MEASURING EDUCATIONAL EFFICIENCY AND ITS DETERMINANTS IN SPAIN WITH PARAMETRIC DISTANCE FUNCTIONS

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Abstract

The aim of this paper is to measure educational efficiency in Spanish regions using data at student level from PISA 2006. For this purpose, we use a parametric output distance function to implement the methodology developed by Battese and Coelli (1995). The use of this framework allows us to obtain significant conclusions. Thus, in Spain regional educational policies seems to matter since Andalusia, Catalonia and the regions that do not participate in PISA 2006 with an extended sample are the most inefficient regions. We also conclude that the peer group effect is a crucial variable to increase students' test scores. However class size or school ownership has no effect on efficiency results.

Keywords: Efficiency, Education, parametric distance function.

JEL classification: C14, H52, I21

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1. INTRODUCTION

One of the main goals in the field of economics of education is to define the relationship between school inputs, student background and achievement at school. However, after five decades of research, evidences found are still not solid enough, especially regarding the role of school inputs (Cohn and Geske, 1990; Hedges *et al.*, 1994; Hanushek, 1997, 2003). This fact implies a serious drawback for policy-makers taking decisions about the allocation of public resources devoted to enhance the accumulation of human quality in their countries.

What we actually know is that education is a high complex process with variables such as organization or non-monetary inputs implied in production (Vandenberghe, 1999), which make it extraordinarily difficult to define a general educational production function that accurately includes all relevant factors in the educational production. Furthermore, it should be taken into account that there may be inefficient behaviours in the learning process which may be due to multiple reasons such as the way in which resources are organized and managed, the motivation of the agents involved in the process or the structure itself of the educational system (Nechyva, 2000; Woessman, 2001).

In order to tackle the inefficiency issue in education, many studies use deterministic nonparametric data envelopment analysis in empirical evaluations. Pioneer studies applying data envelopment analysis in education originate with Bessent and Bessent (1980), Charnes, Cooper, and Rhodes (1981) and Bessent et al. (1982)[1]. Other studies have considered parametric methodologies, mainly using the Cobb–Douglas specifications, but also the translog functional form proposed by Christensen, Jorgenson, and Lau (1971). These studies have included Jiménez (1986), Callan and Santerre (1990), Gyimah-Brempong and Gyapong (1992), Deller and Rudnicki (1993), Grosskopf et al. (1997) and Perelman and Santín (2008). The main advantage of the parametric translog function is its highly flexible nature, which allows the study of second order interactions in the production process as well as allowing the calculus of output-input partial derivatives. Nevertheless it is worth noting that most of the applied work developed around this issue is conducted using school as Decision Making Unit (DMU). However, Summers and Wolfe (1977) and Figlio (1999) used student-level data in their econometric studies; both concluded that the student level is more appropriate than higher levels of aggregation. Their findings show that school

[1] For an empirical survey of frontier efficiency techniques in education, see Worthington (2001).

inputs matter but that their impact on different types of student varies considerably. In addition to this, Hanushek, Rivkin and Taylor (1996) concludes that in the econometric estimation of the educational production function data aggregation at school, district or even country level implies an upwards bias of estimated school resource effects.

In this paper we propose the use of a parametric stochastic distance function at student level. Under this specification, we explicitly consider that education is a process in which students use their own and school inputs in order to transform them into academic results, subject to inefficient behaviours that can be identified at both student and school levels. Moreover, parametric stochastic distance functions allow us to deal simultaneously with multiple outputs (e.g. math, reading and science test scores) and multiple inputs (including school inputs, student background and peer-group characteristics) within a stochastic framework. We adopt here a translog specification to estimate the parametric stochastic distance function at the student level. This allows us to calculate several aspects of educational technology, mainly output elasticities with respect to inputs and outputs. Moreover we employ the methodology proposed by Battese and Coelli (1995) to find out what are the main driven factors for explaining educational inefficiency.

In order to illustrate the potentialities of the approach proposed here, we provide an application to Spanish educational data from the *Programme for International Student Assessment* (PISA), implemented in 2006 by the Organization for Economic Cooperation and Development (OECD). Through this initiative, the cognitive skills of students around the world are measured with the aim of identifying potential causes of school failure and serving as a basis for educational policy. The study was first developed in 2000 and it has been carried out periodically every three years with a regular increase in the number of participating schools and countries. PISA 2006 data base comprises information about over 400,000 students, belonging to 57 countries from which 30 countries belong to OECD and another 27 were not associated.

This database includes a wide variety of background information on the students collected by student questionnaires. Among this individual information we can students' family background or their learning strategies. In addition, the study also conducted interviews among the principals of the respective schools in order to collect information on the school resources, the number of teachers in the school, the responsibility of the school regarding school relevant decisions or the principles of selecting students and so on (for an extensive review see OECD, 2007 and 2009).

This great volume of data offers an exciting framework to analyze and identify the potential influence of those different variables on results. Although we restrict our analysis to the Spanish case, in 2006 ten Spanish regions decided to take part in evaluation with an extended representative sample of their population. In Spain, the decision about the quantity of the educational budget and its allocation is full competency of the regions. For this reason this analysis allows us to evaluate potential efficiency divergences among regions within the same country.

As we mentioned before, the possibility of using information at student level involves a great advantage regarding most of the studies completed within the educational context, which usually use aggregate data at country (Alfonso and St. Aubyn, 2006), district (McCarty and Yaisawarng, 1993; Banker *et al.*, 2004) or school (Muñiz, 2002; Cordero *et al.*, 2008) level. In addition to facilitate the analysis and interpretation of results from estimations (Summers and Wolfe, 1977; Hanushek *et al.*, 1996), it allows providing information on students' efficiency independently of either educational system or school efficiency. Furthermore, measurement of efficiency at student level allows considering separately student's own socioeconomic level and their schoolmates one (the so-called *peer-group effect*), two inputs which cannot be simultaneously included with aggregated data (Santín, 2006).

The paper is organized as follows. Section 2 provides an overview of educational production functions and presents the parametric stochastic distance function and our estimation strategy. In Section 3 data set and variables selected are described. Section 4 provides results and a discussion of our empirical analysis and the final section offers some conclusions.

2. EDUCATION AND EFFICIENCY MEASUREMENT WITH A PARAMETRIC DISTANCE FUNCTION

2.1. *Estimating an educational production function through distance functions*

The attempts to estimate educational production functions are based on the analogy between this sector and an industry. In the latter, the firms produce different outputs using inputs such as labour and capital which are transformed according to the existing technology into commodities and/or services. In education, schools produce educational outputs in the form of student achievement and other valued results using facilities, equipment, teachers, students' own characteristics, peer-group interactions, supervisors and administrators. This relationship can be defined with a basic formulation expressed on the following way (Levin, 1974; Hanushek, 1986):

$$A_{is} = f\ (B_{is}, S_{is}, P_{is}, I_{is}) \qquad (1)$$

where A_{is} represents the achievement of student *i* at school *s*, usually represented by the results obtained in standardized tests. This output vector depends on a set of factors represented by socioeconomic background (B_{is}), mainly family characteristics, school inputs (S_{is}) such as educational material, teachers or infrastructures in school, influence of classmates or *peer-group* effect (P_{is}), and the students' innate abilities (I_{is}).

This function can be estimated statistically using a multivariate regression model. A further refinement of the educational production function would be to construct a frontier production function where only those units that maximize their results according to their resources are placed within the boundary. In this case, instead of using simple econometric analysis to estimate the Equation (1), more sophisticated methods are required. In this paper we propose to use parametric stochastic distance functions at student level in order to go beyond in the analysis of production functions in education. For this purpose, Equation (1) becomes:

$$D_{is} = g\ (A_{is}, B_{is}, S_{is}, P_{is})\ \ I_{is} \qquad (2)$$

where *g* represents the best practice technology used in the transformation of educational inputs to outputs, and D_{is} is the distance that separates each student *i* attending school *s* from the technological boundary. Unobservable student innate abilities, I_{is}, are assumed to be randomly normally distributed in the population and to influence individual performance in a multiplicative way. This simple transformation places the empirical estimation of Equation (2) within the framework of parametric stochastic frontier analysis, which, under specific distributional assumptions, allows to disentangling educational inputs, random effects and efficiency (distance to the production frontier).

2.2. The parametric stochastic distance function

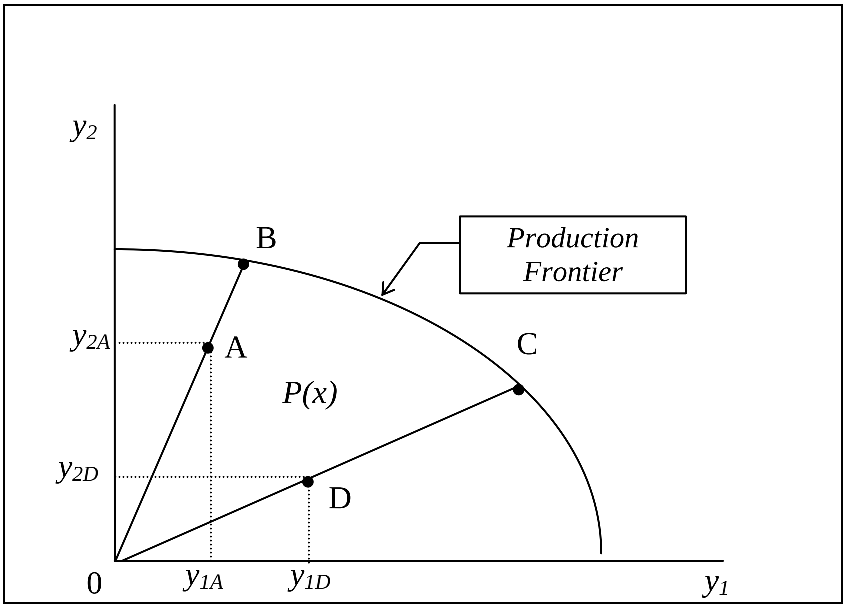
Defining a vector of inputs $x = (x_1, x_2, ..., x_K) \in \Re^{K+}$ and a vector of outputs $y = (y_1, y_2, ..., y_M) \in \Re^{M+}$, a feasible multi-input multi-output production technology can be defined using the output possibility set $P(x)$, which represent the set of all outputs, $y \in \Re^M_+$, that can be produced using the input vector, $x \in \Re^M_+$. That is, $P(x) = \{(x, y) : x\, can\ produce\ y\}$ and we assume that the technology satisfies the set of microeconomic axioms listed in Fare and Primont (1995) including strong disposability, convexity, closedness and boundedness.

In order to capture efficiency behaviours the output distance function, introduced by Shephard (1970), can be defined in the output set, $P(x)$, as $D_o(x, y) = \min\{\theta : \theta > 0, (x, y/\theta) \in P(x)\}$. As noted in Fare and Primont (1995), $D_o(x, y)$ is non-decreasing, positively linearly homogeneous and convex in *y* and non-increasing and quasi-convex in *x*. The distance function, $D_o(x, y)$, will take a value that is less or equal to one if the output vector, *y*, is an element of the feasible production set, $P(x)$. Then, if $D_o(x, y) \leq 1$ the mix (x, y) belongs to the production set $P(x)$ and only when $D_o(x, y) = 1$ the output vector, *y*, is located on the boundary of the output possibility set[2].

Figure 1 illustrates these concepts in a simple two-output one input setting. Let assume that DMUs A, B, C and D dispose of equal input endowment to produce outputs y_1 and y_2. Then B and C are efficient because both lies on the boundary of the output possibility set, whereas D and A, as interior points, are inefficient. The measurement of the relative inefficiency for A and D is given by the distance function $\theta_A = OA/OB$ and $\theta_D = OD/OC$.

[2] The distance function may be specified with either input or output orientation. So input distance function analysis could be defined in a similar way imposing an input orientation and given output endowments.

Figure 1: output possibility set *P(x)*



Our analysis is focused on an output distance function in order to reach our aim of evaluating the behavior of a group of students seeking to obtain the best possible academic results. More in depth, the definition of the distance function in the educational context is how the achievement vector may be proportionally increased subject to a fixed input vector.

In our study we assume a *translog* functional form to estimate the distance function with some properties such as flexibility, easily to calculate or homogeneity of degree +1 behavior[3]. This form has been used previously in other studies such as Lovell *et al*. (1994), Grosskopf *et al*. (1997) or Coelli and Perelman (1999, 2000).

The translog distance function for the case of M outputs and K inputs adopts the following specification:

$$\ln D_{oi}(x,y) = \alpha_0 + \sum_{m=1}^{M} \alpha_m \ln y_{mi} + \frac{1}{2}\sum_{m=1}^{M}\sum_{n=1}^{M} \alpha_{mn} \ln y_{mi} \ln y_{ni} + \sum_{k=1}^{K} \beta_k \ln x_{ki} + \frac{1}{2}\sum_{k=1}^{K}\sum_{l=1}^{K} \beta_{kl} \ln x_{ki} \ln x_{li} + \sum_{k=1}^{K}\sum_{m=1}^{M} \gamma_{km} \ln x_{ki} \ln y_{mi} \qquad (i = 1,2,...,N) \qquad (3)$$

[3] The Cobb Douglas form does not satisfy the concave imposition in the output dimension.

Where sub-index *i* denotes the *ith* firm in the sample, *K* is the total number of inputs and *M* the total number of outputs. With the aim of obtaining the frontier surface, we set $D_o(x,y)=1$, which implies that $\ln D_o(x,y)=0$. Furthermore, the parameters of the above distance function must satisfy some restrictions of symmetry

$\alpha_{mn} = \alpha_{nm}$; $m, n = 1, 2,\ldots, M,$

$\beta_{kl} = \beta_{lk}$; $k, l = 1, 2,\ldots, K,$

and homogeneity of degree +1 in outputs[4]. The analytical expressions of those restrictions are:

$$\sum_{m=1}^{M}\alpha_m = 1 \ ; \quad \sum_{m=1}^{M}\alpha_{mn} = 0 \ (m,n=1,2,...,M) \quad \text{and} \quad \sum_{m=1}^{M}\gamma_{km} = 0 \ (k=1,2,...,K) \qquad (4)$$

In order to impose the homogeneity of degree + 1 in outputs we normalize the output distance function arbitrarily by one of the outputs according to Lovell et al. (1994) and the expression can be expressed as follows:

$$\ln D_{oi}(x,y)/\ln y_{Mi} = TL(x_i, y_i / y_{Mi}, \alpha, \beta, \gamma) \quad (i=1,2,...,N) \qquad (5)$$

where:

$$TL(x_i, y_i / y_{Mi}, \alpha, \beta, \gamma) = \alpha_0 + \sum_{m=1}^{M-1}\alpha_m \ln(y_{mi}/ y_{Mi}) + \frac{1}{2}\sum_{m=1}^{M-1}\sum_{n=1}^{M-1}\alpha_{mn}\ln(y_{mi}/y_{Mi})\ln(y_{ni}/y_{Mi}) +$$

$$+\sum_{k=1}^{K}\beta_k \ln x_{ki} + \frac{1}{2}\sum_{k=1}^{K}\sum_{l=1}^{K}\beta_{kl}\ln x_{ki}\ln x_{li} + \sum_{k=1}^{K}\sum_{m=1}^{M-1}\gamma_{km}\ln x_{ki}\ln(y_{mi}/y_{Mi}) \qquad \text{i = 1,2,…N} \quad (6)$$

Rearranging terms, the function above can be rewritten as follows:

$$-\ln(y_{Mi}) = TL(x_i, y_i / y_{Mi}, \alpha, \beta, \gamma) - \ln D_{oi}(x,y) \quad (i=1,2,...,N) \qquad (7)$$

Following Lovell et al. (1994) we can consider the unobservable term $-\ln D_{oi}(x,y)$ as a random error term, which is the radial distance from the boundary.

[4] The homogeneity restriction implies that the distance of the unit to the boundary of the production set is measured by radial expansion.

Then we can easily obtain the Battese and Coelli (1988) expression of the traditional stochastic frontier model proposed by Aigner, Lovel and Smith (1977) and Meeusen and van den Broeck (1977) considering $u = -\ln D_{oi}(x, y)$ and adding another term v_i capturing for noise:

$$-\ln(y_{Mi}) = TL(x_i, y_i / y_{Mi}, \alpha, \beta, \gamma) + \varepsilon_i \quad (\varepsilon_i = u_i + v_i) \tag{8}$$

Notice that the term $u = -\ln D_{oi}(x, y)$ is a negative random term assumed to be independently distributed as truncations at zero of the $|N(\varphi, \sigma_u^2)|$ distribution and the term v_i is assumed to be a two-sided random (stochastic) disturbance designated to account for statistical noise and distributed iid $v \sim N(0, \sigma_v^2)$. Both terms are independently distributed $\sigma_{uv} = 0$.

In the context of this study, three kinds of variables are considered: scores obtained by students in standardized tests (*outputs*), one vector of educational variables indispensable for achievement (*inputs*), whose effect on results must be positive, i.e., a greater endowment of any of these variables must have positive impact on results, and finally, a set of variables about which we need to know whether or not they have influence on educational process since it cannot be known *a priori* if their effect is positive, negative or inexistent (*environmental variables*).

Therefore, we opt for using the Battese and Coelli (1995) model who propose a stochastic frontier model in which the inefficiencies effects u_i are expressed as an explicit function of a vector of environmental variables $z = (z_1, z_2, ..., z_s) \in \Re^S$. Now u_i is assumed to be independently distributed as truncations at zero of the $|N(\varphi_{is}, \sigma_u^2)|$ distribution, where

$$\varphi_{is} = \delta_0 + z_{is}\delta \tag{9}$$

Where δ is a vector of parameters that must be estimated. This model allows us to analyse the sign of each environmental variable but its influence over students' efficiencies. We think this framework is appealing in terms of educational policy makers taking of decisions in order to get a better distribution and organization of public resources.

2.3. Variance decomposition

Due to the purpose of the paper, our main concern is not only to obtain an efficiency score for each pupil, but to identify which can be the causes of detected inefficiency: school inefficiency and the own student inefficiency. We are especially interested in disentangling the inefficiency attributable to school management of educational resources, since this is a factor over which public sector can make interventions through education policy.

After the estimation of the Battese and Coelli (1995) model depicted above, the decomposition of estimated efficiency may be carried out through an analysis of variance of the term $\hat{u}_{is}$. Following Perelman and Santin (2008) we assume mean inefficiency differences among schools are due to inefficiency attributable to schools (*between*) while differences among students in the same school (*within*) are due to students' self efficiency. Hence, the decomposition of efficiency variance can be done as follows through a one way analysis of variance,

$$\hat{S}^2_{u_{is}} = \hat{S}^2_{u_s B} + \hat{S}^2_{u_i W} \qquad (10)$$

Thus, inefficiencies *between schools* ($\hat{S}^2_{u_s B}$) include teachers' characteristics and motivation, pedagogical methods employed, management strategies or relationship between parents and principals. On the other hand, inefficiencies *within school* ($\hat{S}^2_{u_i W}$) are attributable to students' dedication and effort.

2.4. Elasticity estimations

One advantage of parametric distance function is that this technique allows calculating the output and input elasticities which give us relevant information about the effect of each input on each output. A peculiarity of translog distance functions is that elasticity value is different in each observed unit, thus it is necessary to obtain the elasticity for each point. As it is usual in educational studies we analyse the distance function elasticity with respect to inputs and outputs and the change rate between inputs and outputs. For these purposes we use the following expressions:

$$r_{D,x_k} = \frac{\partial D}{\partial x_k} = \frac{\partial \ln D(x,y)}{\partial \ln x_k}\frac{D(x,y)}{x_k}\ ; \quad r_{D,y_m} = \frac{\partial D}{\partial y_m} = \frac{\partial \ln D(x,y)}{\partial \ln y_m}\frac{D(x,y)}{y_m} \tag{11}$$

where positive values of r_{D,x_k} (r_{D,y_m}) indicate that an increase in the input (output) implies a higher inefficiency (efficiency).

Expressions of partial elasticities between output "*m*" and input "*k*", which indicate the variation in output "*m*" level before an increase in the input "*k*" proportion, and the variation of an output "*n*" with respect to another one "*m*", which can be interpreted as the extent the output "*n*" changes before an increase in the output "m", are as follows:

$$s_{y_m,x_k} \equiv \frac{dy_m/y_m}{dx_k/x_k} = \frac{r_{D,x_k}}{r_{D,y_m}} = \frac{\beta_k + \sum_{k=1}^{K}\beta_{kl}\ln x_k + \sum_{m=1}^{M}\delta_{km}\ln y_m}{\alpha_m + \sum_{m=1}^{M}\alpha_{mn}\ln y_m + \sum_{k=1}^{K}\delta_{km}\ln x_l} \tag{12}$$

$$s_{y_m,y_n} \equiv \frac{dy_n/y_n}{dy_m/y_m} = -\frac{r_{D,y_m}}{r_{D,y_n}} = \frac{\alpha_m + \sum_{m=1}^{M}\alpha_{mn}\ln y_m + \sum_{k=1}^{K}\delta_{km}\ln x_k}{\alpha_n + \sum_{n=1}^{M}\alpha_{mn}\ln y_n + \sum_{k=1}^{K}\delta_{kn}\ln x_k} \tag{13}$$

A positive sign in Equation (12) means that an increase in input "*k*" produces another increase in output "*m*". The interpretation is the opposite for the case of a negative sign. While in Equation (13) a negative sign entails that an increase in output "*m*" produces a decrease in output "*n*", and the opposite interpretation in case of a positive sign.

3. ANALISYS OF SPANISH EDUCATION IN PISA 2006

3.1. Data

In our empirical analysis, we use Spanish data from PISA 2006 which provides us with data from 15 year-old students belonging to ten regions that decided to take part in evaluation with an extended representative sample of their population[5] (Andalusia, Aragon, Asturias, Cantabria, Castile Leon, Catalonia, Galicia, La Rioja, Navarre, Basque Country) and a group labelled as ‘other regions’ including the seven remaining Spanish regions. It is worth noting here, that the Spanish Autonomous Communities (hereafter the regions) are actually fully responsible for the management of educational resources in Spain since 2000. Therefore, they should be the ones most interested in analysing PISA results as a previous step for the application of more effective educational policies. To perform this analysis, we have data about 19,605 students and 685 schools distributed across eleven regions as shown in Table 1. Schools can be divided into three groups according to the type of ownership: public (financed from government), private (government independent) and government dependent (private management and financed by the government).

Table 1: Distribution of students and schools by ownership and region.

Region	Students	Schools	Public	Semi-Private	Private
Andalusia	1,463	51	37	13	1
Aragon	1,526	51	31	16	4
Asturias	1,579	53	31	14	8
Cantabria	1,496	53	31	19	3
Castile-Leon	1,512	52	31	17	4
Catalonia	1,527	51	29	11	10
Galicia	1,573	53	36	11	6
La Rioja	1,333	45	22	20	3
Navarre	1,590	52	30	19	3
Basque Country	3,929	150	63	83	4
Remainder regions	2,077	74	44	20	10
Spain	**19,605**	**685**	**385**	**243**	**57**

Source: PISA 2006 Report for Spain

Basque Country has the highest number of students (3,929) and schools (150) since it has an extended sample. Most of regions have over 1,400 students and 50 schools so it guarantees that their sample is representative. Regarding the ownership,

[5] In 2003 three regions took part in evaluation (Castile-Leon, Catalonia and the Basque Country).

we can see that almost 60 percent of schools are public and most of the remainder are semi-private, thus the number of private schools is really small. This proportion is similar in all regions although, but in the Basque Country where there are more government dependent than public schools. Andalusia is the region with the least number of private schools (only one) while Catalonia and the ‘other regions’ are the ones with the highest number(10)[6].

One of the main advantages of the PISA study is that it does not evaluate cognitive abilities or skills through using one single score but each student receives a score in each test within a continuous scale. In this way, PISA attempts to collect the effect of particular external conditioning factors not depending on the students when taking the test, namely being ill, becoming very nervous, among other random factors. Furthermore, it also involves that measurement error in education is not independent from the position of the student in the distribution of results. Precisely, students with very low or high results have higher associated measurement errors and higher asymmetry in error distribution.

Likewise, given that school factors, home and socioeconomic context play an important role in students’ learning, PISA also collects an extensive dataset on these variables through two questionnaires: one completed by the students themselves and another one filled out by school principals. From these data, it is possible to extract a great amount of information referred to the main determining driven factors of educational performance represented by variables associated to familiar and educational environments as well as to school management and educational supply.

3.2. Variables

Outputs and plausible values

The true output as result of an individual education is very difficult to measure empirically due to its inherent intangibility. Education does not only consist of the ability of repeating information and answering questions, but it also involves the skills to interpret the information and learn how to behave in the society. Unfortunately, it is really difficult to measure all of them. In spite of the multi-product nature of education, most studies have used the results obtained in cognitive tests since they are difficult to

[6] Most of private schools in the sample of “other regions” belong to Madrid.

manipulate and respond to administration demands. But perhaps, according to Hoxby (2000), the most important reason could be that both policy makers and parents use this criterion to evaluate the educational output and its subsequent information to choose the school for their children and even their place of residence.

In this study we use the results obtained by students in the three competences evaluated in PISA (mathematics, reading comprehension and sciences) as the vector of educational output. As it has already been mentioned above, PISA uses the concept of plausible values to measure the performance of students, since measures in these subjects have a wide margin of error due to the fact that the measuring concept is abstract and is subject to the special circumstances of students and their environment on the date of their exams. Moreover, questions about educational knowledge may have different levels of difficulties and the measuring error is dependent on the student's position in the distribution of performance results. Therefore, students with very high result suffer higher measuring error and higher asymmetry in his distribution than those students with average result. For this reason PISA 2006 used measures based on Rasch model (Rasch, 1960; Wright and Masters, 1982), which uses plausible values instead of working with a particular mean value for each student's knowledge. These values are random values obtained from the distribution function of results estimated from the answers in each test. They can be interpreted as a representation of the ability range for each student[7] (Wu and Adams, 2002).

Table 2 reports the average value for plausible values for the three tests (math, reading comprehension and sciences) in each region. Plausible values in the three tests are used as outputs in the efficiency analysis. In order to obtain correct results and avoid problems of bias in estimations it will be necessary to calculate five different efficiency measures for each trio of plausible values and take the mean value afterwards, instead of using mean values to obtain one efficiency measure (OECD, 2005).

[7] For a review of plausible values literature see Mislevy *et al.* (1992). For a concrete Studio of Rasch model and how obtain feasible values in PISA, see OECD (2005.).

Table 2. Plausible Values in Sciences, Math and Reading

	Plausibles Values Science					Plausibles Values Maths					Plausibles Values Read				
	Sci_1	Sci_2	Sci_3	Sci_4	Sci_5	Math_1	Math_2	Math_3	Math_4	Math_5	Read_1	Read_2	Read_3	Read_4	Read_5
Andalusia	479,38	479,99	478,66	478,70	478,96	467,92	468,31	468,00	467,82	468,42	450,74	451,94	449,70	450,01	450,42
Aragon	514,11	514,79	515,68	515,03	515,66	513,87	514,01	516,08	514,56	514,72	484,84	485,09	485,84	484,90	484,82
Asturias	512,91	511,77	513,24	512,88	513,51	501,09	499,89	501,82	500,84	502,34	481,84	480,59	482,26	481,30	480,86
Cantabria	511,15	510,22	509,44	510,74	510,23	501,71	501,30	500,87	501,40	501,53	476,58	476,20	475,21	477,07	476,19
Castile Leon	522,99	521,74	520,57	521,09	521,65	518,52	517,90	517,20	516,39	517,14	481,54	480,87	480,01	479,82	481,35
Catalonia	492,34	493,32	494,91	493,18	493,99	487,43	488,13	490,19	488,17	488,69	477,10	478,68	479,13	478,93	478,04
Galicia	506,40	507,04	507,20	507,21	506,90	496,37	496,38	496,32	496,55	495,64	481,88	481,93	481,79	481,65	481,57
La Rioja	517,93	516,24	518,71	517,52	517,48	522,31	522,48	523,22	521,79	522,36	496,18	494,11	495,91	495,49	494,75
Navarre	511,81	511,42	512,19	511,93	512,37	515,80	518,20	517,57	517,83	517,78	481,98	481,63	481,86	481,16	481,80
Basque Country	492,55	493,66	492,69	492,05	493,55	498,90	499,07	498,32	497,69	499,29	487,31	487,21	486,19	486,53	487,80
Other	487,39	488,08	487,66	486,19	488,62	476,78	477,85	478,24	476,73	479,14	459,66	459,98	459,70	458,64	459,41
Total Spain	**502,13**	**502,27**	**502,29**	**501,84**	**502,61**	**498,96**	**499,23**	**499,45**	**498,72**	**499,57**	**478,72**	**478,63**	**478,41**	**478,27**	**478,60**

Source: PISA 2006 Report for Spain

Inputs

In order to carry out the distance function efficiency analysis we have used three different inputs that are directly involved with student learning (ESCS, SCMATEDU and PEER) together with a set of control variables. Table 3 presents a brief description of each variable and Table 4 reports the main descriptive statistics of inputs and environmental variables by regions.

Table 3. Variable definitions

VARIABLE	***DESCRIPTION***
Inputs	
SCMATEDU	Index of the quality of the school's educational resources
ESCS	Index of economic, social and cultural status
PEER	Average ESCS index of the student's peer group
Z's	
PRIVATE	Attending to a private school (1 = yes; 0 = no)
GOVDEP	Attending to a government-dependent school (1 = yes; 0 = no)
SCHLSIZE	Number of students in school
STRATIO	Weighted number of teachers divided by total number of students
REPEAT ONCE	The student has repeated once (1 = yes; 0 = no)
REPEAT MORE	The student has repeated more than once (1 = yes: 0 = no)
IMMIGRANT1	The student and at least one of the parents was born abroad
IMMIGRANT2	The student was born in Spain but at least one of the parents were not
REGIONS	Belong to one region (ten different dummy variables)

Source: PISA 2006 Report

SCMATEDU represents school resources. This variable is an index derived from school principals' responses to seven items related with the availability of educational resources, such us computers to learning practising, educational software, calculators, books and library items, audiovisual resources and laboratory equipment[8]. ESCS reflects the s*ocio-economic background* of each student. It is an index of economic, social and cultural status of students created by PISA analysts from three variables related to family background from students' questionnaire: the index of highest level of parental education in number of years of education according to the *International Standard Classification of Education* (ISCED, OECD, 1999), the index of highest parental occupation status according to International Socio-economic index of Occupational Status (ISEI, Ganzeboom *et al*., 1992) and the index of educational possessions at home. Finally, PEER incorporates information about classmates'

[8] Since positive and negative values can be found in the original variable, we have re-scale all the values in order to have only positive values for the input variables.

characteristics of students[9]. This variable is defined by the average of ESCS variable of students that share the same school with the evaluated one.

In addition to inputs variables we have considered that other factors related to the characteristics of schools and students can influence efficiency in education (*z´s variables*). In particular, we have analyzed the effect of the following ones:

- *School type* (SCHLTYPE): We consider interesting to analyze whether the public, government-dependent private or private schools have some influence over students efficiency. There is a wide literature approaching this idea, some of them have found evidence that supports the idea of a higher level of effectiveness in private schools (Chubb and Moe, 1990; Sander, 1996; Figlio and Stone, 1997; Neal, 1997; Stevans and Sessions, 2000; Opdennaker, M. and Van Damme, J. (2006), McEwan, 2001) while others do not find enough evidence to justify this superiority (Witte, 1992; Goldhaber, 1996; Fertig, 2003; Vandenberghe and Robin, 2004; Mancebón and Muñiz, 2007). In our case, we have included this information using public school as reference. So two dummy variables have been defined: *Private*, which takes the value one if the school is private and zero otherwise, and *Government-dependent*, which takes the value one if the school is government-dependent and zero otherwise.

- *School size* (SCHLSIZE): This variable indicates the total number of students in school. It is derived from school principals' questionnaire. About the influence of this variable in the educational process there is also a wide debate in the literature. Thus, there are some studies that find a direct relationship among a bigger size of the school and academic results (Bradley and Taylor, 1998; Barnett *et al.*, 2002), while others conclude that this factor does not have influence on results (Hanushek and Luque, 2003).

[9] For a review of the effect of these variables over results see Betts and Shkolnik (2000) or Hanushek *et al.* (2001).

Table 4. Descriptive statistics of inputs and environmental variables

Region	Observ.	Statistic	ESCS	SCMAT EDU	PEER	Private (%)	Semi-Priv (%)	School Size	Teacher-Student Ratio	Repeat once	Repeat more	Inmig1	Inmig2
Andalusia	1,463	Mean	5.508	4.050	5.488	0.023	0.243	700.88	13.51	0.322	0.091	0.027	0.073
		St. Dev.	(1.075)	(1.012)	(0.548)	(0.148)	(0.429)	(356.82)	(4.059)	(0.467)	(0.288)	(0.163)	(0.256)
Aragon	1,526	Mean	5.957	4.632	6.024	0.088	0.299	708.24	12.12	0.279	0.064	0.068	0.096
		St. Dev.	(1.016)	(0.892)	(0.479)	(0.282)	(0.458)	(412.82)	(3.953)	(0.448)	(0.245)	(0.253)	(0.294)
Asturias	1,579	Mean	5.967	4.605	6.010	0.156	0.238	645.18	11.44	0.252	0.052	0.034	0.093
		St. Dev.	(1.023)	(0.920)	(0.545)	(0.363)	(0.426)	(336.62)	(4.603)	(0.434)	(0.222)	(0.182)	(0.291)
Cantabria	1,496	Mean	5.933	4.438	5.965	0.063	0.331	619.23	11.46	0.298	0.058	0.055	0.102
		St. Dev.	(0.970)	(0.821)	(0.452)	(0.243)	(0.471)	(257.44)	(4.640)	(0.457)	(0.234)	(0.227)	(0.303)
Castile-Leon	1,512	Mean	5.889	4.657	5.863	0.089	0.304	717.15	12.07	0.282	0.056	0.038	0.067
		St. Dev.	(1.014)	(0.945)	(0.472)	(0.285)	(0.460)	(390.38)	(3.938)	(0.450)	(0.229)	(0.192)	(0.250)
Catalonia	1,527	Mean	5.913	4.675	5.944	0.232	0.220	636.09	12.35	0.242	0.028	0.099	0.153
		St. Dev.	(1.049)	(1.024)	(0.585)	(0.422)	(0.414)	(283.75)	(3.408)	(0.428)	(0.166)	(0.299)	(0.359)
Galicia	1,573	Mean	5.745	4.218	5.766	0.114	0.190	517.31	10.49	0.277	0.100	0.051	0.110
		St. Dev.	(1.048)	(0.890)	(0.596)	(0.318)	(0.393)	(261.76)	(3.982)	(0.447)	(0.300)	(0.220)	(0.314)
La Rioja	1,333	Mean	5.972	4.665	5.992	0.061	0.424	611.76	13.10	0.270	0.048	0.070	0.101
		St. Dev.	(0.989)	(0.855)	(0.449)	(0.239)	(0.494)	(363.27)	(4.461)	(0.444)	(0.214)	(0.255)	(0.301)
Navarre	1,590	Mean	5.947	4.690	5.884	0.054	0.383	700.04	10.78	0.216	0.038	0.081	0.122
		St. Dev.	(1.007)	(0.910)	(0.519)	(0.225)	(0.486)	(424.33)	(3.577)	(0.412)	(0.192)	(0.273)	(0.328)
Basque Country	3,929	Mean	6.062	4.517	6.107	0.019	0.581	784.88	11.99	0.184	0.035	0.048	0.077
		St. Dev.	(0.981)	(0.896)	(0.512)	(0.137)	(0.493)	(518.17)	(4.733)	(0.388)	(0.183)	(0.214)	(0.267)
Remainder Regions	2,077	Mean	5.894	4.443	5.920	0.141	0.296	764.63	13.36	0.291	0.058	0.094	0.159
		St. Dev.	(1.084)	(0.985)	(0.642)	(0.348)	(0.457)	(344.37)	(5.263)	(0.454)	(0.233)	(0.292)	(0.366)
SPAIN	**19,605**	Mean	5.494	3.209	5.760	0.087	0.350	689.49	12.07	0.255	0.055	0.060	0.103
		St. Dev.	(0.885)	(0.119)	(0.368)	(0.282)	(0.477)	(395.23)	(4.45)	(0.436)	(0.227)	(0.238)	(0.304)

Source: Personal compilation based on PISA 2006 data for Spain

- *Size of classroom* (STRATIO): This variable is a ratio between total number of students in school (SCHLSIZE) and total number of teachers weighted on their dedication (part-time teachers contributes 0.5 and full-time teachers 1). This variable is usually considered a school input in efficiency analysis according to the results of some studies in which a direct relationship is found between reduced groups and higher academic performance (Card and Krueger, 1992; Hoxby, 2000; Krueger, 2003). However, other studies conclude that this variable is not significant (Hanushek, 1997 and 2003; Pritchett and Filmer, 1999). In order to avoid potential bias in estimation, we decide to introduce this information as an environmental variable in efficiency analysis, instead of considering it as an input.

- *Immigrant condition.* This factor, whose influence has received increasing attention in literature within the last years (Gang and Zimmermann, 2000; Entorf and Minoiu, 2005, Cortes, 2006), becomes especially interesting for Spain as a consequence of the huge growth undergone by immigrant population at school age during the last decade. According to Spanish official statistics captured by MEC (2008), foreign students in non-university education have grown from 72,335 in 1998 to 695,190 in 2008. In view of this phenomenon, several studies have studied recently the influence of this factor on the results of Spanish students by using information provided by PISA database (Calero and Escardibul, 2007; Zinovyeva *et al.*, 2008). In our study, this factor is incorporated throughout two dummy variables (*Inmig1 and Inmig2)* that allow us to identify the first (the student and at least one of the parents was born abroad) and second order (the student was born in Spain but at least one of the parents was born abroad) immigrant condition, according to the nationality of the own students or their parents.

- *Academic year*, defined through two dummy variables: *Repeat once* and *Repeat more*, which indicate if the student has repeat one or more than one courses. This phenomenon is quite important in the case of Spain, where the repeat rate is much higher than in OE[10] (Fuentes, 2009). Again, the effect over academic performance of this politic is controversial. Thus, in the literature is possible to find studies where there is a positive relationship (Pierson and Connell, 1992; Roderick *et al.*, 2002), although most of them find out that this

[10] More than 40% of Spanish students have repeated a course almost once.

practical drives to decrease the scholar performance and increase the possibilities of leaving the educative system (Holmes and Mathews, 1984; Shepard *et al.*, 1996; Alexander *et al.*, 2003).

- *Regions.* Under the hypothesis that the students of certain regions may be more efficient than those from others, ten different dummy variables have been constructed, one for each region. Therefore, the reference with which regions are compared is the sample belonging to the remainder regions.

4. RESULTS

In this section, we present the main results obtained in our analysis. We estimate five output distance function, one for each trio of plausible values, assuming a stochastic *translog* technology to measure students' efficiency in PISA 2006. To do that, the first step is to impose homogeneity condition by selecting students' performance in math (y_1) as the dependent variable and then the ratios (y_2 / y_1) and (y_3 / y_1) as explanatory variables instead of y_2 or y_3 (students' performance in reading and sciences, respectively)[11].

In order to facilitate the interpretation of parameters, the original variables were transformed into deviation to the mean values, so first order parameters should be interpreted as the partial elasticity at mean values. Table 5 shows the results after averaging the five estimations.

[11] Following Lovell et al. (1994) homogeneity of degree +1 may be imposed if one arbitrary output is chosen and set $w = 1/y_M$ one obtains $D_o(x, y/y_M) = D_o(x, y)/y_M$.

Table 5: Average of the five parametric output distance function estimations.

Variables	Coeff	St. Dev	t-ratio	Variables	Coeff	St. Dev	t-ratio
Intercept	-0,1969	0,004	-45,91	$(Lnx_2)(Lny_2)$	-0,0330	0,055	-0,61
Lny_1 (mathematics score)	*0,4219*			$(Lnx_2)(Lny_3)$	0,1710	0,075	2,30
Lny_2 (reading score)	0,3014	0,009	32,91	$(Lnx_3)(Lny_1)$	*0,1159*		
Lny_3 (science score)	0,2767	0,012	22,58	$(Lnx_3)(Lny_2)$	0,6005	0,110	5,48
$(Lny_1)^2$	*1,9146*			$(Lnx_3)(Lny_3)$	-0,7164	0,142	-5,06
$(Lny_2)^2$	0,0995	0,008	11,73	*z`s variables*			
$(Lny_3)^2$	1,1993	0,046	25,95	Intercept	0,2269	0,030	7,52
$(Lny_1)(Lny_2)$	*-0,4074*			Repeat once	0,2317	0,007	31,75
$(Lny_1)(Lny_3)$	*-1,5072*			Repeat more	0,3738	0,010	38,73
$(Lny_2)(Lny_3)$	0,3079	0,028	9,10	Gov-Dep	0,0123	0,009	1,40
Inputs				Private	-0,0045	0,012	-0,37
Lnx_1 (Scmatedu)	-0,0100	0,004	-2,23	LN School size	-0,0141	0,005	-2,99
Lnx_2 (ESCS)	-0,1265	0,007	-19,39	Inmig1	0,0511	0,011	4,74
Lnx_3 (EFCO)	-0,1169	0,014	-8,25	Inmig2	0,0086	0,009	0,94
$(Lnx_1)^2$	0,0041	0,002	2,29	LN Stratio	-0,0221	0,013	-1,75
$(Lnx_2)^2$	0,1008	0,050	2,01	Andalusia	-0,0136	0,010	-1,31
$(Lnx_3)^2$	-0,2709	0,205	-1,31	Aragon	-0,0855	0,011	-8,08
$(Lnx_1)(Lnx_2)$	-0,0072	0,012	-0,59	Asturias	-0,0559	0,010	-5,33
$(Lnx_1)(Lnx_3)$	0,0013	0,026	0,05	Cantabria	-0,0741	0,011	-6,93
$(Lnx_2)(Lnx_3)$	0,0582	0,077	0,76	Castile-Leon	-0,1017	0,011	-9,40
Input-output				Catalonia	-0,0052	0,010	-0,51
$(Lnx_1)(Lny_1)$	*-0,0082*			Galicia	-0,0901	0,011	-8,47
$(Lnx_1)(Lny_2)$	-0,0229	0,016	-1,40	La Rioja	-0,1164	0,012	-9,66
$(Lnx_1)(Lny_3)$	0,0311	0,024	1,29	Navarre	-0,0663	0,011	-6,03
$(Lnx_2)(Lny_1)$	*-0,1380*			Basque Country	-0,0185	0,009	-2,13
Sigma-squared	0,0256	0,001	39,48	*Expected mean*			
Gamma	0,7796	0,011	71,66	*efficiency*			0,82

Note: Underlined parameters are calculated by applying imposed homogeneity conditions

Therefore, mathematics, reading and science parameters are all of them positive which means that the efficiency increases when, *ceteris paribus*, the performance in these subjects improve. In contrast, the opposite effect happens in input coefficients, which are all negative and significant; indicating that an input expansion suppose a reduction in the student efficiency performance keeping the output vector fixed. For this estimation we consider the model without separability between inputs and outputs due to most of the input-output cross-products coefficients are statistically significant. The average efficiency, computed as $E\left[\exp\left(-u_i|\varepsilon\right)\right]$, is equal to 0.82, indicating average student efficiency in Spain.

The results derived from the analysis with z´s variables allow us to draw some interesting conclusions. The first relevant idea is that the class size has not effect on estimated inefficiency. In fact, we find a weak but significant at 90% effect pointing out that more students per teacher provides better efficiency[12]. This result bears strong implications for the educational policies instrumented by many Spanish regional governments generally concerned about reducing class size in schools. From this result we can learn that class size is not a major concern for parents when choosing school. Most of the families seek the best possible peer group for their children although these schools had bigger groups as a consequence of a demand effect.

The second evidence is that variables related to course repetition show a clear negative relation with efficiency scores, even higher when the student has repeated more than one academic year. These results are also relevant from the viewpoint of educational policy, since it raises certain questions regarding decisions on the convenience of repetition policies and their conditioning factors. Therefore, it seems more productive to early invest in at risk students in order to prevent school failure than continue devoting resources to fight against the economic consequences of students not finishing secondary education.

Thirdly, as we expected, the immigrant condition have a negative influence on efficiency scores, although this relationship is only significant for first generation immigrants, being non-significant for the second-generation immigrants[13]. These results reveal the need to implement specific policies aimed at improving the academic performance of these students.

Fourthly, schools' ownership is not significant so do not contribute to explain the students' efficiency. In other words, once school, student and environmental variables are taken into account we cannot conclude that ownership matter for explaining differences in efficiency. And finally, the results obtained by students from all regions (with the exception of Catalonia and Andalusia) present better results in terms of efficiency than the students forming the sample of the remainder Spanish territory.

Once the results of the initial efficiency analysis and second stage analysis have been carried out, we may step forward and calculate the percentage of student inefficiency directly attributable to their schools once the effect of the exogenous variables has been discounted. For this purpose and following Equation 10 we have

[12] Calero and Escardibul (2007) also obtain this non expected result between class size and PISA tests scores.

[13] This result may be conditioned by the low number of observations that have the value of one in this variable, since in Spain there are few second order immigrant yet.

completed an analysis of variance of results obtained at student level which allows us identifying differences in average efficiency in students belonging to different schools (between-school variance), which can be attributed to school managerial inefficiency, and the variance among students belonging to the same school (within-school variance).

Results reported in Table 6 show that the most important proportion of inefficiency detected depends on the student, thus the average school inefficiency is 14.7 percent, denoting that school quality is quite uniform in Spain. However, some significant divergences among regions can be detected. Hence, whereas Andalusia, Galicia or Cantabria presents a percentage around 8.5 percent, the Basque Country has a school variance of 25 percent.

Table 6: Variance Analysis

CC.AA.	Between (school)	Within (student)	Nº Observations Schools	Nº Observations Students	F-test*
Andalucía	8.66	91.34	51	1,463	2.638
Aragón	11.48	88.52	51	1,526	3.806
Asturias	12.01	87.99	53	1,579	3.991
Cantabria	8.53	91.47	53	1,496	2.565
Castilla and León	10.24	89.76	52	1,512	3.259
Cataluña	16.16	83.84	51	1,527	5.648
Galicia	8.57	91.43	53	1,573	2.728
La Rioja	13.34	86.66	45	1,333	4.502
Navarra	11.04	88.96	52	1,590	3.733
País Vasco	25.10	74.90	150	3,929	8.357
Others	17.00	83.00	74	2,077	5.588
Mean	**14.7**	**85.3**	**685**	**19,605**	

* All F-test present statistical signification at 99%.

Finally, with regard to elasticity estimations, we only report inter-quartiles values for the sake of simplicity, since we have an elasticity value for each student as it was discussed in section 2.4. Table 7 reports the output elasticities with respect outputs and inputs. For output elasticities with respect to outputs, the results show that an average loss of 1.40 percent in Reading scores or 1.34 percent in Science scores would be necessary for a 1% improvement in Math. However, an increase of one percent in the Reading score implies only a decrease of 0.68 percent in Math and 1.02 percent in Sciences. Finally, an increase of one percent in the Science score is at the cost of around 0.62 percent in Math and a decrease of 0.92 in Reading. Therefore, these results suggest that in the production frontier the improving on Sciences scores has mean smaller costs in terms of other disciplines scores.

Table 7: Output/output and output/input derivates[14]

	Math Inter-quartiles			Reading Inter-quartiles			Science Inter-quartiles		
	25%	50%	75%	25%	50%	75%	25%	50%	75%
Output with respect to outputs									
Math score				-1.0343	-0.6820	-0.4834	-1.2040	-0.6192	-0.2712
Reading score	-2.0227	-1.4006	-0.8917				-1.2686	-0.9225	-0.5632
Science score	-2.7111	-1.3431	-0.6491	-1.5720	-1.0179	-0.7261			
Output with respect to inputs									
SCMATEDU	-0.3175	-0.0319	0.2589	-0.3766	-0.0379	0.3983	-0.4781	-0.0710	0.3675
ESCS	0.2338	0.2845	0.3976	0.3221	0.4216	0.5581	0.2636	0.4101	0.6845
PEER	0.1403	0.2689	0.4400	0.2228	0.3784	0.5584	0.1897	0.3823	0.6811

For inputs elasticities, the first and second inter-quartil values are negatives for SCMATEDU, what means that less than one half of students obtains benefits from educational resources with a median effect close to zero. The opposite effect happens with ESCS and PEER, indicating that socio-economic background or peer-group effect has a positive and significant influence on scores. Furthermore, the variations in outputs over inputs are different depending on the discipline. On the one hand the median elasticity of the ESCS on reading is 0.42, 0.28 on Math and 0.41 on Sciences. The average elasticity of PEER on mathematics, reading and sciences is 0.2689, 0.3784 and 0.3823 respectively. Here newly arises that an educational policy to avoid the concentration of students with a low socioeconomic background can become more productive that investing more in educational resources.

[14] The interpretation of elasticities is referring to the mean values, since original variables were transformed in deviation to the mean values.

5. CONCLUSIONS

In this paper we have analyzed the differences on Spanish students' results in PISA 2006 through an educational frontier framework. With this aim, we have implemented an efficiency analysis using data at student level and considering information about Spanish regions and schools ownership that participate in this study. To the best of our knowledge, this is the first paper that analyzes the results of Spanish students in PISA 2006 using individual data.

Considering the uncertain environment around the educational production function, we apply a stochastic parametric distance function methodology in order to measure students' efficiency. Our results show that detected divergences among regions results maintain even when information about socioeconomic background, quality of resources and peer effects are taken into account in the analysis.

Moreover, the influence of exogenous variables over the student efficiency level is proved in the analysis using the Battese and Coelli (1995) approach in which inefficiencies effects are expressed as an explicit function of a vector of these specific variables. The results show that the teacher-student ratio is not a significant variable for explaining students' efficiency results. This result entails strong implications for the educational policies instrumented by many Spanish regional governments generally concerned about reducing class size in schools. Moreover, the type of school (private or government dependent) do not seem to have influence on results either, since after considering the socioeconomic characteristics of students attending to schools they obtain similar results than public ones.

In contrast, students repeating courses or those who were born in a foreign country have worse results in terms of efficiency. These results reveal the need to implement specific policies aimed at improving the academic performance of these students, such as hiring support teachers, improving teachers' training to cater for diversity or strengthening the role of social workers when it comes to make parents aware of the importance of education. Likewise, the school size or belong to any region, with the exception of Andalusia, Catalonia and remaining Spain, have a positive effect on the results.

Furthermore, an important advantage of our study is the interpretation of output and input elasticities. After carrying out this analysis, the results show that all output-output elasticities present negative signs, being an increase in Math the discipline that supposes a higher impact on the remaining. Regarding the input-elasticities, we conclude that school resources have a close to zero median effect on students´ scores, while socio-economic background and peer-group effect have a positive and significant effect on scores. This last result claims for a deep revision of the actual system of assigning students to public financed schools that is strongly based on proximity to residence criteria.

Although these conclusions should be interpreted with caution, since they are referred to cross-sectional data from a single year, our results have relevant implications for regional educational policy, which seems to be focused on enhancing students' efforts in view of the scarce percentage of variance attributable to schools.

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