DO PARENTS PERCEIVE THE TECHNICAL QUALITY OF PUBLIC SCHOOLS? AN ACTIVITY ANALYSIS APPROACH

LÓPEZ-TORRES, Laura[a]
PRIOR, Diego[a1]

Abstract
The quality of education is a topic of interest and, according to the literature, efficient school management is required to ensure proper students' performance. This paper analyzes the level of "technical" quality in public schools and determines whether or not there are discrepancies between this indicator and parents' subjective perception of quality. A sample of public schools in Catalonia is surveyed. The results show that parents correctly perceive the technical quality. Furthermore, there is a significant negative relationship between the concentration index and parental demand. The findings reveal that parents have some awareness of school quality when enrolling their children and try to obtain their choice based on quality considerations.
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JEL Codes: C61, D24, I21, I24.

1. Introduction

The study of the quality of the education system and the factors that may be associated with better outcomes has raised interest from both practitioner and academic points of view (Heyneman and Loxley, 1983; Ngware, Oketch, and Ezeh, 2011). The emphasis on human capital has become a key issue in the design and implementation of government programs in various fields around the world. One of the reasons is the increasing recognition of the importance of the education sector to economies as a whole, since this sector provides intellectual training for the population, better human capital, and improved labor productivity (Lee and Barro, 2001). The role of human capital in particular has been emphasized in the recent literature on economic growth (Hanushek and Luque, 2003; Krueger and Lindahl, 2001).

The academic literature, both theoretical and methodological, on school efficiency and quality is increasing (Coleman, Campbell, and Hobson, 1966; Hanushek, 1971; Hanushek; 1986; Hanushek and Luque, 2003; Heyneman and Loxley, 1983; Kingdon, 1996; Michaelowa, 2001; Ouellette and Vierstraete, 2005; Smith and Mayston, 1987; Tooley, Dixon, Shamsan, and Schagen, 2010). However, most of this research has studied either the issue of quality or that of efficiency, not both. In some cases, achieving a higher quality of education has been associated with increased management efficiency (Hanushek and Luque, 2003; Kingdon, 1996, among others). However, a framework is needed to solidly establish whether the technical or objective quality of education is linked to management efficiency.

Most of the studies on the economics of education considered in this present study have focused on the economic consequences of quantity of education (years of schooling); less attention has been paid to issues of quality. As Hanushek and Luque (2003) note, no one believes that all schools within a country are the same in terms of the knowledge transmitted. For this reason, among others, we find in the literature different approaches to determining educational quality (Fehrler, Michaelowa, and

[1] E-mail: Laura.Lopez.Torres@uab.es and Diego.Prior@uab.es.
[a] Business Department, Universitat Autònoma de Barcelona.

Wechtler, 2009). These studies use approaches ranging from descriptive techniques (Heyneman and Loxley, 1983; Ngware *et al.*, 2011) and regressions (Fehrler *et al.*, 2009; Kingdon, 1996; Lee and Barro, 2001; Michaelowa, 2001) to more complex models such as the multilevel methodology (Tooley *et al.*, 2010).

In all cases, the central hypothesis is that certain features of schools and environmental conditions affect the results achieved by students. Likewise, all studies agree on a basic definition of quality. Although the concept is difficult to define precisely, we can describe school quality as some measure of the outcome of schooling. It refers to the knowledge base and analytical skills the transmission and development of which is the focus of education. Specific elements that have been considered to bear on or constitute part of quality include learning achievement; the relevance of the curriculum; the social, cultural and political environment; and the condition of the teachers and facilities (Hanushek and Luque, 2003). However, most prior studies use the student achievement on a standardized skill test as a good proxy for education outcomes and therefore quality.

Although we adopt this framework, we want to go one step further. We aim to measure quality of education through a specific methodology less often used in this kind of literature, which measures the efficiency of a set of decision-making units (DMUs) by the use of activity analysis—more precisely, Data Envelopment Analysis (DEA) (Charnes, Cooper, and Rhodes, 1978). Our focus is on determining whether there is significant convergence between the subjective perception of school quality by parents and the quality as technically assessed using DEA. Therefore, this paper addresses the following research questions: 1) What is the technical quality level of public schools? and 2) Is there a discrepancy between subjective perception of quality by parents and the technical quality of a school?

To answer these questions, we use a database containing information on public elementary and primary schools in Catalonia. The results show that the parents correctly perceive the real quality of these schools. There is a significant negative relationship between low technical quality and parents' subjective perceptions of it. Also, as the concentration index of a municipality increases (meaning that there is a lower number of schools to choose from), parents have less power of decision over the school in which they choose to enroll their children. We find a significant negative relationship between the concentration index of a municipality and parental demand; thus, the larger the number of schools in a municipality, the more scope for decision by parents. On the other hand, the higher the center and the higher the number of permanent teachers working in it, the more in demand will be by parents. Conversely, an increasing level of students' turnover implies a drop in parental demand in relation to that school.

The results obtained by this study have direct and useful application: they provide valuable information for decision-making by parents and public authorities. Parents can receive an objective assessment of the quality of the school and better decide where to send their children. At the same time, understanding the determination of school quality will inform policy decisions as well. To create opportunities for interventions targeting school improvement, it is imperative to understand the current quality of schooling. Public investment in education can then target identified school quality characteristics for intervention, with a view to developing higher-quality schools.

Following this introduction, Section 2 describes the conceptual framework used in the research. Then, Section 3 details the proposed methodological approach. In Section 4, we comment on and discuss the results. Finally, in Section 5, we establish the main implications and the conclusions of the study.

2. Conceptual Framework

2.1. Conceptual Issues: Quality and Efficiency

As mentioned above, the concept of quality of education is difficult to define. It can be conceptualized in several aspects, for example the quality of the students, the quality of inputs and institutional processes, and the quality of outcomes (Ngware *et al.*, 2011). Many studies have used learner achievement as an indicator of educational quality. However, students and school inputs interact within a socioeconomic environment over which the school system has limited control. Therefore, to comprehensively understand and evaluate the quality of education, it is important to consider the environmental factors that affect quality indicators.

There are several ways of assessing quality. Some are based on empirical evidence, others on subjective judgments and perceptions. Regardless, what is clear is that how well students are taught and how much they learn has an impact on the school's quality (Fehrler *et al.*, 2009). Parents send their children to a particular school depending on their personal judgments about the quality of teaching provided and learning achieved at that school. Various information channels help parents develop these perceptions. For instance, open house events in schools are one mechanism for parents to get to know and appreciate the quality of education offered. It is also quite usual for parents to be affected by word of mouth from other parents who have had good or bad experiences at some school. This paper aims to assess the quality of a set of public schools under a multicriterion methodology in order to determine whether are there significant divergences between subjective quality as perceived by the parents and technical quality as assessed by the DEA technique.

Educational efficiency measures the performance of a school in the context of the use of resources. Several empirical studies have estimated the impact on school outcomes of both internal and environmental factors. Some have indicated that students' educational and socioeconomic characteristics explain the differences in their educational achievement, not within but also between schools (Cervini, 2009; Elacqua, Schneider, and Buckley, 2006; Opdenakker and Van Damme, 2001; Thieme, Prior, and Tortosa-Ausina, 2013). From this comparison of quality and efficiency, we can conclude that they are closely related. In fact, as will be seen, the same variables can be used for evaluation of both. Thus, the first proposition is posed as follows:

Proposition 1: Parents' demand for a particular school depends on the information they gain by informal channels to perceive school quality, and this subjective perceived quality may have some connection with technical quality.

Another important point related to quality of education concerns the schooling options available to parents by geographical jurisdiction. There are situations in which a municipality has a very small number of inhabitants and only one public school is available. In this case, the school operates isolated, as parents do not have any other option than sending their children to this school. In contrast, we can find cities with large populations and many schools operating. In this case, the options available to parents increase. They may decide better, employing more decision variables, which school is most suitable for their children. Schools in these locations operate in a situation of increased competition compared to other schools. That is why we pose the second proposition:

Proposition 2: Demand for a school is affected by the options available to parents. The larger the number of schools in a

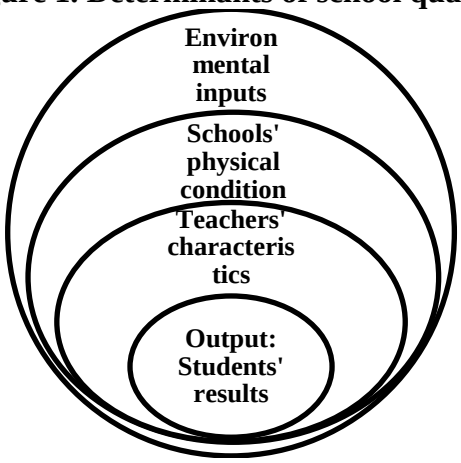
municipality, the more decision-making scope is to parents and demand can be influenced.

2.2. Determinants of Education Efficiency and Quality

Since its inception, research in education has contributed to improving knowledge of the factors that affect the development of students and thus providing information for decision-making in the classroom, the school, and the educational system. For more than two decades, researchers, politicians, and teachers have been concerned with what makes an efficient, high-quality school—that is, what are the factors that contribute to achieving higher-than-expected results in a particular context (Goldstein and Woodhouse, 2000).

Despite the importance of measuring school performance and its many positive externalities, researchers have not reached a consensus about the key variables to take into account.—In other words, on the relative importance of various school inputs and environmental factors in achieving results. Some authors doubt that school inputs have as much effect on educational outcomes as has often been thought (Hanushek, 1971, 1986), but there is more agreement on the effect of environmental factors (Figure 1).

Figure 1. Determinants of school quality



Source: Self devised

Table 1 summarizes the input and output variables used in the previous literature to evaluate school efficiency and quality. As can be seen, most papers use as an output results from aptitude tests that were homogeneous for all students. In terms of inputs, most studies distinguish between teachers' quality and schools' physical conditions. Finally, non-discretionary inputs may have different origins; they can be derived from environmental factors (which include the student's personal characteristics and close family environment) or complexity factors (variables reflecting diversity inside the school).

Table 1. School efficiency and quality studies review

Variables		*Dimensions*	*Papers*
School Inputs	Teachers' characteristics	Educational level Teaching experience Leadership role School's assessment policy Innovation projects Teachers' methodology	Deller and Rudnicki (1993); Dewey *et al.* (2000); Ehrenberg and Bewer (1994); Fehrler *et al.* (2009); Hanushek (1986); Hanushek and Luque (2003); Heyneman and Loxley (1983); Johnson and Ruggiero (2013); Kingdon (1996); Lee and Barro (2001); Michaelowa (2001); Muñiz (2002); Ngware *et al.* (2011); Opdenakker and Van Damme (2001); Ouellette and Vierstraete (2005, 2010); Phillips (1997); Ruggiero *et al.* (1995); Silva-Portela and Thanassoulis (2001); Smith and Mayston (1987); Tooley *et al.* (2010).
	School's physical condition	School size Groups of the school School budget Sports facilities	
Environmental Inputs	Contextual Variables	Families' Socioeconomic level Families' educational level Family involvement Spillover effect	Coleman *et al.* (1966); Cordero *et al.* (2008);Hanushek (1971); Hanushek and Luque (2003); Lee and Barro (2001); Mancebón and Mar-Molinero (2000); Mancebón and Muñiz (2008); Michaelowa (2001); Ouellette and Vierstraete (2005); Pepin (1999); Silva-Portela and Thanassoulis (2001); Smith and Mayston (1987); Ruggiero *et al.* (1995); Ruggiero (1998); Thanassoulis and Dunstan (1994); Tooley *et al.* (2010).
Output	Results	Students' academic outcomes Grades on a homogeneous test Number of students passing the test Number of students repeating a grade	Fehrler *et al.* (2009); Hanushek and Luque (2003); Heyneman and Loxley (1983); Johnson and Ruggiero (2013); Lee and Barro (2001); Madaus, Kellaghan, Rakow and King (1979); Mancebón and Mar-Molinero (2000); Mancebón and Muñiz (2008); Michaelowa (2001); Ngware *et al.* (2011); Ouellette and Vierstraete (2005, 2010); Ray (1991); Ruggiero *et al.* (1995); Silva-Portela and Thanassoulis (2001); Smith and Mayston (1987); Thanassoulis and Dunstan (1994); Tooley *et al.* (2010).

Source: Self devised

Based on the literature review, it is possible to build a school quality assessment model that collects in detail the variables considered in the review (Figure 2).

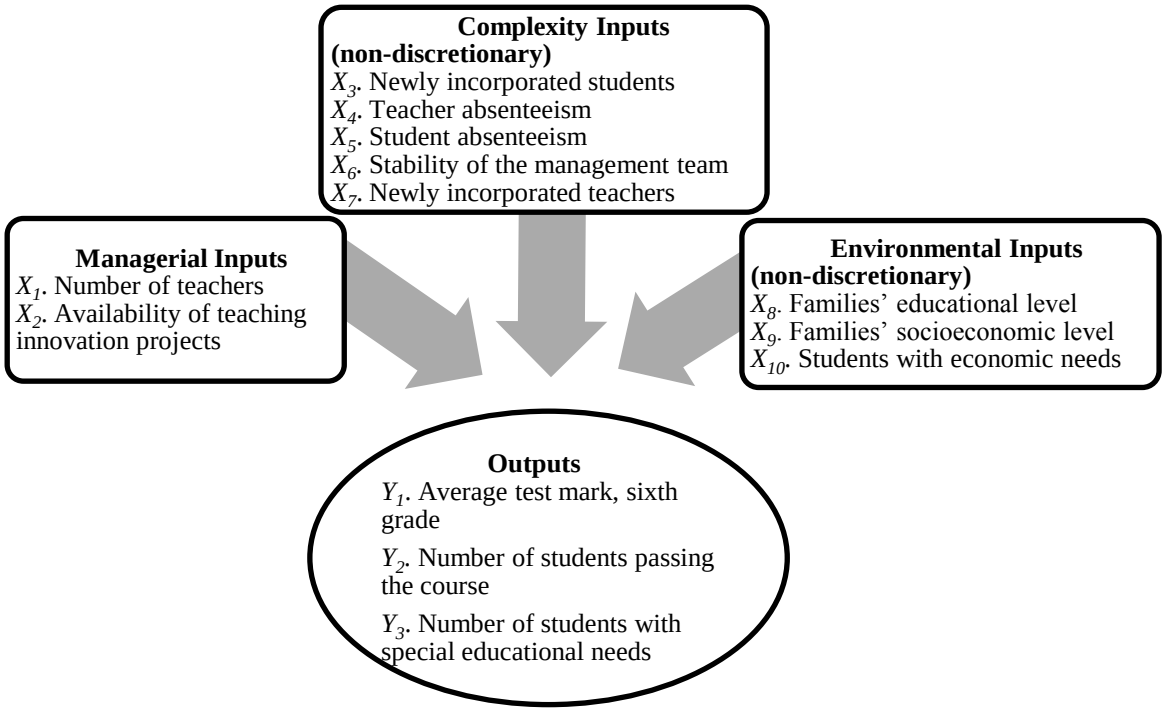
As can be seen, the proposed model includes different variables in each category, and the unit of analysis is the school. It should be noted that this model is descriptive, containing elements that constitute the school's internal and external context. It is important to highlight the fact that we do not have any data about the school's budget and the students' level.

Outputs (Y) are conditioned by different inputs (X); two of the latter (number of teachers (X_1) and availability of teaching innovation projects (X_2)) are discretionary, and the remainder non-discretionary ($X_{3\text{-}10}$). Likewise, outputs are measured by three indicators, considered at the same level. However, actually, there is a trade-off between the number of approved students (Y_2) and the average final grade (Y_1)[2]. As we have no

[2] We are aware about the possible correlation between these two variables (Y_1 and Y_2). Despite showing a positive correlation, we decided keeping both of them because of the Y_2 also includes other important variables such as the number of repeaters' and students absenteeism. This choice serves us to get a more complex vision about the reality inside the school. Furthermore, in the hypothetic case in which we consider only one of them, we could use a parametric approach like stochastic frontier analysis (SFA) (Aigner, Lovell and Schmidt, 1977; Bauer, 1990; Meeusen and Van den Broeck, 1977). However, this model forces us to work with only one dimension of output instead more than one. Nevertheless, we have

indication of which goal is more desirable, we define them at the same level, although in practice some schools value one more than the other. The variable number of students with special educational needs (Y_3) is an indicator of output complexity—we assume that these students require more resources and attention from the teachers because of they have some educational disabilities.

Figure 2. School quality assessment model



Source: Self devised

It is worth pointing out certain issues about the inputs as well. First, one input variable is availability of teaching innovation projects (X_2). This indicator expresses the existence of valuable human capital and refers to the internal consistency in ability among teachers at a school. In other words, it gives an idea of the teachers' level of involvement in the school. It is a binary variable, where the teachers are either more or less involved in school management, setting goals, and initiating improvements. Although it is binary, it does not divide the sample into two groups, as we follow Banker and Morey's (1986) proposal on how to introduce categorical variables in DEA models. Once this approach is applied, we perform a lenient assessment of those schools that do not have any teaching innovation projects, in that these schools are compared with similar schools only. The schools that do have teaching innovation projects are compared against the entire sample.

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an indicator about the output complexity (Y_3) and we consider it is important to include it in the DEA model. Moreover, the SFA model requires a specific functional form of the education production function. Nonetheless, the extreme difficulty of any assessment process is a major problem in the public sector, due to its multidimensional structure and the complexity of precisely defining the objectives assigned and the production function. Due to this complex structure, the DEA application, in order to assess the efficiency of a group of decision-making units (DMU's) has been broad.

Second, we consider a group of variables representing the internal complexity of the center. These items are made non-discretionary, because the school cannot influence them. As we initially had 14 variables in this group, we decided to reduce their number by performing a principal components analysis (PCA) and we obtained the five factors included in Figure 2 ($X_{3\text{-}7}$). Likewise, we initially had 17 variables representing environmental context, so we applied another PCA to reduce this number. Finally, we obtained three factors related to the family's educational (X_8) and socioeconomic level (X_9), and the student's economic needs[3] (X_{10})[4].

3. Methodology

3.1. Variables, Sample, and Data Collection

On the basis of the literature review, we identified a number of variables related to education quality and efficiency (Table 2). We developed our own database for the variables used in this study because it was difficult to find a secondary database that contained all of them. We contacted the Superior Council of Education System Assessment in Catalonia (*Consell d'Avaluació del Sistema Educatiu de la Generalitat de Catalunya*) to create a more complete database.

Table 2. Description of input/output variables

	Variable	*Variable Type*	*Description*
X_1	Number of teachers	Discretionary input	Total number of teachers at the school
X_2	Availability of teaching innovation projects	Discretionary input	Quality indicator. Availability of Innovation Projects (0. No, 1. Yes)
X_3	New students (at the school)	Non-discretionary input	Factor representing newly incorporated children (at the beginning of an academic year or midway through the year)
X_4	Teacher absenteeism	Non-discretionary input	Factor representing teacher absences during the academic year
X_5	Student drop-out	Non-discretionary input	Factor representing student absences during the academic year (counting students absent more than 75% of the days)
X_6	Stability of the management team	Non-discretionary input	Factor representing changes in the management team since the school started operating
X_7	Newly incorporated teachers	Non-discretionary input	Factor representing newly incorporated teachers
X_8	Families' educational level	Non-discretionary input	Factor representing parent education
X_9	Families' socioeconomic level	Non-discretionary input	Factor representing the employment status of families
X_{10}	Students with special economic needs	Non-discretionary	Factor representing the complexity of the classroom (number of grants)

[3] It is important to note that inside this variable (X_{10}), the PCA included the number of immigrants' students. This is an important variable that is used isolated in other studies like PISA. However, in our case, the PCA grouped this variable with other such as the number of non-identified parents in the enrollment or the number of students with economic needs.

[4] For space reasons, we do not show tables for the two PCAs carried out. This data may be obtained from us upon request.

		input	
Y_1	Average test mark, sixth grade	Output	Measures the quality of teaching. Defined by the average test mark obtained by the school's students in a general test in sixth grade
Y_2	Number of students passing the course	Output	Total enrolled – repeaters – absentee students (with more than 75% absences each quarter)
Y_3	Number of students with special educational needs	Output	Total students with special educational needs (additional supporting classes)

Source: Self devised

The sample included 1,371 elementary and primary schools, or 81% of all schools in Catalonia, for the academic year 2009–2010. We excluded schools that only offered special education and those for which we did not have any data about the students' results. Once the database was constructed, we validated it externally through the inspectors and we did an internal evaluation in which we analyzed each observation.

Other variables, related to the next phases of the methodological procedure, which will be explained below, are shown in Table 3.

Table 3. Description of regression variables

Variable		*Variable Type*	*Description*
Z	School demand	Quantitative	Applications / Places offered. Reflects the subjective quality of the school.
θ	Efficiency score	Quantitative	Relative efficiency index; reflects the technical quality of the school.
HI	Herfindahl–Hirschman index	Quantitative	Shows the concentration index of the municipality.
PUPILS	Number of students	Quantitative	LN (Total number of regular students enrolled in the school)
PERM	Full-time teachers	Quantitative	Number of stable teachers / Total number of teachers
POPUL	Population	Quantitative	LN (Inhabitants of the municipality where the school is located)
AGE	Number of years operating	Quantitative	Reflects the age of the school in years.
MOBILITY	Student mobility level	Quantitative	New enrollments + Exits / Total enrollment

Source: Self devised

As can be seen, in order to achieve the second objective, we define a number of variables related to the subjective quality that parents may perceive in a school. These variables are the best proxies available in terms of establishing the (non-)existence of the relationship between technical quality (θ) and subjective quality as perceived by parents (Z). In other words, we believe that these are some of the variables actually taken into account by parents when they choose a school for their child's education.

First, the subjective quality of the school (Z) is defined as the ratio between families' demand and the places offered at the school. This variable can only take non-negative values. A coefficient equal to one indicates that the places offered are fully covered by the demand. When the coefficient takes a value less than one, it reflects that not all places are covered, so it is not a school in high demand. Conversely, when it takes values greater than one, it indicates that the demand for this school is higher than the supply, and thus that it is perceived as a high-quality school.

Second, subjective demand can depend on other variables apart from technical quality, including the number of students enrolled (*PUPILS*), the percentage of full-time

employees (*PERM*), the municipal population (*POPUL*), the age of the school or length of time it has been in operation (*AGE*), and the school's student mobility rate (*MOBILITY*). A big school is expected to have more demand, as parents will perceive that it does a good job if it has more students. A school with a high level of mobility of students will be less in demand by parents, as they could perceive that there is "too much transit" within the school. These variables are taken as control variables because they are the most commonly used in the literature. Finally, the other two variables we assume are related to subjective school quality are the relative efficiency coefficient (θ) and the concentration municipality index (*HI*). In the following sections, we explain them in detail.

3.2. Methodological Procedure

The methodological approach of the present study is developed in several parts, each of which plays a role in addressing the objectives previously posed. First, we conduct a quality assessment for each school. This measures the average score of sixth-grade students on a standardized test and the number of students who pass this test. This first stage will be conducted using the DEA technique, considering all the variables of the model (Figure 2): output (*Y*), school inputs, complexity, and environmental factors (*X*). DEA models have become one of the most commonly used techniques to evaluate school efficiency (Smith and Mayston, 1987; Mancebón and Mar-Molinero, 2000; Silva-Portela and Thanassoulis, 2001; Muñiz, 2002; Muñiz, Paradi, Ruggiero, and Yang, 2006; Cordero, Pedraja, and Santín, 2009, 2010; Thieme *et al.*, 2013; among others).

In order to do this, we carry out a standard, output-oriented variable returns to scale DEA for the total units (n = 1,371). The relative efficiency score of each school will determine its level of technical quality (the lower the efficiency coefficient, the better). At this point, it is important to emphasize that the efficiency ratio can take values equal to or greater than one. In this case, if the ratio is equal to one, the DMU under evaluation will be defined as efficient. Otherwise—if it is above one—the DMU will be inefficient. This point is important when interpreting the regression coefficients, as we will explain later on. The problem to be solved for each school is the following:

$$
\begin{aligned}
&\max . \theta \\
&s.t.: \\
&\sum_{j=1}^{J} \lambda_j x_{dj} \leq x^{\circ}{}_d, \qquad d = 1,...,D, \\
&\sum_{j=1}^{J} \lambda_j x_{ndj} \leq x^{\circ}{}_{nd}, \qquad nd = D+1,...,ND, \\
&\sum_{j=1}^{J} \lambda_j y_{kj} \geq \theta y^{\circ}{}_k, \qquad k = 1,...,K, \\
&\sum_{j=1}^{J} \lambda_j = 1, \\
&\lambda_j \geq 0, \quad \theta \text{ free.}
\end{aligned}
\tag{1}
$$

Where $j = 1, 2, \ldots, J$: is the sub-index for each DMU; k = 1, 2, …, K for each output; x_d symbolizes the vector of the discretionary inputs (d = 1, …, D), while x_{nd} represents the vector of the non-discretionary inputs (nd = 1, …, ND); y_k indicates the outputs vector produced by each DMU; and θ stands for the technical efficiency coefficient. Finally, ($\lambda_1, \lambda_2, \ldots, \lambda_J$) symbolizes the intensity vector of each DMU.

The result of this assessment, the relative efficiency coefficient (θ), will be included as an independent variable in the next step of the methodological procedure. It allows us to achieve the first objective and answer the first proposition.

The second stage of the process is to calculate the Herfindahl–Hirschman index (*HI*) in each population. This indicator is a measure of economic concentration in a specific market. Conversely, therefore, it reflects the extent of lack of competition in an economic system. The higher the index, the more concentrated and less competitive is the market is being evaluated. The index is calculated by squaring the market share of each school and adding those amounts. Analytically:

$$HI = \sum_{i=1}^{I} s_i^2 \; where \; i = 1, \dots, I \qquad (2)$$

where *s* refers to market share and *I* indicates the number of existent schools in each population. This index represents existent competition (meaning, the available alternatives for parents choosing a school) in each municipality. When local *HI* is equal to one, it indicates that there is only one school in the town, and therefore that parents do not have any alternative to that school in the public network. In contrast, a population exhibiting an index close to 0 indicates that many schools are available and therefore that parents have more options. This index (*HI*) is included as an explicative variable in the next step of the methodological procedure. The significance of the coefficient serves to give answer to the second proposition.

Once these two variables (θ and *HI*) are estimated, the next step involves determining through ordinary least squares (*OLS*) regression which variables influence perceived school quality (*Z*) from the parents' point of view:

$$Z_j = \alpha + \beta_1 \times \theta_j + \beta_2 \times \theta_j^2 + \beta_3 \times HI_j + \beta_4 \times HI_j^2 + \beta_5 \times \theta_j \times HI_j + \beta_6 \times PUPILS_j + \beta_7 \times PERM_j + 8 \times POPUL_j + \beta_9 \times AGE_j + 10 \times MOBILITY_j + \varepsilon_j \qquad (3)$$

The independent variables[5] are determined by those explained in the previous section, as shown in Table 3.

4. Results and Discussion

Descriptive statistics for the input/output variables considered in the technical quality analysis are shown in Table 4. It is worth noting that the values of non-discretionary factors are standardized. These values have been obtained from two previous PCAs; although the values have changed, they contain the same information as the originals. On the other hand, one can see that the average mark on the sixth grade test (the output variable) is expressed as the sum of the student's marks (i.e., the sum of the average score of students in each school). This was needed to make this transformation possible, so as to ensure that all variables were expressed in absolute terms.

[5] In a first stage of this paper, we used other explanatory variables related to the school's size such as the number of groups (*GROUPS)* in the school or the number of students per class (*STUDGROUP)* in addition to the number of students enrolled (*PUPILS)*. However, we realized they exhibited a high, positive, and significant correlation. For instance, the Pearson's coefficient was 0.980** between *PUPILS* and *GROUPS* and 0.895** between *PUPILS* and *STUDGROUP*. Furthermore, this coefficient was 0.749** between *GROUPS* and *STUDGROUP*. For this reason, we only consider the variable *PUPILS* as indicative of the school's size.

Table 4: Descriptive statistics of input and output variables

Variable	*N*	*Mean*	*Median*	*Standard Deviation*	*Maximum*	*Minimum*	*Q25*	*Q75*
X_1	1371	22.37	22	11.24	52	1	17	32
X_2	1371	0.52	1	0.50	1	0	0	1
X_3	1371	0.59	0.54	2.57	95.33	0.10	0.41	0.61
X_4	1371	1.21	1.06	0.74	17.89	0.05	0.79	1.59
X_5	1371	0.97	0.99	0.57	16.71	0.07	0.79	1.11
X_6	1371	3.90	3.89	1	7.99	0.07	3.28	4.40
X_7	1371	0.40	0.35	1.05	38.73	0.12	0.28	0.43
X_8	1371	3.70	3.63	1	7.36	0.04	3.03	4.42
X_9	1371	0.70	0.36	10.16	375.94	0.15	0.29	0.49
X_{10}	1371	0.67	0.58	0.96	33.81	0.11	0.47	0.74
Y_1	1371	19423.55	17997.78	12074.63	57586.59	334.71	8876.30	30093.01
Y_2	1371	270.11	245	163.38	727	4.96	127	426
Y_3	1371	6.24	3	8.59	93	0	1	9

Source: Self devised

Let us consider the results of the first phase of the study (the efficiency analysis) (Third row of Table 5). We conclude that out of the 1371 schools analyzed 38.95% are efficient (say, 534 schools appear to be fully efficient). These schools manage resources properly and achieve the greatest number of students passed, with the highest grades possible. These are the schools that should be taken as references for schools that are not efficient. As Table 5 shows, the average relative efficiency coefficient is 1.169. This indicates that on average, a 16.9% potential output increase is required for the overall sample to be fully efficient without requiring more inputs.

With regard to the most inefficient school, we can observe that it needs to increase its output by five times (as the efficiency coefficient reach the level of 6.519), what is a huge task even considering the environmental impact[6]. This may well be due to the small size of many municipalities in which there is only one school. In these cases, it is difficult to improve efficiency, as the number of students is always very limited and the closure of the school is not possible without generating serious social costs. For example, one can imagine a municipality in which there is one school, which employs five teachers (the director, the teacher of the core subjects, the gym teacher, the music teacher and the English language teacher) and has only 10 students. This school is extremely inefficient because it has so many resources for so few students. However, this unit cannot really be closed, due to the need to serve all students (perhaps the closest school is in another town several miles away), or improve its performance, due to the infeasibility of increasing the number of the students. Summing up, some inefficient units in the sample do not have suitable tools available to improve their performance.

[6] Despite the fact that we carried out an efficiency analysis distinguishing between discretionary and non-discretionary inputs, we would like pointing out that this potential increase in outputs should not be considered as inefficiency of the school in a global sense. As we suggest above, this inefficiency level is affected by the school's environmental conditions. Because of this, it is not suitable to consider these results as inefficiency *per se* without purifying first for the effects of these non-discretionary variables. In order to consider this process, there are consistent proposals to solve this issue, for instance Pastor (1999, 2002) and Pastor and Serrano (2005).

Table 5: Descriptive statistics of regression variables

Variables	*N*	*Mean*	*Median*	*Standard Deviation*	*Maximum*	*Minimum*	*Q25*	*Q75*
Z	1371	0.855	0.920	0.486	8	0	0.640	1
θ	1371	1.169	1.051	0.302	6.519	1	1	1.230
$\boldsymbol{\Theta^2}$	1371	1.457	1.104	1.425	42.492	1	1	1.513
HI	1371	0.491	0.355	0.411	1	0.006	0.077	1
$\boldsymbol{HI^2}$	1371	0.410	0.126	0.451	1	0	0.006	1
Θ* HI	1371	0.613	0.366	0.603	6.519	0.006	0.084	1.015
PUPILS	1371	5.282	5.513	0.998	6.593	1.609	4.860	6.068
PERM	1371	0.796	0.825	0.136	1	0.214	0.727	0.895
POPUL	1371	9.669	9.640	2.406	14.295	4.625	7.691	11.353
AGE	1371	15.580	14.000	4.130	37	1	14	18
MOBILITY	1371	1.800	1.549	1	9.159	0.098	1.134	2.172

Source: Self devised

As noted in the previous section, we include the relative efficiency index as an explanatory variable in the later regression analysis (θ). This has an important implication. The assessment of technical quality uses a different efficiency coefficient for each assessed school. Thus, we do not use average values; that is, each school operates and is assessed within a particular environment, different from the rest. This is an important contribution to the existent literature, as to date there are no studies that address this issue; in fact, one of the main drawbacks of the studies reviewed above is their lack of information concerning the intrinsic quality of individual schools. Instead, they assume that all schools have the same average quality, which may be problematic.

In the next stage of the process, we conduct a regression analysis using the variables included in Table 5. As can be seen, in addition to the variables defined in the previous sections, we consider the square of two variables (θ and *HI*) in order to detect potential quadratic relations. Similarly, the interaction between θ and *HI* was included to detect any moderating effects.

Table 6 shows the correlations between the variables. As can be seen, there is significant correlation among them. However, multicollinearity problems between the main study variables and control variables, the Toler test values are higher than 0.3 and the variance inflation factor (VIF) takes values lower than 3.33, what indicates that the collinearity is not a big issue.

The regression analysis results are shown in Table 7. As can be seen, we estimated seven models. Model 1 included the control variables only. In Model 2, we added the technical quality coefficient of each school (θ). In Model 3, we also contrasted the possible quadratic relationship between school demand and the squared technical quality index, while Model 4 also took into account the *HI*, in order to determine the relationship of demand for schools over supply. Model 5, as Model 3, included the squared *HI*. The most complete analysis is represented by Model 6, which considered the interaction factor between variables θ and *HI*. Lastly, it is presented what we considered a more representative model (Model 7), which included the separate and joint effects of the efficiency and concentration indices. This model serves to test the empirical validity of the two propositions.

Table 6: Correlations matrix

	Z	***θ***	***Θ²***	***HI***	***HI²***	***Θ* HI***	***PUPILS***	***PERM***	***POPUL***	***AGE***	***MOBILITY***
Z	1										
θ	-0.164***	1									
Θ²	-0.133***	0.900***	1								
HI	-0.229***	0.315****	0.209***	1							
HI²	-0.236***	0.331***	0.220***	0.982***	1						
Θ* HI	-0.235***	0.668***	0.569***	0.902***	0.895***	1					
PUPILS	0.298***	-0.338***	-0.269***	-0.534***	-0.555***	-0.539***	1				
PERM	0.169***	-0.088***	-0.061*	-0.192***	-0.175***	-0.185***	0.330***	1			
POPUL	0.229***	-0.284***	-0.208***	-0.899***	-0.840***	-0.819***	0.620***	0.264***	1		
AGE	-0.071**	0.180***	0.139***	0.117***	0.155***	0.156***	-0.112***	0.102***	-0.042	1	
MOBILITY	-0.111***	0.053*	0.04	-0.189***	-0.150***	-0.136***	0.005	-0.101***	0.234***	0.239***	1

* denotes significance at the 5% level.
** denotes significance at the 1% level.
*** denotes significance at the 0.1% level.

Source: Self devised

Table 7: Regression analysis results

	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*	*Model 6*	*Model 7*
	Z	**Z**	**Z**	**Z**	**Z**	**Z**	**Z**
Constant	0.078	0.209	0.210	0.433*	0.428*	0.573**	0.629**
θ		-0.087	-0.088	-0.043	-0.043	-0.215	-0.253*
Θ^2			0.000	-0.007	-0.007	-0.022	
HI				-0.156*	-0.145	-0.339	-0.371*
HI^2					-0.008	-0.092	
Θ* ***HI***						0.276	0.206
Control variables							
PUPILS	0.100***	0.094***	0.094***	0.098***	0.097***	0.088***	0.093***
PERM	0.213*	0.217*	0.217*	0.233*	0.234*	0.241*	0.235*
POPUL	0.023**	0.022**	0.022**	-0.003	-0.003	0.005	0.001
AGE	-0.002	-0.001	-0.001	0.000	0.000	0.000	0.000
MOBILITY	-0.062***	-0.061***	-0.061***	-0.060***	-0.060***	-0.059***	-0.059***
N	1371	1371	1371	1371	1371	1371	1371
R^2	0.113	0.116	0.116	0.119	0.119	0.121	0.121
Change in R^2		0.0265***	0	0.259***	0	0.0169***	0

* denotes significance at the 5% level.
** denotes significance at the 1% level.
*** denotes significance at the 0.1% level.

Source: Self devised

Discussing the results of Model 7, we can see first that the coefficient of θ is negative and significant at the 95% confidence level. This means that there is a significant negative relationship between inefficient technical quality and the parents' subjective perceptions. A decrease of one point in the inefficiency of technical quality[7] (i.e., an increase in quality) causes an increase in demand of 0.253 points. In this way, we can reject the null hypothesis and confirm that the informal channels parents use to choose a school have a significant relationship with its technical quality—a finding aligned with that of Fehrler *et al.* (2009) in another context. In other words, parents correctly perceive the technical quality of a school.

However, it is also worth pointing out that the value of R^2 is low. Model 7 includes only 12% of the total variability. This means that there are other variables that parents take into account that are still missing from the model. These variables may have various origins, such as the lunch facilities available at the school, the science labs, music classrooms, computer rooms, or the proximity to the school's catchment area. Unfortunately, we do not have information about these and similar variables.

Furthermore, the low coefficient yielded may be related to the situation of the education system in Spain. The allocation of students to schools in the Spanish public education system is highly regulated by scoring and distance systems: the former constitutes a points system intended to reflect issues such as whether the student has siblings at the school, while the latter measures the distance from the student's place of residential registration to the school.

It should be noted that there other forms of management have the potential to improve subjective quality as seen by parents and it increase R^2. One good possibility is giving families additional information when they are choosing a school. This is in line with the general principles of transparency and accountability; a good example of it is the publication of inspectors' evaluation reports in the United States (Roderick, Jacob, and Bryk, 2002). Another example is in the United Kingdom, where the Office for Standards in Education (OFSTED) publishes inspection reports annually.

Second, we note that the coefficient of *HI* is also negative and significant at the 95% confidence level, indicating a significant negative relationship between the concentration index of a municipality and parental demand. As the concentration index increases (i.e., as there are fewer schools in the municipality), parents have less decision power over the school in which to enroll their children. Specifically, the available options are reduced by 0.371 points. As in the previous case, we reject the null hypothesis and confirm Proposition 2 that demand for a

[7] In this case, the inefficiency coefficient approaches one. Let us remember that, as we follow an output orientation, a school is efficient when $\theta = 1$.

school depends on the options available to parents. Thus, the larger the number of schools in a municipality, the greater parents' decision-making capacity.

There is also a positive, significant coefficient between the variables *PUPILS* and *PERM*. This means that the higher quality the school and the higher the percentage of teachers who are permanent employees, the more demand there is on the part of parents. Thus, parents perceive that a large school is one doing a better job, even despite the possible issues associated with the larger number of students. In accord with Hanushek (1999), we find that smaller schools do not yield better student outcomes or quality. At the same time, parents may perceive higher quality when the majority of teachers have stable work contracts. Otherwise, they may interpret the employment situation of teachers as volatile, to the potential detriment of their child.

Conversely, we find a negative significant relationship (at the 0.1% confidence level) between the variable *MOBILITY* and subjective quality as perceived by parents. In other words, increasing student transit lessens school demand by parents (as they perceive more movement by students during the academic year as indicating lower quality).

Finally, it is important to highlight that, when the model includes the variable *HI*, the control variable *POPUL* becomes non-significant. This could be due to the similar informational content of these variables. That is, schools in municipalities with larger populations have higher demand due to the existence of perfect students' mobility among different schools. For these schools, it is possible to cover the entire supply, and even more, because there will be parents who prefer a particular school, elevating its demand. Conversely, in a small town, supply is fixed and demand is probably insufficient (for instance, supply or capacity might be 20 students per course, but in the town there might be only five students per course); for these schools the analogy between efficiency, quality and demand index is not applicable. This can be addressed by checking for differences in behavior between large cities and small towns. We carried out an additional estimation defining two subsamples (Table 8) by municipality size. One includes municipalities with the median number of inhabitants (15,367) or more. The other group has less than the median. The results confirm the findings of Model 7.[8]

[8] In order to confirm the robustness of the results, a quartile regression was carried out; the results appeared consistent with those presented in Table 7.

Table 8. Estimation models applied to two sub-samples

	Model 7	
	Inhabitants ≥15,367	**Inhabitants < 15,367**
Constant	1.3	0.854
Θ	-0.304**	-0.253
HI	0.994	-0.486
Θ* HI	-0.93	0.209
Control variables		
PUPILS	-0.021	0.156***
PERM	0.214*	0.283*
POPUL	0.006	-0.063
AGE	-0.000	-0.001
MOBILITY	-0.066***	-0.037
N	684	687
R^2	0.105	0.087

* denotes significance at the 5% level.
** denotes significance at the 1% level.
*** denotes significance at the 0.1% level.

Source: Self devised

In large municipalities, as parents perceive a school to have better technical quality, confidence level increases. The coefficient of θ is negative and significant (99% confidence level). In this case, the result reinforces Proposition 1. Parents have access to certain information and perceive the quality of a school through this information. Additionally, they prefer schools whose teachers have stable contracts. The latter finding also reinforces the idea that parents perceive greater experience and dedication among permanent full-time teachers. In addition, parents disprefer schools with a high student mobility rate. In this case, they may be finding some complications regarding the type of students who attend that school.

In contrast, parents do not have faith in the technical quality of schools located in small municipalities. We do not find a significant relationship between school demand and θ. As previously argued, in such cases it may well be that only one school exists in the town and thus that parents have no choice but to enroll their children in this school. Therefore, parents do not have real decision-making power in these municipalities.

5. Conclusions, Implications, and Limitations

This paper aimed to measure education quality through a specific methodology, scarcely used in this type of literature, which measures the efficiency of a set of DMUs. This in turn determines whether a connection exists between the subjective perception of school quality by parents and technical quality estimated through DEA methods (Charnes *et al.,* 1978).

As aforementioned, the study of education system quality and the factors that may be associated with better outcomes has raised interest from both practitioner and academic viewpoints (Heyneman and Loxley, 1983; Ngware *et al.,* 2011), for reasons including the increasing importance of the education sector in the economy globally. However, there are several ways of assessing quality. Some are based on empirical evidence, others on subjective judgments and perceptions. It is precisely this issue that the present study aims to investigate. That is, our aim has been to show whether higher perceived quality corresponds to higher efficiency in the provision of educational services.

Previous studies in this area, as reviewed above (for example Fehrler *et al.*, 2009; Hanushek and Luque, 2003; Heyneman and Loxley, 1983; Lee and Barro, 2001; Ngware *et al.,* 2011; Tooley *et al.,* 2010) focus on trying to determine what factors determine school quality. However, we include in the present assessment a relative efficiency index, which is different for each school evaluated. We do not use average values. This makes our study a contribution to the existent literature, in that it is the first to answer this issue.

As mentioned, the previous studies analyze what factors affect the quality of a school. In our study, these factors are included in a first efficiency analysis in order to determine the technical quality of each school individually, not on average. These factors are the most common: student outcomes on a homogeneous aptitude test, internal school-based variables, and external or socioeconomic variables.

The results showed that the parents correctly perceived the real quality of a school. There is a significant negative relationship between inefficient technical quality at a school and parents' subjective perceptions of it. Second, as the concentration index increases, parents have less decision power over the school in which they choose to enroll their children. We found a significant negative relationship between the concentration index of a municipality and parents' demand. In other words, the larger the number of schools in a municipality, the more decision-making scope have parents. These finding were reinforced when we performed a deep analysis by municipality size. However, it remains to be tackle in a future extension the question regarding to the proximity among schools in larger municipalities. Indeed, the parents demand of a specific school can be determined not only by the efficiency (quality) of the school but also the by the proximity of another school.

However, R^2 was low for this finding. Therefore, there also exist other variables that parents take into account when enrolling their children in a particular school. The tangible elements of a school are an example. As suggested above, parents may see a school as higher quality and therefore demand it more if it has especially good sports facilities, study rooms, lunchroom, science labs, or classroom computers. Another important factor, and one that is especially difficult to measure, is the family's relationship with the school—for example, if the father attended the school as a youth, this will of course affect the family's attitude toward it. A third example is the school's quality trajectory—if the school was of high quality in the past and has developed a good reputation, the parents may still rate it high even if the longitudinal data show that its performance has declined. We do not currently have available data to assess possibly influential variables like these, and unfortunately cannot consider these factors in the model, due to this lack.

The low R^2 may also be due to the condition of the Spanish education system. As we have shown above, the Spanish public education system is highly regulated. One good way to change the bad results for perceived quality seen here could be to offer additional information to parents—for example, by publishing inspection reports. This analysis considers policies that recognize the power of information and transparency to be particularly promising for the promotion of higher-quality schools in all countries.

These conclusions have implications for management and policymaking practice, and provide valuable information for decision-making by parents and public authorities. Parents will be able to achieve a more objective valuation of a school's quality while policymakers will find that they have greater opportunity to implement improvement programs in schools that can contribute to higher levels of quality, motivation, and fairness within the system. Understanding the ways in which school quality is determined by families will, in this way, lead to better policy decisions and give them support. Public investment in education could then target for intervention characteristics related to school quality, with a view to making schools more learner friendly.

Despite these theoretical and practical implications, the paper has some limitations that should be noted. First, the unit of analysis was the school. It would be very interesting to have student-level data as well. Moreover, we considered data for one academic year only. To derive further applications, it would be very fruitful to undertake a longitudinal analysis over several years in order to contrast different dynamic effects on school demand. Furthermore, a relevant issue to be tackle in the future could be the separation between endogenous and environmental factors causing inefficiency.

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