	43.3	52.7
Pasco	25.6	18.8	24.3	31.1	43.2	12.0	7.3	10.2	18.4	32.0
Piura	26.2	28.8	28.8	30.3	47.6	11.9	13.8	12.5	16.5	29.7
Puno	-	18.5	19.5	25.2	42.4	-	7.5	7.6	16.3	30.2
San Martín	17.2	17.1	17.9	26.7	35.7	6.2	7.5	7.1	14.0	22.1
Tacna	47.8	48.4	55.2	60.3	67.3	29.9	28.6	36.0	40.9	51.0
Tumbes	28.8	25.2	25.9	27.5	38.9	14.4	10.7	11.1	12.4	17.4
Ucayali	14.4	15.0	15.3	16.8	21.8	4.1	4.3	4.4	5.1	7.8

Note. The satisfactory level implies that the student has achieved the expected and corresponding learning in second grade of elementary education, and even is fit to continue their learning process. Cases where no results are presented has not been a minimum number of assessments as to establish valid and reliable inferences. 1 / Includes the province of Lima. 2 / Includes the rest of the province of Lima region, except the province of Lima. Source: ECE from second grade of elementary education (MINEDU 2010 -2014).

Annex 1. Factorial Analysis and Reliability Analysis for indexes built

Cronbach Alpha statistical considers that the composition of a set of sub-indexes can considered valid while the correlation between the components is sufficiently significant. Thus, this statistic has the ability to evaluate the reliability of a certain scale.

As Kaiser (1974) mentions in the context of factor analysis, it is possible to estimate the individual contribution of the set of variables or items considered for estimating a latent variable or index. Thus, the statistic Kaiser Meyer and Olkin (KMO) refers to the adequacy of the sub-indexes and consistency in correlational terms, being closest to one that values imply greater communion among the factors.

Table 6. IREdu: Factorial Analysis and Reliability Analysis (2010 – 2014)

Variable		Average	Standard deviation
Access to education			
Tota attendance rate (% of 6 to 11)	Overall	0.9370	0.0214
	Among schools		0.0141
	Intra school		0.0161
Permanence in the educational system			
Repetition rate	Overall	0.7334	0.3780
	Among schools		0.2624
	Intra school		0.2721
Promotion Rate	Overall	0.7167	0.3696
	Among schools		0.2571
	Intra school		0.2656
Impact of the educational system			
Score ECE Comunicación	Overall	315.5216	252.1605
	Among schools		194.5558
	Intra school		160.4188
Score ECE Matematica	Overall	314.1118	254.5224
	Among schools		195.5695
	Intra school		162.8973
Educational Outcome Index			
IREdu	Overall	0.4887	0.2168
	Among schools		0.1503
	Intra school		0.1563

	2010	Correlation Item - Item	Correlation Item - Rest	Cronbach's Alpha Test 1/	Factor 1	Factor 2	Factor 3	Statistical KMO
Access	Attendance rate	0.10	0.10	0.66	0.00	-0.01	**0.07**	0.71
Permanence	Repetition rate	0.66	0.66	0.66	-0.20	**0.66**	-0.33	0.67
	Promotion Rate	0.65	0.65	0.66	-0.14	**0.58**	0.35	0.66
Impact	ECE Communication Scor	1.00	0.99	0.01	**0.58**	-0.24	-0.90	0.65
	ECE Mathematics Score	1.00	0.99	0.01	**0.60**	-0.30	0.89	0.65
			Average:	*0.66*			*Average:*	*0.66*
	2011							
Access	Attendance rate	-0.04	-0.04	0.67	0.00	0.01	**0.07**	0.55
Permanence	Repetition rate	0.60	0.60	0.66	-0.16	**0.58**	-0.43	0.64
	Promotion Rate	0.57	0.57	0.66	-0.18	**0.58**	0.45	0.64
Impact	ECE Communication Scor	1.00	0.99	0.00	**0.61**	-0.22	-3.16	0.63
	ECE Mathematics Score	1.00	0.99	0.00	**0.54**	-0.18	3.17	0.63
			Average:	*0.62*			*Average:*	*0.63*
	2012							
Access	Attendance rate	0.07	0.07	0.66	0.00	0.01	**0.08**	0.60
Permanence	Repetition rate	0.68	0.68	0.66	-0.14	**0.65**	-0.71	0.67
	Promotion Rate	0.66	0.66	0.66	-0.14	**0.64**	0.73	0.67
Impact	ECE Communication Scor	1.00	0.99	0.01	**0.59**	-0.32	-2.94	0.66
	ECE Mathematics Score	1.00	0.99	0.01	**0.57**	-0.32	2.93	0.66
			Average:	*0.62*			*Average:*	*0.66*
	2013							
Access	Attendance rate	0.07	0.07	0.67	0.00	0.00	**0.08**	0.47
Permanence	Repetition rate	0.62	0.62	0.66	-0.20	**0.63**	-0.54	0.65
	Promotion Rate	0.60	0.60	0.66	-0.15	**0.56**	0.55	0.65
Impact	ECE Communication Scor	1.00	0.99	0.00	**0.58**	-0.19	-1.30	0.64
	ECE Mathematics Score	1.00	0.99	0.00	**0.59**	-0.24	1.30	0.64
			Average:	*0.62*			*Average:*	*0.64*
	2014							
Access	Attendance rate	0.01	0.01	0.66	0.00	0.00	**0.07**	0.43
Permanence	Repetition rate	0.59	0.59	0.66	-0.18	**0.59**	-0.45	0.64
	Promotion Rate	0.57	0.57	0.66	-0.17	**0.57**	0.46	0.63
Impact	ECE Communication Scor	1.00	0.99	0.00	**0.59**	-0.19	-1.30	0.63
	ECE Mathematics Score	1.00	0.99	0.00	**0.57**	-0.20	1.30	0.63
			Average:	*0.62*			*Average:*	*0.63*

Note. (1) Refers to the value of Cronbach's alpha statistic when removed from the analysis each variable. The sign of the relationship between the component and the latent variable is always positive, which means a direct relationship between components and IREDU. The values obtained by statistical Cronbach's alpha are acceptable as recorded values close to 0.62. The KMO statistic reaches values greater than 0.63, suggesting the existence of a valid construct. The results suggest the presence of three latent factors and related indicators included. Just these three factors refer to the three dimensions suggested by the literature. For practical purposes the composition will use three factors with the variables included, however, in subsequent studies it suggested work best using variables, more accurate and less collinear. Source. Own elaboration.

Table 7. Infrastructure Quality Index: Factorial Analysis and Reliability Analysis (2010 – 2014)

Variable		Average	Standard deviation
Wall material	Overall	0.7448	0.2383
	Among schools		0.2230
	Intra school		0.1080
Roof material	Overall	0.6510	0.2492
	Among schools		0.2262
	Intra school		0.1250
Floor material	Overall	0.8452	0.2546
	Among schools		0.2338
	Intra school		0.1280
Infrastructure Quality Index	Overall	0.7480	0.1793
	Among schools		0.1730
	Intra school		0.0796

	Correlation Item - Item	Correlation Item - Rest	Cronbach's Alpha Test 1/	Factor 1	Statistical KMO
			2010		
Wall material	0.74	0.38	0.24	0.37	0.55
Roof material	0.66	0.24	0.48	0.23	0.61
Floor material	0.71	0.29	0.40	0.29	0.57
		Average:	*0.48*	*Average:*	*0.57*
			2011		
Wall material	0.74	0.38	0.29	0.36	0.56
Roof material	0.69	0.28	0.47	0.26	0.61
Floor material	0.70	0.29	0.44	0.28	0.60
		Average:	*0.50*	*Average:*	*0.59*
			2012		
Wall material	0.74	0.40	0.28	0.37	0.56
Roof material	0.68	0.28	0.48	0.26	0.61
Floor material	0.71	0.30	0.45	0.28	0.59
		Average:	*0.51*	*Average:*	*0.58*
			2013		
Wall material	0.76	0.44	0.32	0.38	0.57
Roof material	0.71	0.32	0.50	0.28	0.61
Floor material	0.71	0.32	0.51	0.27	0.62
		Average:	*0.55*	*Average:*	*0.59*
			2014		
Wall material	0.78	0.48	0.39	0.39	0.59
Roof material	0.73	0.38	0.55	0.28	0.64
Floor material	0.73	0.37	0.56	0.28	0.64
		Average:	*0.60*	*Average:*	*0.61*

Note. (1) Statistical value of Cronbach's alpha when removed from an index analysis. The sign of the relationship between the component and the latent variable is always positive, which means a direct relationship between components and construct. The values obtained by statistical Cronbach's alpha are acceptable as average values recorded close to 0.5. The statistical KMO reaches values greater than 0.6, suggesting the existence of a valid construct. The results suggest the presence of a latent analysed and related to the factor. Source: Own elaboration.

Table 8. Index of quality of basic services: Factorial Analysis and Reliability Analysis (2010 – 2014)

Variable		Average	Standard deviation
Access to electric service	Overall	0.7941	0.3829
	Among schools		0.3551
	Intra school		0.1829
Access to potable water	Overall	0.7006	0.4118
	Among schools		0.3636
	Intra school		0.2147
Access to hygienic services	Overall	0.6389	0.3029
	Among schools		0.2766
	Intra school		0.1424
Index of quality of basic services	Overall	0.6927	0.2904
	Among schools		0.2788
	Intra school		0.1178

	Correlation Item - Item	Correlation Item - Rest	Cronbach's Alpha Test [1/]	Factor 1	Statistical KMO
			2010		
Access to electric service	0.71	0.50	0.62	0.30	0.69
Access to potable water	0.87	0.56	0.55	0.38	0.64
Access to hygienic services	0.78	0.51	0.56	0.31	0.68
		Average:	*0.68*	*Average:*	*0.67*
			2011		
Access to electric service	0.68	0.46	0.61	0.29	0.69
Access to potable water	0.87	0.54	0.52	0.37	0.63
Access to hygienic services	0.77	0.50	0.52	0.32	0.66
		Average:	*0.66*	*Average:*	*0.66*
			2012		
Access to electric service	0.67	0.45	0.61	0.28	0.69
Access to potable water	0.87	0.53	0.50	0.38	0.63
Access to hygienic services	0.77	0.49	0.51	0.32	0.66
		Average:	*0.65*	*Average:*	*0.65*
			2013		
Access to electric service	0.76	0.44	0.62	0.27	0.70
Access to potable water	0.82	0.52	0.51	0.37	0.63
Access to hygienic services	0.74	0.50	0.56	0.34	0.64
		Average:	*0.66*	*Average:*	*0.65*
			2014		
Access to electric service	0.75	0.44	0.62	0.27	0.70
Access to potable water	0.83	0.52	0.51	0.37	0.62
Access to hygienic services	0.74	0.49	0.56	0.33	0.64
		Promedio:	*0.66*	*Promedio:*	*0.65*

Note. (1) Statistical value of Cronbach's alpha when removed from an index analysis. The sign of the relationship between the component and the latent variable is always positive, which means a direct relationship between components and construct. The values obtained by statistical Cronbach's alpha are acceptable as average values recorded close to 0.5. The statistical KMO reaches values greater than 0.6, suggesting the existence of a valid construct. The results suggest the presence of a latent analysed and related to the factor. Source: Own elaboration.

Table 9. Index of physical spaces availability: Factorial Analysis and Reliability Analysis (2010 – 2014)

Variable		Average	Standard deviation
Workshops	Overall	0.2784	0.4482
	Among schools		0.3073
	Intra school		0.3263
Computer rooms	Overall	0.5477	0.4977
	Among schools		0.2916
	Intra school		0.4034
Science Labs	Overall	0.2880	0.4528
	Among schools		0.3205
	Intra school		0.3200
Slabs and sports areas	Overall	0.1829	0.3866
	Among schools		0.2661
	Intra school		0.2827
Classroom libraries	Overall	0.5991	0.4901
	Among schools		0.3153
	Intra school		0.3752
Index of physical spaces availability	Overall	0.1514	0.2340
	Among schools		0.1907
	Intra school		0.1339

	Correlation Item - Item	Correlation Item - Rest	Cronbach's Alpha Test [1/]	Factor 1	Statistical KMO
			2010		
Workshops	0.88	0.79	0.69	0.27	0.71
Computer rooms	0.85	0.75	0.69	0.31	0.71
Science Labs	0.89	0.82	0.68	0.34	0.69
Slabs and sports areas	0.63	0.31	0.84	0.17	0.77
Classroom libraries	0.60	0.41	0.82	0.04	0.72
		Average:	*0.80*	*Average:*	*0.71*
			2011		
Workshops	0.84	0.74	0.66	0.28	0.71
Computer rooms	0.80	0.66	0.67	0.32	0.70
Science Labs	0.86	0.77	0.65	0.31	0.69
Slabs and sports areas	0.62	0.31	0.80	0.18	0.75
Classroom libraries	0.62	0.41	0.78	0.05	0.68
		Average:	*0.76*	*Average:*	*0.71*
			2012		
Workshops	0.88	0.80	0.65	0.30	0.65
Computer rooms	0.80	0.66	0.68	0.27	0.70
Science Labs	0.88	0.81	0.65	0.36	0.63
Slabs and sports areas	0.48	0.22	0.81	0.12	0.74
Classroom libraries	0.62	0.41	0.79	0.05	0.67
		Average:	*0.77*	*Average:*	*0.66*
			2013		
Workshops	0.86	0.77	0.63	0.28	0.67
Computer rooms	0.78	0.63	0.66	0.27	0.70
Science Labs	0.86	0.78	0.62	0.36	0.64
Slabs and sports areas	0.56	0.28	0.79	0.16	0.75
Classroom libraries	0.60	0.37	0.77	0.05	0.72
		Average:	*0.75*	*Average:*	*0.68*
			2014		
Workshops	0.84	0.71	0.41	0.25	0.67
Computer rooms	0.08	0.03	0.67	0.00	0.58
Science Labs	0.85	0.71	0.39	0.39	0.59
Slabs and sports areas	0.59	0.35	0.62	0.31	0.62
Classroom libraries	0.64	0.36	0.61	0.06	0.78
		Average:	*0.62*	*Average:*	*0.62*

Note. (1) Statistical value of Cronbach's alpha when removed from an index analysis. The sign of the relationship between the component and the latent variable is always positive, which means a direct relationship between components and construct. The values obtained by statistical Cronbach's alpha are acceptable as average values recorded close to 0.5. The statistical KMO reaches values greater than 0.6, suggesting the existence of a valid construct. The results suggest the presence of a latent analysed and related to the factor. Source: Own elaboration.

Table 10. Sufficiency rate of furniture per student: Factorial Analysis and Reliability Analysis (2010 – 2014)

Variable		Average	Standard deviation
Desks in good condition	Overall	0.3508	0.4230
	Among schools		0.3140
	Intra school		0.2835
Tables in good condition	Overall	0.7323	0.2790
	Among schools		0.1924
	Intra school		0.2021
Chairs in good condition	Overall	0.8835	0.2148
	Among schools		0.1433
	Intra school		0.1601
Sufficiency rate of furniture per student	Overall	0.7946	0.2164
	Among schools		0.1469
	Intra school		0.1589

	Correlation Item - Item	Correlation Item - Rest	Cronbach's Alpha Test [1/]	Factor 1	Statistical KMO
			2010		
Desks in good condition	0.78	0.29	0.82	0.22	0.59
Tables in good condition	0.82	0.60	0.27	0.51	0.51
Chairs in good condition	0.70	0.47	0.48	0.38	0.52
		Average:	*0.60*	*Average:*	*0.52*
			2011		
Desks in good condition	0.76	0.16	0.74	0.19	0.48
Tables in good condition	0.75	0.44	0.10	0.46	0.50
Chairs in good condition	0.62	0.36	0.32	0.40	0.50
		Average:	*0.46*	*Average:*	*0.50*
			2012		
Desks in good condition	0.76	0.14	0.72	0.17	0.49
Tables in good condition	0.73	0.40	0.08	0.45	0.50
Chairs in good condition	0.60	0.35	0.28	0.41	0.50
		Average:	*0.42*	*Average:*	*0.50*
			2013		
Desks in good condition	0.71	0.08	0.74	0.10	0.50
Tables in good condition	0.71	0.36	0.05	0.44	0.50
Chairs in good condition	0.63	0.35	0.16	0.43	0.50
		Average:	*0.38*	*Average:*	*0.50*
			2014		
Desks in good condition	0.73	0.10	0.74	0.05	0.65
Tables in good condition	0.71	0.37	0.10	0.44	0.50
Chairs in good condition	0.64	0.37	0.19	0.43	0.50
		Average:	*0.41*	*Average:*	*0.51*

Note. (1) Statistical value of Cronbach's alpha when removed from an index analysis. The sign of the relationship between the component and the latent variable is always positive, which means a direct relationship between components and construct. The values obtained by statistical Cronbach's alpha are acceptable as average values recorded close to 0.5. The statistical KMO reaches values greater than 0.6, suggesting the existence of a valid construct. The results suggest the presence of a latent analysed and related to the factor. Source: Own elaboration.

Annex 2. Efficiency Analysis: Results

Table 11. Peru: Average Efficiency for estimation methodology as educational outcome and period considered

	Non-parametric Methodology				*Parametric Methodology*			
Educational Outcome Index								
	Average	*S. E.*	*C. I. (95%)*		*Average*	*S. E.*	*C. I. (95%)*	
Panel								
2010 -2014	0.71	0.0004	0.71	0.71	0.96	0.0001	0.96	0.96
By year								
2010	0.67	0.0009	0.67	0.67	0.96	0.0002	0.96	0.96
2011	0.71	0.0010	0.71	0.71	0.96	0.0002	0.96	0.96
2012	0.72	0.0010	0.72	0.72	0.95	0.0003	0.95	0.95
2013	0.73	0.0009	0.73	0.73	0.96	0.0002	0.96	0.96
2014	0.73	0.0010	0.73	0.74	0.95	0.0002	0.95	0.95
ECE Score: Reading comprehension								
	Average	*S. E.*	*C. I. (95%)*		*Average*	*S. E.*	*C. I. (95%)*	
Panel								
2010 -2014	0.71	0.0004	0.71	0.71	0.97	0.0001	0.97	0.97
By year								
2010	0.70	0.0008	0.69	0.70	0.97	0.0002	0.97	0.97
2011	0.70	0.0009	0.69	0.70	0.97	0.0002	0.97	0.97
2012	0.74	0.0008	0.73	0.74	0.97	0.0002	0.97	0.97
2013	0.71	0.0009	0.70	0.71	0.97	0.0001	0.97	0.97
2014	0.70	0.0009	0.70	0.71	0.97	0.0002	0.97	0.97
ECE Score: Mathematics								
	Average	*S. E.*	*C. I. (95%)*		*Promedio*	*Error Est.*	*I. C. (al 95%)*	
Panel								
2010 -2014	0.65	0.0005	0.65	0.65	0.97	0.0001	0.97	0.97
By year								
2010	0.58	0.0009	0.58	0.59	0.98	0.0001	0.98	0.98
2011	0.63	0.0010	0.63	0.64	0.98	0.0001	0.98	0.98
2012	0.67	0.0010	0.67	0.68	0.97	0.0001	0.97	0.97
2013	0.69	0.0010	0.69	0.69	0.97	0.0001	0.97	0.97
2014	0.65	0.0011	0.65	0.65	0.97	0.0001	0.97	0.97

Note. Estimate with information the CE, the ECE and the ENAHO (2010-2014). The contested information in accordance with the procedure outlined in the previous section is considered. In total it has 14 785 schools per year.

Table 12. Peru: Average Efficiency for estimation methodology and management type as educational outcome and period considered

Public Schools	***Non-parametric Methodology***				***Parametric Methodology***			
Educational Outcome Index								
	Average	*S. E.*	*C. I. (95%)*		*Average*	*S. E.*	*C. I. (95%)*	
Total	*0.64*	*0.000*	*0.64*	*0.64*	*0.74*	*0.001*	*0.74*	*0.74*
2010	0.59	0.001	0.59	0.60	0.60	0.003	0.60	0.61
2011	0.62	0.001	0.61	0.62	0.78	0.003	0.77	0.78
2012	0.66	0.001	0.66	0.66	0.80	0.003	0.80	0.81
2013	0.69	0.001	0.69	0.69	0.73	0.002	0.72	0.73
2014	0.65	0.001	0.64	0.65	0.80	0.003	0.79	0.80
ECE Score: Reading comprehension								
Total	*0.53*	*0.001*	*0.53*	*0.53*	*0.63*	*0.001*	*0.62*	*0.63*
2010	0.49	0.002	0.49	0.50	0.54	0.003	0.54	0.55
2011	0.49	0.002	0.49	0.50	0.61	0.002	0.61	0.62
2012	0.59	0.002	0.58	0.59	0.66	0.002	0.66	0.67
2013	0.55	0.002	0.54	0.55	0.67	0.002	0.67	0.68
2014	0.53	0.002	0.52	0.53	0.64	0.002	0.64	0.64
ECE Score: Mathematics								
Total	*0.49*	*0.001*	*0.48*	*0.49*	*0.60*	*0.001*	*0.60*	*0.61*
2010	0.42	0.002	0.41	0.42	0.53	0.002	0.53	0.54
2011	0.44	0.002	0.44	0.45	0.60	0.002	0.59	0.60
2012	0.53	0.002	0.53	0.54	0.64	0.002	0.63	0.64
2013	0.53	0.002	0.53	0.54	0.64	0.002	0.63	0.64
2014	0.48	0.002	0.48	0.49	0.61	0.002	0.61	0.62

Private Schools	***Métodología No Paramétrica***				***Métodología Paramétrica***			
Educational Outcome Index								
	Average	*S. E.*	*C. I. (95%)*		*Average*	*S. E.*	*C. I. (95%)*	
Total	*0.64*	*0.000*	*0.64*	*0.64*	*0.74*	*0.001*	*0.74*	*0.74*
2010	0.59	0.001	0.59	0.60	0.60	0.003	0.60	0.61
2011	0.62	0.001	0.61	0.62	0.78	0.003	0.77	0.78
2012	0.66	0.001	0.66	0.66	0.80	0.003	0.80	0.81
2013	0.69	0.001	0.69	0.69	0.73	0.002	0.72	0.73
2014	0.65	0.001	0.64	0.65	0.80	0.003	0.79	0.80
ECE Score: Reading comprehension								
Total	*0.53*	*0.001*	*0.53*	*0.53*	*0.63*	*0.001*	*0.62*	*0.63*
2010	0.49	0.002	0.49	0.50	0.54	0.003	0.54	0.55
2011	0.49	0.002	0.49	0.50	0.61	0.002	0.61	0.62
2012	0.59	0.002	0.58	0.59	0.66	0.002	0.66	0.67
2013	0.55	0.002	0.54	0.55	0.67	0.002	0.67	0.68
2014	0.53	0.002	0.52	0.53	0.64	0.002	0.64	0.64
ECE Score: Mathematics								
Total	*0.49*	*0.001*	*0.48*	*0.49*	*0.60*	*0.001*	*0.60*	*0.61*
2010	0.42	0.002	0.41	0.42	0.53	0.002	0.53	0.54
2011	0.44	0.002	0.44	0.45	0.60	0.002	0.59	0.60
2012	0.53	0.002	0.53	0.54	0.64	0.002	0.63	0.64
2013	0.53	0.002	0.53	0.54	0.64	0.002	0.63	0.64
2014	0.48	0.002	0.48	0.49	0.61	0.002	0.61	0.62

Note. Estimate with information the the CE, the ECE and the ENAHO (2010-2014). The contested information in accordance with the procedure outlined in the previous section is considered. On average, there are 21,590 schools with governance and 2,057 privately run schools per year.

Table 13. Peru: Average Efficiency for estimation methodology and type of organization as educational outcome and period considered

Full-grade Schools	***Non-parametric Methodology***				***Parametric Methodology***			
Educational Outcome Index								
	Averag	*S. E.*	*C. I. (95%)*		*Averag*	*S. E.*	*C. I. (95%)*	
Total	*0.64*	*0.000*	*0.64*	*0.64*	*0.74*	*0.001*	*0.74*	*0.74*
2010	0.59	0.001	0.59	0.60	0.60	0.003	0.60	0.61
2011	0.62	0.001	0.61	0.62	0.78	0.003	0.77	0.78
2012	0.66	0.001	0.66	0.66	0.80	0.003	0.80	0.81
2013	0.69	0.001	0.69	0.69	0.73	0.002	0.72	0.73
2014	0.65	0.001	0.64	0.65	0.80	0.003	0.79	0.80
ECE Score: Reading comprehension								
Total	*0.53*	*0.001*	*0.53*	*0.53*	*0.63*	*0.001*	*0.62*	*0.63*
2010	0.49	0.002	0.49	0.50	0.54	0.003	0.54	0.55
2011	0.49	0.002	0.49	0.50	0.61	0.002	0.61	0.62
2012	0.59	0.002	0.58	0.59	0.66	0.002	0.66	0.67
2013	0.55	0.002	0.54	0.55	0.67	0.002	0.67	0.68
2014	0.53	0.002	0.52	0.53	0.64	0.002	0.64	0.64
ECE Score: Mathematics								
Total	*0.49*	*0.001*	*0.48*	*0.49*	*0.60*	*0.001*	*0.60*	*0.61*
2010	0.42	0.002	0.41	0.42	0.53	0.002	0.53	0.54
2011	0.44	0.002	0.44	0.45	0.60	0.002	0.59	0.60
2012	0.53	0.002	0.53	0.54	0.64	0.002	0.63	0.64
2013	0.53	0.002	0.53	0.54	0.64	0.002	0.63	0.64
2014	0.48	0.002	0.48	0.49	0.61	0.002	0.61	0.62

Multi-grade Schools	***Métodología No Paramétrica***				***Métodología Paramétrica***			
Educational Outcome Index								
	Averag	*S. E.*	*C. I. (95%)*		*Averag*	*S. E.*	*C. I. (95%)*	
Total	*0.64*	*0.000*	*0.64*	*0.64*	*0.74*	*0.001*	*0.74*	*0.74*
2010	0.59	0.001	0.59	0.60	0.60	0.003	0.60	0.61
2011	0.62	0.001	0.61	0.62	0.78	0.003	0.77	0.78
2012	0.66	0.001	0.66	0.66	0.80	0.003	0.80	0.81
2013	0.69	0.001	0.69	0.69	0.73	0.002	0.72	0.73
2014	0.65	0.001	0.64	0.65	0.80	0.003	0.79	0.80
ECE Score: Reading comprehension								
Total	*0.53*	*0.001*	*0.53*	*0.53*	*0.63*	*0.001*	*0.62*	*0.63*
2010	0.49	0.002	0.49	0.50	0.54	0.003	0.54	0.55
2011	0.49	0.002	0.49	0.50	0.61	0.002	0.61	0.62
2012	0.59	0.002	0.58	0.59	0.66	0.002	0.66	0.67
2013	0.55	0.002	0.54	0.55	0.67	0.002	0.67	0.68
2014	0.53	0.002	0.52	0.53	0.64	0.002	0.64	0.64
ECE Score: Mathematics								
Total	*0.49*	*0.001*	*0.48*	*0.49*	*0.60*	*0.001*	*0.60*	*0.61*
2010	0.42	0.002	0.41	0.42	0.53	0.002	0.53	0.54
2011	0.44	0.002	0.44	0.45	0.60	0.002	0.59	0.60
2012	0.53	0.002	0.53	0.54	0.64	0.002	0.63	0.64
2013	0.53	0.002	0.53	0.54	0.64	0.002	0.63	0.64
2014	0.48	0.002	0.48	0.49	0.61	0.002	0.61	0.62

Note. Estimate with information the the CE, the ECE and the ENAHO (2010-2014). The contested information in accordance with the procedure outlined in the previous section is considered. On average it has 8,868 full grade schools and grade schools multigrade 14,779 per year.

Table 14. Peru: average per type of educational outcome and efficiency region, according to estimation methodology (2010 - 2014)

Average	Non-parametric						Parametric					
	Educational Outcome Index		ECE Score: Reading comprehension		ECE Score: Mathematics		Educational Outcome Index		ECE Score: Reading comprehension		ECE Score: Mathematics	
	Rank	*Score*	*Rank*	*Score*	*Rank*	*Score*	*Rank*	*Score*	*Rank*	*Score*	*Rank*	*Score*
Amazonas	15	0.7309	9	0.7095	9	0.6610	19	0.9489	22	0.9602	21	0.9633
Ancash	22	0.6710	23	0.6582	24	0.5911	22	0.9434	21	0.9609	22	0.9624
Apurimac	17	0.7165	24	0.6573	23	0.5953	12	0.9566	19	0.9632	19	0.9643
Arequipa	4	0.7718	7	0.7225	7	0.6669	4	0.9658	3	0.9748	3	0.9706
Ayacucho	21	0.6732	21	0.6706	18	0.6183	20	0.9480	15	0.9665	14	0.9668
Cajamarca	12	0.7389	12	0.7041	8	0.6625	9	0.9615	6	0.9712	6	0.9701
Cuzco	20	0.6779	22	0.6643	22	0.5977	21	0.9471	20	0.9627	20	0.9638
Huancavelica	13	0.7383	16	0.6889	13	0.6452	7	0.9625	12	0.9686	8	0.9690
Huanuco	18	0.7141	13	0.7019	15	0.6361	18	0.9493	17	0.9657	15	0.9655
Ica	3	0.7745	6	0.7229	5	0.6704	2	0.9672	5	0.9719	4	0.9705
Junin	19	0.7115	14	0.7008	16	0.6358	16	0.9549	10	0.9692	13	0.9672
La Libertad	8	0.7514	11	0.7046	12	0.6522	8	0.9621	13	0.9679	12	0.9675
Lambayeque	16	0.7286	15	0.6991	14	0.6432	15	0.9551	18	0.9639	18	0.9649
Lima	7	0.7544	3	0.7661	3	0.7097	11	0.9585	4	0.9732	5	0.9704
Loreto	23	0.6629	19	0.6792	21	0.5981	23	0.9227	23	0.9502	23	0.9558
Madre de Dios	6	0.7639	2	0.7777	2	0.7197	17	0.9540	7	0.9702	11	0.9677
Moquegua	5	0.7694	5	0.7329	10	0.6599	5	0.9655	2	0.9756	2	0.9723
Pasco	2	0.7965	10	0.7093	6	0.6688	3	0.9671	9	0.9696	7	0.9695
Piura	11	0.7394	4	0.7397	4	0.6946	14	0.9558	8	0.9699	9	0.9689
Puno	10	0.7426	17	0.6866	17	0.6351	6	0.9638	11	0.9691	10	0.9687
San Martin	9	0.7433	8	0.7217	11	0.6582	13	0.9564	16	0.9660	17	0.9650
Tacna	1	0.8370	1	0.7789	1	0.7443	1	0.9714	1	0.9762	1	0.9740
Tumbes	14	0.7340	18	0.6844	19	0.6143	10	0.9594	14	0.9666	16	0.9651
Ucayali	24	0.6403	20	0.6733	20	0.6063	24	0.9149	24	0.9467	24	0.9518
Peru		**0.7366**		**0.7079**		**0.6512**		**0.9564**		**0.9675**		**0.9671**

Note. Estimates information CE and ECE (2010-2014). The contested information in accordance with the procedure outlined in the methodology section is considered.

Table 15. Peru: Medium Efficiency by type of educational outcome and region, according to estimation methodology (2010 - 2014)

Median	Non-parametric						Parametric					
	Educational Outcome Index		ECE Score: Reading comprehension		ECE Score: Mathematics		Educational Outcome Index		ECE Score: Reading comprehension		ECE Score: Mathematics	
	Rank	*Score*	*Rank*	*Score*	*Rank*	*Score*	*Rank*	*Score*	*Rank*	*Score*	*Rank*	*Score*
Amazonas	13	0.7314	9	0.7118	10	0.6493	16	0.9606	10	0.9717	9	0.9696
Ancash	21	0.6652	22	0.6478	23	0.5716	22	0.9513	22	0.9635	22	0.9634
Apurimac	18	0.7101	24	0.6409	21	0.5721	14	0.9615	20	0.9664	19	0.9658
Arequipa	4	0.7672	8	0.7146	9	0.6536	4	0.9683	3	0.9762	3	0.9722
Ayacucho	22	0.6644	21	0.6529	20	0.5949	20	0.9525	19	0.9675	17	0.9675
Cajamarca	15	0.7289	16	0.6856	11	0.6384	9	0.9651	7	0.9727	5	0.9712
Cuzco	20	0.6682	23	0.6471	24	0.5662	21	0.9519	21	0.9639	21	0.9638
Huancavelica	12	0.7315	19	0.6743	15	0.6225	7	0.9652	16	0.9701	10	0.9694
Huanuco	17	0.7186	15	0.6877	16	0.6207	19	0.9567	18	0.9677	18	0.9661
Ica	3	0.7760	7	0.7157	6	0.6599	3	0.9701	5	0.9730	4	0.9717
Junin	19	0.7075	12	0.6957	14	0.6272	18	0.9601	12	0.9709	15	0.9683
La Libertad	8	0.7457	13	0.6945	12	0.6381	8	0.9652	13	0.9703	13	0.9686
Lambayeque	16	0.7265	11	0.6993	13	0.6378	12	0.9625	14	0.9702	16	0.9683
Lima	6	0.7512	3	0.7609	2	0.7027	15	0.9613	4	0.9743	6	0.9711
Loreto	24	0.6525	20	0.6622	22	0.5720	23	0.9354	24	0.9560	24	0.9589
Madre de Dios	9	0.7444	2	0.7668	3	0.6944	17	0.9605	6	0.9730	12	0.9689
Moquegua	5	0.7660	5	0.7250	5	0.6609	5	0.9677	1	0.9775	2	0.9735
Pasco	2	0.8018	10	0.7045	7	0.6594	2	0.9705	9	0.9717	8	0.9701
Piura	11	0.7385	4	0.7369	4	0.6923	13	0.9617	8	0.9727	7	0.9709
Puno	10	0.7395	18	0.6751	17	0.6139	6	0.9666	15	0.9701	11	0.9692
San Martin	7	0.7479	6	0.7211	8	0.6546	10	0.9639	11	0.9716	14	0.9686
Tacna	1	0.8356	1	0.7709	1	0.7437	1	0.9735	2	0.9763	1	0.9749
Tumbes	14	0.7295	14	0.6888	19	0.6053	11	0.9632	17	0.9688	20	0.9653
Ucayali	23	0.6608	17	0.6825	18	0.6082	24	0.9316	23	0.9613	23	0.9606
Peru		**0.7315**		**0.6951**		**0.6380**		**0.9621**		**0.9706**		**0.9687**

Note. Estimates information CE and ECE (2010-2014). The contested information in accordance with the procedure outlined in the methodology section is considered.

Table 16. Descriptive variables discretionary and non-discretionary inputs

Variable		Average	S. D.
Quality of school infrastructure	Overall	0.7514	0.1777
	Among schools		0.1719
	Intra school		0.0785
Access to basic services	Overall	0.6927	0.2904
	Among schools		0.2788
	Intra school		0.1178
Availability of physical spaces	Overall	0.1522	0.2337
	Among schools		0.1906
	Intra school		0.1336
Availability of operating computers	Overall	0.6466	0.3508
	Among schools		0.2072
	Intra school		0.2831
Sufficiency of classrooms by sections	Overall	0.7125	0.2752
	Among schools		0.2116
	Intra school		0.1759
Sufficiency of furniture per student	Overall	0.7946	0.2164
	Among schools		0.1469
	Intra school		0.1589
Length of school calendar	Overall	0.6809	0.0613
	Among schools		0.0449
	Intra school		0.0470
Length of school day	Overall	0.0021	0.0140
	Among schools		0.0161
	Intra school		0.0098
Sufficiency of teachers per student	Overall	0.0243	0.0307
	Among schools		0.0420
	Intra school		0.0154

Variable		Average	S. D.	Hypothesis
Home & Student				
Students with Early Childhood Education	Overall	0.7781	0.3485	+
	Among schools		0.2665	
	Intra school		0.2569	
Cumulative educational outcume (at period t-1)	Overall	0.4679	0.2090	+
	Among schools		0.1454	
	Intra school		0.1502	
Schooling of household heads	Overall	7.6824	1.5346	+
	Among schools		1.5205	
	Intra school		0.2075	
Average annual household spending: In health and related	Overall	7.3168	0.3564	+
	Among schools		0.3413	
	Intra school		0.1026	
School community				
Households in overcrowded dwellings	Overall	0.0786	0.0432	-
	Among schools		0.0412	
	Intra school		0.0131	
Presence of indigenous languages [Si hay lenguas originarias = 1]	Overall	0.6238	0.4844	-
	Among schools		0.2450	
	Intra school		0.4179	
Geographic area [Urban area = 1]	Overall	0.3656	0.4816	+
	Among schools		0.4646	
	Intra school		0.1269	
Government and Education System				
Public expenditure in the Education Sector	Overall	7.5908	0.2694	+
	Among schools		0.1758	
	Intra school		0.2041	
Distance between school and UGELs	Overall	5.5305	13.5786	-
	Among schools		13.2036	
	Intra school		6.4998	
Type of school organization [Full-grade schools = 1]	Overall	0.3747	0.4841	+ / -
	Among schools		0.4687	
	Intra school		0.1210	
Type of school management [Public schools = 1]	Overall	0.9130	0.2819	+ / -
	Among schools		0.2815	
	Intra school		0.0136	

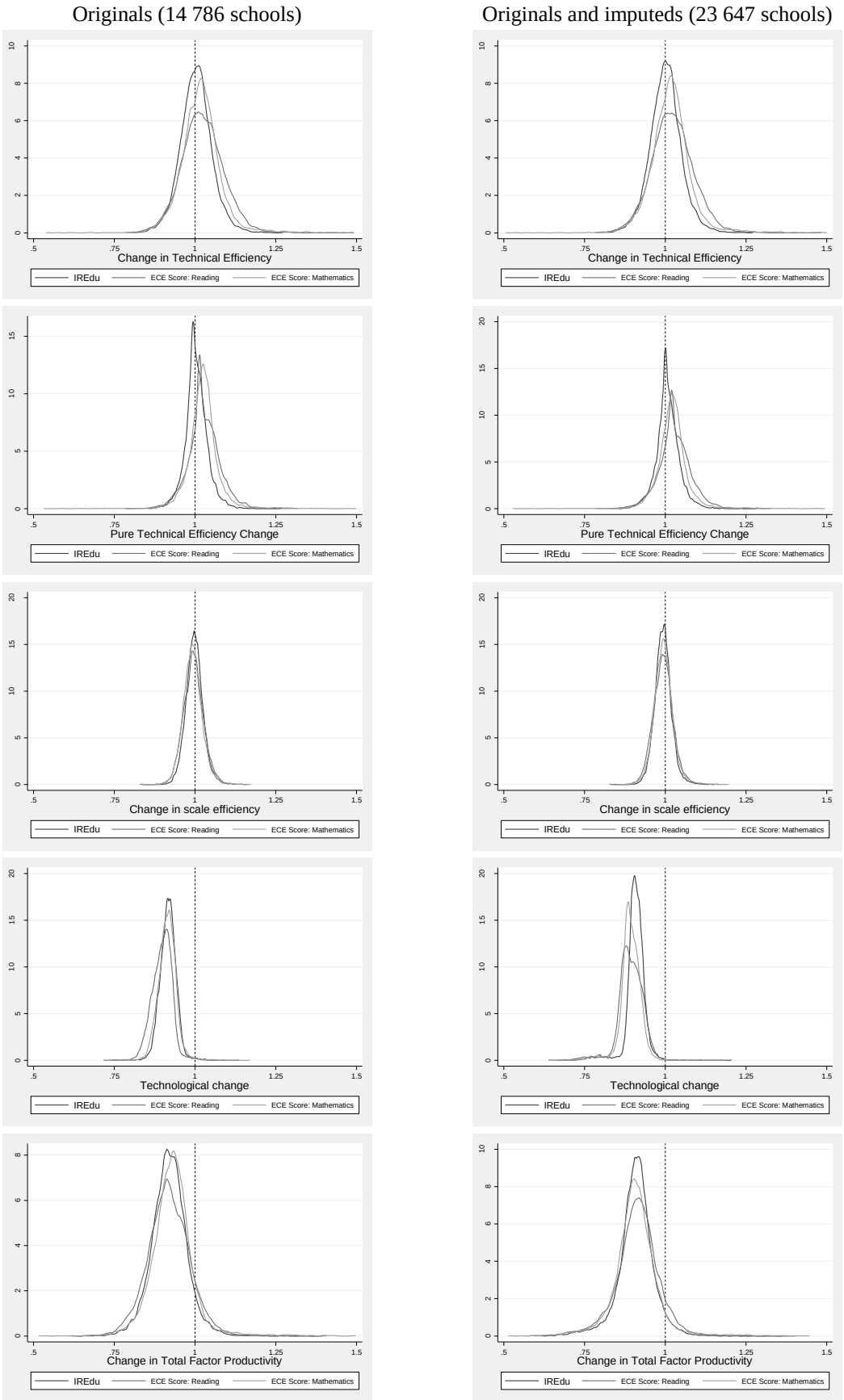
Note. Own elaboration. Source: INEI (2010 - 2014), ENAHO; MINEDU (2010 - 2014), CE and *Registro Nacional de Instituciones Educativas*.

Table 17. Peru: Contribution of discretionary inputs in determining educational efficiency by type of educational outcome (2010 - 2014)

Inputs	2010		2011		2012		2013		2014	
	Average	S. D.	Average	S. D.	Average	S. D.	Average	S. D.	Average	S. D.
Educational Outcome Index										
Infrastructure	-0.13	0.16	-0.08	0.11	-0.05	0.09	-0.08	0.12	-0.08	0.12
Basic services	-0.13	0.15	-0.34	0.26	-0.18	0.18	-0.19	0.19	-0.10	0.13
Physical spaces	-0.16	0.24	-0.16	0.23	-0.10	0.20	-0.09	0.18	-0.10	0.21
Operating computers	-0.19	0.25	-0.05	0.14	-0.05	0.12	-0.06	0.16	-0.05	0.15
Classrooms section	-0.20	0.22	-0.20	0.22	-0.13	0.19	-0.23	0.24	-0.31	0.33
Furniture per student	-0.20	0.18	-0.06	0.09	-0.09	0.12	-0.07	0.09	-0.11	0.13
School calendar	-0.02	0.03	-0.02	0.03	-0.02	0.03	-0.01	0.03	-0.02	0.03
School day	0.00	0.02	-0.01	0.04	-0.01	0.04	-0.01	0.02	0.00	0.01
Teachers per student	0.00	0.02	-0.03	0.06	-0.01	0.03	-0.01	0.03	-0.01	0.04
ECE Score in Reading Comprehension										
Infrastructure	-0.05	0.10	-0.10	0.13	-0.10	0.13	-0.08	0.12	-0.12	0.15
Basic services	-0.13	0.15	-0.44	0.29	-0.27	0.23	-0.19	0.19	-0.16	0.18
Physical spaces	-0.15	0.24	-0.17	0.24	-0.11	0.20	-0.10	0.19	-0.12	0.23
Operating computers	-0.18	0.24	-0.06	0.15	-0.03	0.10	-0.06	0.15	-0.05	0.15
Classrooms section	-0.15	0.21	-0.18	0.21	-0.13	0.18	-0.23	0.24	-0.38	0.37
Furniture per student	-0.09	0.13	-0.05	0.08	-0.16	0.16	-0.07	0.10	-0.23	0.26
School calendar	-0.03	0.03	-0.02	0.03	-0.02	0.04	-0.01	0.03	-0.01	0.03
School day	0.00	0.02	-0.01	0.04	-0.01	0.04	-0.01	0.02	0.00	0.01
Teachers per student	0.00	0.02	-0.03	0.06	-0.01	0.03	-0.02	0.03	-0.01	0.03
ECE Score in Mathematics										
Infrastructure	-0.18	0.17	-0.11	0.14	-0.07	0.11	-0.07	0.11	-0.16	0.18
Basic services	-0.15	0.16	-0.39	0.29	-0.13	0.15	-0.16	0.17	-0.13	0.15
Physical spaces	-0.17	0.26	-0.19	0.26	-0.11	0.20	-0.09	0.18	-0.10	0.21
Operating computers	-0.19	0.25	-0.05	0.15	-0.08	0.17	-0.06	0.15	-0.06	0.16
Classrooms section	-0.28	0.25	-0.20	0.22	-0.20	0.23	-0.16	0.20	-0.37	0.34
Furniture per student	-0.27	0.21	-0.07	0.10	-0.07	0.11	-0.05	0.08	-0.17	0.15
School calendar	-0.01	0.04	-0.02	0.03	-0.02	0.04	-0.01	0.02	-0.02	0.03
School day	0.00	0.02	-0.01	0.04	-0.01	0.04	0.00	0.02	0.00	0.01
Teachers per student	0.00	0.02	-0.03	0.06	0.00	0.02	-0.01	0.03	-0.01	0.04

Note. Estimates with information CE and the ECE (2010-2014). information imputed according to the procedure set is considered.

Figure 10. Peru: Malmquist decomposition, by educational outcome variable, according to data source (2010 - 2014)



Note. Estimates with information CE and the ECE (2010-2014). Information imputed according to the procedure set is considered.

Annex 5. Determinants of educational efficiency

Table 18. Peru: Tobit Estimation for variable educational outcome and efficiency analysis methodology (2010 – 2014)

	Educational Outcome Index		***Reading Comprehension (Score ECE)***		***Mathematics (Score ECE)***	
	Non-parametric	**Parametric**	**Non-parametric**	**Parametric**	**Non-parametric**	**Parametric**
Home & Student						
Students with Initial Education	0.0022	0.0012 ***	-0.0010	0.0001	-0.0025	0.0000
	1.61	3.98	-0.77	0.36	-1.65	0.26
Educational Outcome (Period t-1)	0.2390 ***	0.0625 ***	0.1592 ***	0.0139 ***	0.2119 ***	0.0099 ***
	37.06	38.61	26.88	14.39	30.56	14.78
Schooling of head of household (Average)	0.0155 ***	0.0046 ***	0.0027	0.0007 **	0.0069 ***	0.0003
	7.97	10.98	1.46	2.49	3.15	1.58
Annual household spending: In health and related (Average)	0.0051	0.0023 **	0.0218 ***	0.0026 ***	0.0046	0.0013 ***
	1.09	2.33	4.98	3.99	0.87	2.93
Community						
% Households in overcrowded dwellings	0.1798 ***	-0.0187 **	0.1425 ***	0.0086 *	0.2098 ***	0.0052
	5.08	-2.47	4.27	1.76	5.29	1.55
Presence of indigenous languages [Indigenous languages = 1]	-0.0118 ***	-0.0086 ***	-0.0083 ***	-0.0074 ***	0.0012	-0.0038 ***
	-6.68	-20.67	-4.92	-19.47	0.62	-14.60
Geographic area [Rural area = 1]	-0.0089 ***	0.0010 ***	-0.0143 ***	0.0017 ***	-0.0078 ***	0.0014 ***
	-6.21	3.01	-10.49	6.98	-4.89	8.11
Government and Education System						
Public expenditure in the Education Sector	0.0044	-0.0023 ***	-0.0066 *	-0.0007	0.0132 ***	0.0010 ***
	1.06	-2.62	-1.70	-1.14	2.86	2.65
Distance between school and UGEL	0.0003 ***	0.0000 ***	0.0003 ***	0.0000 ***	0.0004 ***	0.0000
	6.86	-5.02	7.00	-2.82	9.18	-1.55
Type of school organization [Full-grade schools = 1]	0.0084 ***	0.0013 ***	0.0061 ***	0.0002	0.0049 ***	0.0001
	6.20	4.21	4.79	0.90	3.29	0.30
Located in Lima (Metropolitan area) [Lima (Metropolitan area) = 1]						
Type of school management [Public Management = 1]	-0.0672 ***	-0.0013	-0.0889 ***	-0.0022 *	-0.0883 ***	-0.0020 **
	-12.72	-1.02	-17.65	-1.93	-15.25	-2.48
Temporal effects	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Regional effects	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Intercept [c]	0.4471 ***	0.8944 ***	0.5610 ***	0.9420 ***	0.4013 ***	0.9487 ***
	9.86	91.75	13.14	147.99	7.90	215.81
Estimated error between schools [sigma - u]	0.0549 ***	0.0139 ***	0.0529 ***	0.0146 ***	0.0595 ***	0.0101 ***
	96.44	97.67	100.89	141.29	96.74	141.33
Estimated overall error [sigma - e]	0.0834 ***	0.0179 ***	0.0785 ***	0.0115 ***	0.0935 ***	0.0080 ***
	287.36	279.72	290.29	294.61	290.67	294.70
AIC Criterion	-107,100	-293,800	-114,700	-334,800	-94,960	-379,200
BIC Criterion	-106,800	-293,500	-114,300	-334,400	-94,590	-378,900
Likelihood value (Log)	53,609	147,000	57,384	167,400	47,524	189,700

Note. These results consider the original information in accordance with the procedure outlined in the methodology section. This table reports coefficients and t-statistics estimates. Significance levels are reported each coefficient levels of 90% (*), 95% (**) and 99% (***). The estimate includes controls for temporal and regional effects through dummy variables.

Table 19. Public Schools: Tobit Estimation for variable educational outcome and efficiency analysis methodology (2010 – 2014)

Public Schools	*Educational Outcome Index*		*Reading Comprehension (Score ECE)*		*Mathematics (Score ECE)*	
	Non-parametric	Parametric	Non-parametric	Parametric	Non-parametric	Parametric
Home & Student						
Students with Initial Education	0.0116 ***	0.0056 ***	0.0401 ***	0.0216 ***	0.0371 ***	0.0163 ***
	7.38	4.79	11.11	9.86	10.76	8.27
Educational Outcome	0.1180 ***	0.0411 ***	0.3633 ***	0.2212 ***	0.3493 ***	0.1915 ***
(Period t-1)	39.30	13.94	52.46	49.01	52.81	46.92
Schooling of head of household	0.0192 ***	0.0040 **	-0.0064	0.0000	-0.0017	0.0008
(Average)	7.08	2.35	-1.06	0.00	-0.30	0.23
Annual household spending: In health	-0.0360 ***	-0.0258 ***	-0.0313 **	-0.0303 ***	-0.0365 ***	-0.0352 ***
and related (Average)	-5.71	-5.06	-2.23	-3.46	-2.69	-4.44
Community						
% Households in overcrowded	-0.4386 ***	-0.2786 ***	-1.6651 ***	-1.0435 ***	-1.4081 ***	-0.9026 ***
dwellings	-9.15	-7.52	-15.72	-15.89	-13.84	-15.25
Presence of indigenous languages	-0.0557 ***	-0.0260 ***	-0.1237 ***	-0.0746 ***	-0.1186 ***	-0.0650 ***
[Indigenous languages = 1]	-33.00	-28.70	-36.72	-37.70	-36.20	-36.48
Geographic area	-0.0093 ***	0.0005	-0.0740 ***	-0.0302 ***	-0.0615 ***	-0.0172 ***
[Rural area = 1]	-7.58	0.44	-27.13	-17.14	-23.61	-10.85
Government and Education System						
Public expenditure in the Education	0.0325 ***	0.0184 ***	-0.0283 **	-0.0016	-0.0057	0.0083
Sector	6.10	4.57	-2.50	-0.23	-0.53	1.32
Distance between school and UGEL	0.0005 ***	-0.0001 **	-0.0004 ***	-0.0004 ***	-0.0003 ***	-0.0003 ***
	10.36	-2.18	-4.49	-7.90	-2.76	-6.14
Type of school organization	0.0266 ***	0.0011	0.0886 ***	0.0386 ***	0.0816 ***	0.0260 ***
[Full-grade schools = 1]	23.01	1.04	33.72	22.72	32.56	16.94
Type of school management						
[Public Management = 1]						
Temporal effects	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Regional effects	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Intercept	0.6028 ***	1.0448 ***	1.1635 ***	1.1257 ***	0.9185 ***	1.0513 ***
[c]	10.12	21.41	8.89	13.81	7.29	14.29
Estimated overall error	0.1197 ***	0.0879 ***	0.2631 ***	0.1639 ***	0.2528 ***	0.1477 ***
[sigma - e]	314.42	55.41	377.75	246.74	378.95	225.84
AIC Criterion	-97,400	-147,500	14,303	-56,650	8,753	-71,880
BIC Criterion	-97,030	-147,100	14,671	-56,280	9,121	-71,510
Likelihood value (Log)	48,740	73,768	-7,112	28,364	-4,337	35,981

Note. These results consider the original information in accordance with the procedure outlined in the methodology section. This table reports coefficients and t-statistics estimates. Significance levels are reported each coefficient levels of 90% (*), 95% (**) and 99% (***). The estimate includes controls for temporal and regional effects through dummy variables.

Table 20. Private Schools: Tobit Estimation for variable educational outcome and efficiency analysis methodology (2010 – 2014)

Private Schools	*Educational Outcome Index*		*Reading Comprehension (Score ECE)*		*Mathematics (Score ECE)*	
	Non-parametric	Parametric	Non-parametric	Parametric	Non-parametric	Parametric
Home & Student						
Students with Initial Education	0.0235 *	0.0151	0.0656 **	0.0337	0.0567 **	0.0253
	1.68	0.60	2.24	1.30	2.03	1.06
Educational Outcome	0.1388 ***	0.4178 ***	0.2585 ***	0.4608 ***	0.3098 ***	0.4381 ***
(Period t-1)	8.41	12.68	8.57	14.10	10.54	14.49
Schooling of head of household	0.0614 **	0.0355	-0.0089	0.0334	0.0092	0.0331
(Average)	2.28	0.66	-0.20	0.64	0.21	0.68
Annual household spending: In health	0.0403	-0.1958 *	0.1703 *	-0.1405	0.1684 *	-0.1309
and related (Average)	0.79	-1.86	1.67	-1.31	1.74	-1.32
Community						
% Households in overcrowded	0.0077	1.1774	-1.2515	0.3848	-0.8604	0.4692
dwellings	0.02	1.27	-1.57	0.42	-1.11	0.55
Presence of indigenous languages	0.0003	0.0203	-0.0120	0.0116	-0.0091	0.0125
[Indigenous languages = 1]	0.02	0.65	-0.34	0.38	-0.26	0.43
Geographic area	-0.0017	0.0695 **	-0.0923 ***	0.0311	-0.0758 ***	0.0396
[Rural area = 1]	-0.11	2.38	-3.07	1.07	-2.65	1.46
Government and Education System						
Public expenditure in the Education	-0.0306	-0.1664 **	0.0441	-0.1114	0.0208	-0.1114 *
Sector	-1.08	-2.41	0.93	-1.63	0.44	-1.76
Distance between school and UGEL	0.0008	0.0005	0.0010	0.0004	0.0010	0.0005
	1.30	0.51	0.89	0.37	0.91	0.54
Type of school organization	0.0263 ***	0.0348 **	0.1355 ***	0.0834 ***	0.1324 ***	0.0752 ***
[Full-grade schools = 1]	2.95	2.18	7.08	5.08	7.34	5.01
Type of school management						
[Public Management = 1]						
Temporal effects	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Regional effects	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Intercept	0.1051	2.9410 ***	-0.9158	2.0766 **	-0.9811	1.9851 **
[c]	0.23	3.07	-1.01	2.14	-1.12	2.22
Estimated overall error	0.1222 ***	0.3001 ***	0.2412 ***	0.3084 ***	0.2327 ***	0.2842 ***
[sigma - e]	50.69	59.18	43.57	65.96	45.94	64.40
AIC Criterion	-2,580	1,246	247	1,393	104	950
BIC Criterion	-2,353	1,482	473	1,629	330	1,186
Likelihood value (Log)	1,330	-583	-83	-656	-12	-435

Note. These results consider the original information in accordance with the procedure outlined in the methodology section. This table reports coefficients and t-statistics estimates. Significance levels are reported each coefficient levels of 90% (*), 95% (**) and 99% (***). The estimate includes controls for temporal and regional effects through dummy variables.

Table 21. Full-grade Schools: Tobit Estimation for variable educational outcome and efficiency analysis methodology (2010 – 2014)

Full-grade Schools	*Educational Outcome Index*		*Reading Comprehension (Score ECE)*		*Mathematics (Score ECE)*	
	Non-parametric	Parametric	Non-parametric	Parametric	Non-parametric	Parametric
Home & Student						
Students with Initial Education	0.0162 ***	0.0115 ***	0.0514 ***	0.0317 ***	0.0503 ***	0.0252 ***
	5.64	2.61	7.99	6.22	8.22	5.34
Educational Outcome	0.1219 ***	0.1160 ***	0.3276 ***	0.2585 ***	0.3259 ***	0.2317 ***
(Period t-1)	28.03	13.81	33.36	28.16	34.56	27.26
Schooling of head of household	0.0148 ***	-0.0072	-0.0317 ***	-0.0239 ***	-0.0260 ***	-0.0205 ***
(Average)	4.17	-1.61	-4.17	-4.13	-3.59	-3.89
Annual household spending: In health	-0.0221 ***	-0.0076	0.0284 *	0.0148	0.0233	0.0095
and related (Average)	-2.73	-0.66	1.70	1.09	1.43	0.75
Community						
% Households in overcrowded	-0.2655 ***	-0.3206 ***	-1.4976 ***	-1.1106 ***	-1.1760 ***	-0.9185 ***
dwellings	-3.88	-3.31	-10.08	-9.54	-8.18	-8.52
Presence of indigenous languages	-0.0552 ***	-0.0223 ***	-0.1062 ***	-0.0639 ***	-0.1052 ***	-0.0570 ***
[Indigenous languages = 1]	-19.09	-9.54	-18.43	-17.07	-18.73	-16.61
Geographic area	-0.0143 ***	-0.0008	-0.0902 ***	-0.0360 ***	-0.0767 ***	-0.0221 ***
[Rural area = 1]	-9.59	-0.46	-27.27	-15.31	-24.25	-10.21
Government and Education System						
Public expenditure in the Education	0.0282 ***	0.0029	0.0172 *	0.0158	0.0382 ***	0.0272 ***
Sector	4.91	0.34	1.66	1.62	3.75	3.02
Distance between school and UGEL	0.0000	-0.0003 **	-0.0015 ***	-0.0009 ***	-0.0012 ***	-0.0007 ***
	-0.23	-2.05	-7.02	-6.72	-6.07	-5.14
Type of school organization						
[Full-grade schools = 1]						
Type of school management	-0.0243 ***	0.1788 ***	-0.0780 ***	0.1401 ***	-0.0660 ***	0.1321 ***
[Public Management = 1]	-8.18	22.68	-14.65	17.58	-12.52	17.85
Temporal effects	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Regional effects	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Intercept	0.5646 ***	0.8890 ***	0.6941 ***	0.7032 ***	0.4250 ***	0.5968 ***
[c]	7.65	8.40	4.56	5.64	2.87	5.17
Estimated overall error	0.0933 ***	0.1343 ***	0.1822 ***	0.1582 ***	0.1780 ***	0.1469 ***
[sigma - e]	171.88	62.41	139.71	100.65	152.97	99.07
AIC Criterion	-52,980	-34,290	-15,110	-24,720	-16,410	-29,060
BIC Criterion	-52,650	-33,960	-14,780	-24,390	-16,080	-28,730
Likelihood value (Log)	26,530	17,184	7,597	12,400	8,243	14,570

Note. These results consider the original information in accordance with the procedure outlined in the methodology section. This table reports coefficients and t-statistics estimates. Significance levels are reported each coefficient levels of 90% (*), 95% (**) and 99% (***). The estimate includes controls for temporal and regional effects through dummy variables.

Table 22. Multi-grade Schools: Tobit Estimation for variable educational outcome and efficiency analysis methodology (2010 – 2014)

Multi-grade Schools	*Educational Outcome Index*		*Reading Comprehension (Score ECE)*		*Mathematics (Score ECE)*	
	Non-parametric	Parametric	Non-parametric	Parametric	Non-parametric	Parametric
Home & Student						
Students with Initial Education	0.0129 ***	0.0058 ***	0.0404 ***	0.0218 ***	0.0375 ***	0.0165 ***
	7.22	4.44	9.83	8.80	9.53	7.45
Educational Outcome	0.1184 ***	0.0418 ***	0.3706 ***	0.2237 ***	0.3560 ***	0.1938 ***
(Period t-1)	30.94	11.69	42.45	39.75	42.60	38.12
Schooling of head of household	0.0117 ***	0.0038	0.0088	0.0086	0.0077	0.0075
(Average)	3.12	1.63	1.01	1.65	0.95	1.64
Annual household spending: In health	-0.0273 ***	-0.0324 ***	-0.0527 ***	-0.0465 ***	-0.0514 ***	-0.0510 ***
and related (Average)	-3.19	-5.04	-2.70	-3.91	-2.73	-4.77
Community						
% Households in overcrowded	-0.6426 ***	-0.3121 ***	-1.6813 ***	-1.0354 ***	-1.5072 ***	-0.9126 ***
dwellings	-10.54	-7.15	-12.37	-12.50	-11.57	-12.31
Presence of indigenous languages	-0.0468 ***	-0.0227 ***	-0.1259 ***	-0.0731 ***	-0.1163 ***	-0.0629 ***
[Indigenous languages = 1]	-22.37	-21.38	-29.71	-29.82	-28.33	-28.66
Geographic area	-0.0020	0.0039 **	-0.0560 ***	-0.0228 ***	-0.0442 ***	-0.0116 ***
[Rural area = 1]	-1.01	2.46	-12.62	-8.10	-10.48	-4.63
Government and Education System						
Public expenditure in the Education	0.0094	0.0204 ***	-0.0535 ***	-0.0143	-0.0472 **	-0.0108
Sector	1.06	3.45	-2.67	-1.20	-2.49	-1.03
Distance between school and UGEL	0.0005 ***	0.0000	-0.0003 ***	-0.0004 ***	-0.0002	-0.0003 ***
	9.50	-1.28	-2.62	-6.00	-1.43	-4.99
Type of school organization						
[Full-grade schools = 1]						
Type of school management	-0.0374 ***	0.1880 ***	-0.0564 ***	0.1461 ***	-0.0397 **	0.1456 ***
[Public Management = 1]	-4.70	11.84	-3.17	9.37	-2.36	10.05
Temporal effects	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Regional effects	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Intercept	0.8224 ***	0.8944 ***	1.4459 ***	1.1268 ***	1.3073 ***	1.1123 ***
[c]	9.48	13.54	7.42	9.54	7.01	10.54
Estimated overall error	0.1324 ***	0.0942 ***	0.2998 ***	0.1840 ***	0.2870 ***	0.1645 ***
[sigma - e]	271.91	51.51	364.58	266.41	356.93	237.59
AIC Criterion	-52,090	-87,480	21,158	-25,340	17,322	-35,720
BIC Criterion	-51,740	-87,130	21,507	-24,990	17,672	-35,370
Likelihood value (Log)	26,085	43,782	-10,540	12,712	-8,621	17,899

Note. These results consider the original information in accordance with the procedure outlined in the methodology section. This table reports coefficients and t-statistics estimates. Significance levels are reported each coefficient levels of 90% (*), 95% (**) and 99% (***). The estimate includes controls for temporal and regional effects through dummy variables.