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2010

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Keywords: Efficiency, data envelopment analysis, secondary education, educational outcome, PISA.

JEL codes: I21, I22, I28.

Abstract

The purpose of this paper is to compare the efficiency of the Spanish public and publicly-subsidised private high schools using Data Envelopment Analysis (DEA) fed by the results provided by a hierarchical linear model (HLM) applied to PISA-2006 (Programme for International Students Assessment) microdata. This study places special emphasis on the estimation of the determinants of school outcomes, the educational production function being estimated through an HLM that takes into account the nested nature of PISA data. Inefficiencies are then measured through the DEA and decomposed into *managerial* (related to individual performance) and *programme* (related to structural differences between management models), following Silva Portela and Thanassoulis (2001) approach. Once differences in pupils' background and individual management inefficiencies have been eliminated, results reveal that Spanish public high schools are more efficient than publicly-subsidised private ones.

1. Introduction

One of the main traits defining the compulsory Spanish educational system is its mixed or dual character i.e. a majority public network and a substantial private sector. Within the latter, an important position is occupied by publicly-subsidised private schools (PSPS hereafter). These schools, which serve 26% of secondary school enrolment, are owned and run privately but financed by local education authorities and the central government through a system of agreements regulated by the 1985 Right to Education Act (LODE, in its Spanish initials)[1]. The Spanish policy of financing some private schools is aimed at allowing parents to freely choose between different schools and, indirectly, at stimulating competition between schools to attract and retain students, which should bring with improved school efficiency.

The Spanish Publicly-Subsidised Private Schools System is based on an administrative model which establishes the reciprocal rights and obligations of the owner of the private centre and the Education Authority with regard to the economic system, duration, extension and termination of the agreement and other conditions for the provision of education[2].

Formally, the Spanish system PSPS may be seen as a singular mechanism of public intervention in the educational sector. The PSPS system combines public funding and private management of schools. These peculiar characteristics of PSPS make very attractive to explore the relative efficiency of this type of schools in relation to public schools (hereafter PS). The scarcity of research in Spain on the impact of these two alternative systems of free education provision (public and publicly-subsidised) on student performance justifies political interest of this analysis. Is the private

[1] The student distribution among different types of schools in Spain is the following: 67% in public schools, 7% private-independent schools and 26% publicly-subsidised private schools.

[2] The obligations of schools include the following: providing free teaching at the educational level agreed, requesting authorisation for the charging of any fees for complementary activities, maintaining a specific pupil/teacher ratio and applying the same admission criteria as public schools. In turn, the Administration undertakes to finance the activity of the school through a system of economic modules per educational establishment, as established in the General State Budget.

management model of Spanish PSPS more efficient than the public management model of Spanish PS? This is the ultimate question we intend to answer in the context of the data provided by the third wave of the Programme for International Student Assessment (PISA-2006) carried out by the Organization for Economic Co-operation and Development (OECD).

At a first glance, average results on PISA-2006 outcomes could lead us to consider PSPS more efficient than PS, since crude results are higher in the former ones. Certainly, the average score on science competencies for PSPS reaches 502.86, whereas for PS is 475.08 (the average score for the whole population being 488.40) and the ANOVA test (5.89) points out significant statistical differences between these two results. Paying attention to output variables would only be fair if the resources of schools were identical (Kirjavainen and Loikkanen, 1998). However, in actual fact PS and PSPS differ as much in terms of inputs they employ as in their outputs. Main differences are concentrated in pupil characteristics (socio-economic status, parents' education level and job, immigration status) as can be seen in Table A1 in the Appendix. Since several studies prove that these characteristics also affect the results obtained by students (Sirin, 2005), the challenge is to evaluate the performance of schools in a multi-dimensional setting.

In order to assess the impact of ownership on school efficiency, we apply a non-parametric frontier analysis to the sample of Spanish PSPS and PS participating in PISA-2006. The theoretical framework for this work is provided by research involved in assessing the net differential quality of public and private schools. The seminal work by Coleman, Hoffer and Kilgore (1982) is commonly considered as the origin of this literature. Empirical methodologies used in this paper are multilevel analysis and data envelopment analysis (hereafter DEA). As far as we know, both methodologies have not been jointly employed in any paper about the assessment of school efficiency.

Two aspects distinguish this work from previous ones. First of all, a special attention is paid to the empirical estimation of the underlying educational technology in the PISA-2006 data. Hierarchical structure of this dataset involves that estimations must be carried out by means of a multilevel analysis. Conclusions reached from these regressions allow us to select the variables for the subsequent DEA efficiency analysis in a robust empirical way. Secondly, our study decomposes the *overall* inefficiencies of each school into *managerial* (due to its individual performance) and *programme* (due to structural differences between public and private management models) components. In order to undertake this decomposition, we apply the approach of Silva Portela and Thanassoulis (2001) which is based on Charnes *et al.* (1981).

The rest of the paper is organised as follows. In Section 2 we review the literature devoted to study the relationship between school efficiency and public or private ownership. The estimation of the determinants of educational outcomes in PISA-2006 is carried out in Section 3. The empirical assessment of the efficiency of Spanish PS and PSPS is presented in Section 4. The final Section closes the paper with a summary of the main conclusions.

2. The efficiency of public and private schools: Previous studies

There is a fairly widely-held belief in certain academic and social circles that private schools are more efficient than public ones, assessment based upon the economic reasoning which links efficiency to free market competition.

For advocates of private schools, the competition which these schools are subjected to (both within their own system and with public schools), due to their need to attract pupils, forces them to be very receptive to their customers' demands, and stimulates both efficient use of resources and an improvement in the quality of the education provided (Chubb and Moe, 1990, Friedman and Friedman, 1981). It has been stated that the strong dependence upon satisfying the desires and expectations of users for their survival and economic success forces private schools to act efficiently and effectively: *efficiently* as, otherwise, what they provide will be at a disadvantage to the offering of their competitors; and *effectively*, since if they do not satisfy their customers' demands, pupils may leave and go elsewhere, where they are better served (Alchian, 1950). Definitively, the threat of extinction which private schools face, if badly managed, leads invisibly to these schools acting in the best way possible.

In contrast, public schools are seen as monopolies at a local level, with a captive audience guaranteed by the criterion of assigning school places on the basis of residential area (Peterson, 1990; Levin, 1976; Pincus, 1974; O'Donogue, 1971). The opportunity for public school pupils to go elsewhere is therefore very limited for this reason, implying the *tieboutian* mechanisms of *voting with your feet* (see Tiebout, 1956) which, apart from being very costly in economic terms, is very much influenced by circumstances other than strictly educational ones. Furthermore, the alternative of changing over to a private school is also strongly conditioned by the price differential between the public and private supply, so that, as Chubb and Moe (1990) point out, this option will only be taken in cases where the value of private schools, as perceived by families, is much higher than that of public schools. Nor must we forget that this possibility is, of course, limited to a minority of the population: those with greater economic resources. All these considerations lead some authors to consider that, in contrast to the private school setting, achieving efficiency and responding to consumer demands plays a very secondary role in public schools.

However, a more detailed analysis of schools' day-to-day functioning calls the above reasoning into question. This is due to the fact that the ability of users in the education sector to exercise an informed choice – a key element for guaranteeing the potential benefits from competition– is very limited, given the ambiguous nature of the concept of school quality.

In actual fact, after almost forty years of research on the subject, the knowledge of aspects which contribute to defining what is a 'good school' is still very sketchy (see Hanushek, 2003, 1997 and 1986). Schools are to a large extent still *black boxes* for the academics who research them; and even more so, therefore, for their users. This is due to the peculiarities of the education system's production process which make it difficult to clarify the responsibilities which may be attributable to schools, and the definition of a representative concept of school quality (see Mancebón and Bandrés, 1999). In a context of this nature, the best way to assess how well each school functions is the direct contact with it. However, "trying out the product" in the educational sphere involves major personal costs, given the problems of adaptation which changing schools usually involves. This is what Glennerster (1991) terms the *sunk costs* associated with the choice of a school.

The immediate consequence of this situation may be that individuals who must choose between different schooling alternatives do so on the basis of highly visible variables such as: the religious leanings of the school; its facilities; extra-curricular activities; the type of pupils attending; proximity to the home, etc.; factors all of which are of a non-academic nature, and whose relationship with the quality of the actual education is not clearly established. On occasions, families may have information on schools' average academic results although, as Echols and Willms (1995) underline, these do not indicate much as regards quality if they are not accompanied by information on the academic and/or socio-economic background of the pupils. Lee, Croninger and Smith (1996) mention the need to make education decisions on the basis of virtually anecdotal or very superficial data on school quality, given that any other more thorough assessment would mean taking on board high information-related costs.

These limitations to access information on schools question very seriously any effect of competition over quality between different schools, whether these are public or private, since this is not an observable measurement for users. The theoretical argument of those who defend private education, as discussed above, is therefore questionable.

Additionally, empirical research devoted to clarify the relationship between efficiency of schools and public or private ownership is not conclusive. The origins of this literature are in Coleman, Hoffer and Kilgore (1982) who, using cross-section achievement equations, concluded that private schools were more effective than public schools at educating students, even after controlling for differences in the personal and socio-economic background of students. Since then, a number of studies have attempted to contrast this result in a wide range of educational contexts, through the use of parametric and non-parametric techniques. The conclusions reached in this literature are mixed: while a number of studies tend to confirm the results obtained by Coleman *et al.* (1982) (Opdenakker and Van Damme, 2006; Bettinger, 2005; Mizzala *et al.*, 2002; Bedi and Garg, 2000; Stevans and Sessions, 2000; Neal, 1997; Jiménez *et al.*, 1991; Chubb and Moe, 1990 and Hanushek, 1986), in others the superiority of private schools is cancelled out when a wide range of controls are included in the analysis (Perelman and Santin, 2008; Mancebón and Muñiz, 2008; Calero and Escardíbul, 2007; Abburrà, 2005; Fertig, 2003; Kirjavainen and Loikkanen, 1998, Goldhaber, 1996, and Sander, 1996) or this is reduced to specific measurements of the output analysed (Greene and Kang, 2004), or to specific groups of students defined by race, ethnic group, or academic or socio-economic profile (Figlio and Stone, 1997). In some cases, a different effect for independent private schools and for PSPS (see Dronkers and Robert, 2008; Corten and Dronkers, 2006).

Against this background, our work may be seen as a new contribution to this puzzling debate about the efficiency of public versus private schools.

3. Estimation of the determinants of academic achievement in PISA-2006

This Section represents a first and necessary step for selecting correctly the input variables needed for feeding the DEA analysis which is carried out in the next Section. Subsection 3.1 presents the literature review of the determinants of academic achievement. An econometric model is designed from the previous review, the results being presented in Subsection 3.3. Previously, Subsection 3.2 describes the data and methodology used in the analysis.

3.1. Determinants of educational outcomes. Literature review

Our approach to the determinants of educational outcomes will be structured by means of a distinction between two levels, the first one corresponding to student variables and the second one to school variables. In the student level, we will differentiate between three areas: first, personal variables; second, variables related to the family socio-cultural and economic characteristics; and, third, variables related to the household resources and the use of these resources. In the school level, four different areas will be established: first, general variables describing the school; second, variables describing the students of the school (and, hence, the peer-effects generated by the interaction between students); third, variables related to the human and physical resources used by the schools and, finally, a fourth group of variables describing some educational processes undertaken by the school. Following this structure, in this Subsection we review how these variables affect the educational output, taking into account recent theoretical developments and the empirical evidence available in literature.

In the student level, gender stands among the most important personal variables. Girls' school performance is usually better than boys'; however, in the case of maths and science competencies the results are the opposite. In the three competencies measured in the PISA evaluation, for example, girls do better than boys only in reading, lagging behind in maths and science. (see OECD, 2006).

Still in the student level, a great amount of empirical evidence has been provided for the household socio-cultural and socio-economic characteristics as determinants of educational outcomes. The immigration status of the family has received a special attention in recent years. Empirical evidence points out that students born abroad tend to underperform (even after controlling for other significant variables), while there are no significant differences between students born in the country with foreign parents and national students (see Calero and Escardíbul, 2007, Chiswick and Debburman, 2004, Kao and Tienda, 1995 and Rong and Grant, 1992). Schnepf (2008), using TIMSS, PIRLS and PISA data for a set of eight OECD countries, shows that in general there is great heterogeneity inside the group of immigrant students, the dispersion of their educational results being higher than for national students. Other socio-cultural and socio-economic characteristics, such as parental educational level and socio-professional category, have also received much attention. Some of the most relevant studies exploring these effects are Dronkers (2008), Marks (2005), Gamoran (2001) and Rumberger and Larson (1998).

The last set of variables in the student level is related to the household resources and how the student uses them (see Calero and Escardíbul, 2007; Kang, 2007 and Woessman, 2003). Research undertaken with PISA data has stressed the incidence of the availability of books and the use of computers with educational objectives in the household on the student outcome. Specifically, the availability of books in the household is a very strong determinant of student performance, since it absorbs the effect of the family cultural capital transmitted to the student.

In the school level, the general characteristics of the schools are the first area of determinants we would like to address. In this area, one of the most relevant aspects from both a theoretical and empirical point of view is the public or private ownership. Evidence on this area is far from being conclusive, as it has been exposed in Section 2.

Several variables describing the characteristics of students of the school -or the classroom- are included in the second area of school level determinants. These characteristics impinge, through the peer-effects, on the student's performance. Authors such as Farley (2006), Willms (2006) and Coleman *et al*. (1966) have analyzed the socio-cultural and socio-economic profiles of peers incidence on students performance. This kind of approach has also been used to analyze peer-effects generated by immigrant students. Calero and Escardíbul (2007) showed, for example, how a high concentration of immigrant students is associated with negative effects on the student's performance. However, smaller concentrations of immigrant students do not generate any significant effect.

Another area of determinants in the school level is related to the physical and human resources available by the school. The detailed review offered by Hanushek (2003) makes clear that results in this area are far from being conclusive. In OECD (2007), where PISA data are used, most of the variables related to the availability and use of resources by the school are not statistically significant. Mancebón and Muñiz (2003), after reviewing 42 studies published between 1980 and 2002, suggest that a plausible explanation to the lack of significance of school resources when explaining student's performance lies on the fact that most of the reviewed studies are applied to developed countries, with relatively high (and similar) levels of school resources

The educational processes undertaken by schools are included in the fourth and last area of determinants in the school level. As an example of these processes we will solely refer to grouping of students by ability level. Hanushek *et al*. (2003) and Kang (2007) describe how the negative effect of the interaction with low ability students is higher for this same group of low ability students. Thus, processes of student grouping by ability level lead to negative effects on low performance students. We could then expect that the positive effect of grouping on high performance students to be cancelled by the negative effect on low performance students, situation which accounts for Gamoran (2004) results, who finds that these practices seldom have the expected positive results.

3.2. Data and methodology

This study uses PISA-2006 microdata for Spain. Since 2000, the PISA programme examines every three years the academic achievement of 15 year old students from different countries[3] in three competencies (reading, mathematics and science). PISA focused, in year 2006, on the science competence. PISA results are synthesized using a scale with an average score of 500 and a standard deviation of 100, for each of the three competencies. This scale is divided into six levels of proficiency, level 1 corresponding to low-scorers and level 6 to those students who show high-level thinking and reasoning skills.

PISA designs its sample using a two-stage method. In the first stage, a sample of schools is randomly selected from the whole list of centres which provide schooling for 15 year old students. In the second stage, a random sample of 35 students is chosen within each of the schools selected in the first stage. The probability of a school of being selected in PISA is proportional to its size. As a consequence, larger centres have a higher probability of being chosen; nevertheless, students in larger schools have smaller probabilities of being selected in comparison with students enrolled in smaller schools which have been chosen in the PISA sample. Therefore, the probability for a school of being chosen is equal to the result of multiplying the size of the centre (N_i) by the number of schools selected for the sample (n_c), divided by the total number of 15 year old students (N).

$$p_{1\_i} = \frac{N_i . n_c}{N} \qquad (1)$$

[3] 28 OECD and 4 non-OECD countries took part in PISA-2000. 14 non-OECD members joined the programme in 2002. 41 countries participated in PISA-2003. 57 countries (30 OECD; 27 non-OECD) took part in 2006.

Table 1. Total population and sample size for Spain.

15 year old population	439.415
Number of students in PISA-2006	19.604
Weighted number of students in PISA-2006	381.686
Number of schools in PISA-2006	682

Source: Own elaboration from PISA 2006

The empirical analysis of the determinants of science competencies in PISA-2006 which will be used as the main reference for the selection of variables of the DEA study is based on a multilevel model, due to the hierarchical structure of the PISA-2006 dataset[4]. The principle of independence of variables among the students of each centre does not hold, as a consequence of the aforementioned two-stage sampling method used. Students enrolled in the same school usually share socio-economic circumstances which make the average correlation among the variables of the students within the centre to be higher than that found between students of different schools (Hox, 1995)[5].

Multilevel models take into account the nested structure of students in schools. Hierarchical linear models (HLM, hereafter) calculate a separate regression for each of the centres included in the sample (OECD, 2005a). Somers *et al.* (2004) or Willms (2006) are examples of the application of this methodology in the educational field.

In this paper data is structured into two levels: students (level 1) and centres (level 2). Multilevel regressions enable to analyze simultaneously the effects of variables of different levels and to study the influence of these variables on the inequality within and between centres. In other words, HLM enable to identify the proportion of the total variance in scholastic achievement which can be attributed to the characteristics of schools and students.

$$Y_{ij} = \beta_{0j} + \sum_{k=1}^{n} \beta_{1j} X_{kij} + \varepsilon_{ij} \qquad \varepsilon_{ij} \sim N(0,\sigma^2) \qquad (2)$$

[4] Bryk and Raudenbusch (1988) provide a good explanation about the convenience of applying multilevel models for analyzing the effects of schools on educational outcomes.

[5] The intra-class correlation in the scientific competencies for the sample used in this paper from a null model is 0.15. The intra-class correlation is the proportion of the total variance explained by the differences between schools. If the intra-class correlation was equal to zero, it would not be necessary to use a multilevel model (as the whole variance would be explained by the differences in the characteristics within schools).

$$\beta_{0j} = \gamma_{00} + \sum_{1} \gamma_{01} Z_{lj} + \mu_{0j} \qquad \mu_{0j} \sim N(0, \tau_0) \tag{3}$$

$$\beta_{1j} = \gamma_{10} + \mu_{1j} \qquad \mu_{1j} \sim N(0, \tau_1) \tag{4}$$

$$Y_{ij} = \gamma_{00} + \gamma_{10} X_{kij} + \gamma_{01} Z_{lj} + \mu_{1j} X_{kij} + \mu_{0j} + \varepsilon_{ij} \tag{5}$$

Y_{ij} is the expected result in science of student "i" enrolled in school "j". X_{kij} is a vector of "k" independent variables of the individual level and Z_j is a vector of "l" variables of the school level. Equation 5 is obtained by substituting equations 3 and 4 (level 2) for the β in equation 2 (level 1). It is possible to distinguish in equation 5 a set of fixed effects $(\gamma_{00} + \gamma_{10} X_{kij} + \gamma_{01} Z_{lj})$ from a set of random effects $(\mu_{1j} X_{kij} + \mu_{0j} + \varepsilon_{ij})$.

The dependent variable is the score in science for students enrolled in PS and PSPS[6]. This score is calculated using plausible values (PV hereafter) for each student and a replication method which enables to obtain efficient estimations (OECD, 2005b). PV are random values calculated from the distribution of the results. In PISA, students only answer to part of the items which constitute each test. PISA estimates the score of each student for all the items using the distribution of probabilities of the different plausible values that the student could have for the items. This procedure makes it possible to work with more than one estimation of the students results of the students.

3.3. Results

Table 2 presents the results corresponding to the multilevel regression: the first column lists the independent variables[7] introduced in the model, grouped into three blocks, depending on their belonging to the individual, family or school spheres. These variables have been included based on the theoretical approaches and empirical evidence explained in Subsection 3.1. The second column presents the effects of those variables on PISA scores, following the same structure presented in Subsection 3.1 (two levels, divided into different areas). The main results are put forward in the following lines. On the other hand, Table 3 provides information about the proportion of the variance explained, for each level, by the variables included in the complete model, in

[6] Our sample includes 18.283 students from 643 schools. 61.8% of the students in the sample are enrolled in PS (61.4% of the total schools) and 39.2% in PSPS. Students enrolled in non-subsidised private schools are not considered in our analysis.

[7] Further information about the independent variables is provided in Table A2 in the Appendix.

comparison to the null model. Nearly 85% of the variance in scores can be attributed to differences of the characteristics in students within schools.

Table 2. Estimation of fixed effects with robust standard errors in the hierarchical lineal model.

Area	Variable	Coefficient
	INTERCEPT	352.4[a]
		(6.4)
Individual		
	AGE	8.9[a]
		(2.7)
	WOMEN	-17.8[a]
		(-10.1)
	REPMORE (student enrolled in 1st or 2nd year of compulsory secondary education).	-110.7[a]
	)	(-27.6)
	REPONE (student enrolled in 3rd year of compulsory secondary education).	-65.8[a]
	Ref: Student enrolled in 4th year of compulsory secondary education	(-29.7)
Household 1. Socioeconomic and cultural characteristics		
	SECGEN (born in Spain; immigrant parents)	8.2
		(0.7)
	FIRST3 (born in a foreign country; in Spain for 3 years or less)	-38.0[a]
		(-3.4)
	FIRST4 (born in a foreign country; in Spain for 4 or more years)	-20.7[b]
	Ref: Born in Spain; Spanish parents	(-2.2)
	LANG2 (national student that speaks a non-national language at home)	-6.0
		(-0.5)
	LANG3 (foreign student that speaks a national language at home)	7.7
		(0.9)
	LANG4 (foreign student that speaks a non-national language at home)	2.7
	Ref: National student that speaks a national language at home	(0.2)
	ACTIVE (both parents are economically active)	13.1[a]
		(5.8)
	NQWHITEC (white collar, low skilled father)	-7.2[b]
		(-2.5)
	QBLUEC (blue collar, high skilled father)	-5.4[b]
		(-2.0)
	NQBLUEC (blue collar, low skilled father)	-8.5[a]
	Ref: White collar, high skilled father	(-3.0)
	MOTSCHY(years of schooling of the mother)	0.8[a]
		(2.9)
	FATSCHY (years of schooling of the father)	0.4
		(1.2)
Household 2. Educational resources and their use		
	NCOMPUT (no computer at home)	-7.1
		(-1.4)
	SPUSECOM (sporadic use of computers)	-6.3[b]
		(-2.5)
	NUSECOM (never uses a computer)	1.9
	Ref: Frequent use of computers	(-2.0)
	SPOWRITE (sporadic use of word processors)	7.7[a]
		(3.2)
	NEVWRITE (never uses word processors)	-16.0[a]
	Ref: Frequent use of word processors	(-4.6)
	25BOOKS (0 to 25 books at home)	-42.2[a]
		(-13.2)
	100BOOKS (26 to 100 books at home)	-21.0[a]
		(-7.9)
	200BOOKS (101 to 200 books at home)	-9.1[a]
	Ref: More than 200 books at home	(-3.2)

Table 2. Estimation of fixed effects with robust standard errors in the hierarchical lineal model (cont).

Area	Variable	Coefficient
School 1. School characteristics		
	PRIVPUBF (publicly subsidised private school)	-15.2[c]
		(-1.7)
	SCHSIZ (school size)	-0.0
		(-0.1)
	CITYSIZ2 (school in a city with a population of 100.000 to 1.000.000 inhabitants)	5.8
		(1.5)
	CITYSIZ3 (school in a city with a population higher than 1.000.000 inhabitants)	21.6[a]
	Ref: School in town with a population smaller than 100.000	(3.5)
	NOTHERSC (few schools in the neighbourhood -maximum, 2-)	0.1
		(0.0)
School 2. Students characteristics		
	ORINMIG1 (proportion of immigrant students from 0,1 to 10%)	0.0
		(0.0)
	ORINMIG2 (proportion of immigrant students from 10 to 20%)	-9.9[c]
		(-1.7)
	ORINMIG3 (proportion of immigrant students higher than 20%)	-17.7[a]
		(-3.4)
	SCEDMO (average years of schooling of the mothers)	2.9[b]
		(2.6)
	PCGIRLS (proportion of girls at school)	44.4[b]
		(2.0)
	SCNQWHIT (white collar, low skilled parents -mode-)	-6.4
		(-1.0)
	SCQBLUE (blue collar, high skilled parents -mode-)	3.5
		(0.8)
	SCNQBLUE (blue collar, low skilled parents -mode-)	-3.2
	Ref: White collar, skilled parents -mode-	(-0.6)
School 3. School resources		
	STRATIO (student-teacher ratio)	0.3
		(0.6)
	PTEACH (proportion of part-time teachers)	0.1
		(0.5)
	CLSIZ (class size)	-0.2[c]
		(-1.9)
	COMPWEB (proportion of computers connected to the Internet)	-1.9
		(-0.3)
	IRATCO (ratio of computers for instruction to school size)	-60.1[a]
		(-2.9)
	NCOUNS (no school counsellors at the centre)	-0.3
		(-0.1)
School 4. Educational practices		
	AUTCONT (school with autonomy in selecting teachers for hire)	-3.9
		(-1.2)
	AUTBUDG (school with budgetary autonomy)	4.3
		(1.1)
	AUTEXT (autonomy for selecting textbooks)	5.1
		(0.8)
	AUTCONTE (school with autonomy for selecting course contents)	2.9
		(0.4)
	AUTOCU (school autonomy for modifying the curriculum)	-3.6
		(-0.9)
	CRITADMI (religious or philosophical issues are used as an admittance criterion)	2.9
		(0.7)
	STREB (ability grouping between classes)	-3.9
		(-1.2)
	STREW (ability grouping within classes)	-1.1
		(-0.3)
	Number of level units	18.283

Note: [a] statistically significant at the 0.01 level; [b] statistically significant at the 0.05 level; [c] statistically significant at the 0.10 level; t-ratio (in parentheses). Estimations have been computed using HLM 6.25.

Table 3. Multilevel regression: Random effects.

Variances	Null model	Complete model
Schools (uj)	1.221,8	411,9
Students (εij)	6.748,3	4.117,3
Total (uj + εij)	7.970,1	4.529,2
% of the total variance explained by the variables		43,2
% of the level 1 (students) variance explained by the variables		39,0
% of the level 2 (schools) variance explained by the variables		66,3

Results for the individual level variables are consistent with previous empirical evidence. In line with OECD (2006) women score lower than men in science. The fact that students born earlier in the year still have an advantage over the rest at age 15 is also remarkable. The strongest effect among all the factors included in the model is linked to the course repetition variables. The negative signs of these effects suggest, on the one hand, the weak effectiveness of course repetition policies; on the other hand, that it is difficult to distinguish if repeating course causes directly low achievement or if "repeaters" share certain characteristics, not included in the model, that make them be low-scorers.

Household socio-economic and cultural characteristics turned out to be very important for explaining the students' performance in science. Students whose parents are economically active and which bellows to qualified white-collar households achieve higher scores in PISA. Results also show the positive and significant relationship between the years of schooling of mothers and the educational outcome of their children. Results associated to the immigrant origin of the family are noteworthy: students born in Spain with Spanish parents obtain better results in the science test than first generation immigrant students; however, differences in score with second generation immigrants are non-significant. This can be interpreted as the evidence of an assimilation and integration process of immigrant families. This result is reinforced by the fact that first generation immigrant students who have not studied at least the whole compulsory secondary education level in Spain (ESO), score lower than first generation immigrants who have been living in Spain at least for 4 years.

Other results that we would like to highlight are those which try to come close to the household educational resources and their use by the students. The household's number of books seems to be a good proxy for the family cultural capital and it is strongly and positively correlated with outcomes in PISA., Coefficients related to the computer use variables show that making a correct use of educational resources (such as computers) has a stronger impact on the students educational outcomes than the simple fact of having educational resources at home.

Ceteris paribus, students in PS obtain better results in the science test of PISA than those enrolled in PSPS. This result must be emphasized as previous studies about this topic in Spain such as Calero and Escardíbul (2007) and Mancebón and Muñiz (2008), did not find significant differences in the educational outcomes of public and private school and, in the bivariate analysis, the former score were lower than the latter.

Results point out peer effects as the most important variables of the school level. The education level of mothers does not only have a positive effect on their children but it also has a positive effect on their children's classmates. The proportion of girls at school is as well directly related to outcomes in PISA. Results in Table 2 also show that the negative impact on the educational outcome of students of sharing their class with immigrant students is only significant when the accumulation of immigrant students exceeds a certain threshold.

The only significant variables among the school resources factors included in our analysis were the class size and the ratio of computers for instruction to school size. Larger classes seem to have a negative effect on educational outcomes. The strong and negative sign linked to the ratio of computers variable remains unexplained and should be subject for future studies. The lack of significance of variables such as the student-teacher ratio or the existence of counsellors at the school should help policy makers to measure the opportunity cost of frequently used input-based policies.

Finally, no significant effects were found among the educational practices variables. Different types of school autonomy are found to be irrelevant. However, a deeper insight into this matter would require more detailed data on different aspects of autonomy. For this reason, our results in this area should be taken with caution.. When interpreting the ability grouping variables, one must keep in mind that, although being non significant *in average*, ability grouping policies may have important effects on different types of students as it has been explained in Subsection 3.1.

4. Efficiency assessment of the Spanish Public and Publicly-Subsidised Private Schools from PISA-2006

In this Section, efficiency analysis of PS and PSPS participating in PISA-2006 is carried out using DEA methodology. This analysis involves comparing academic results obtained by pupils in each school with all the relevant inputs in the procurement of those results. A school is considered efficient if there is no other in the sample which is able to reach better outcomes with the same or less resources. On the other hand, an inefficient school obtains from its inputs endowment worse results than the reachable maximum ones.

The three stages which have to be accomplished in every productive efficiency analysis are sequentially described: inputs and outputs selection, evaluation model selection and results description.

4.1. The selection of the inputs and outputs of Spanish High Schools for DEA analysis

The first stage in order to carry out a productive efficiency analysis is to select the variables which proxy the results and inputs of evaluated decision making units (DMUs). In this regard, data supplied by PISA-2006 are plentiful. As we have explained in Section 3, in this International Programme there is detailed information about competencies of pupils in different subjects (mathematics, reading and science), socio-economic family background of students and school inputs.

Prescriptions generally accepted in DEA literature about selection of variables establish that this selection must respect some minimum requirements established by Bessent and Bessent (1980): a conceptual basis for the relationship of inputs to outputs; an empirically inferred relationship of measured inputs to outputs; increases in inputs must be associated with increases in outputs; and the measurements must not have zero elements.

In order to fulfil all these conditions, we base the selection of variables on the results obtained from the empirical research on the determinants of educational outcomes in

PISA-2006 (see Section 3). Specifically, we select the scores of 15 year-old students in science competencies as the output of Spanish PS and PSPS and all the statistically significant variables found in the previous Section as inputs[8]. Table A3 in the Appendix summarises the average and standard deviation for all these variables.

In summary, the efficiency of the Spanish PS and PSPS which participate in PISA-2006 will be estimated on the basis of 12 variables. One of them (PV) proxies the output, two of them approach the resources available to each school (IRATCO and CLSIZ) and the other eight ones proxy the socio-economic and cultural context of the students.

4.2. The selection of the DEA model

In addition to the choice of input variables, efficiency analysis requires to decide how to measure performance. In recent years, during which the assessment of the efficiency of different samples of educational institutions has seen notable growth, it has become clear that parametric techniques reveal major drawbacks as an instrument for assessing the results of school institutions. Non-parametric frontier methods, such as DEA, on the other hand, have revealed themselves as being much more attractive in this context. The advantages attributed to this methodology, when assessing the efficiency of schools, have gained further backing by the intensive use made of this approach (see Worthington, 2001). The basic idea of DEA is to view schools as productive units which use multiple inputs (controllable and non-controllable) and outputs. The method produces measures of schools' efficiency deriving a frontier production function (efficiency frontier) and measuring the distance of observations to this frontier to get their efficiency scores. Observations on the frontier get an efficiency score of one and those below the frontier get scores below one depending on their location (Kirjavainen and Loikkanen, 1998).

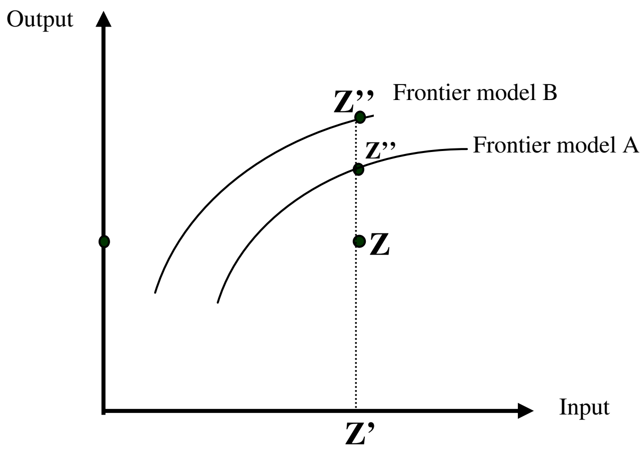
The technique, which is based on mathematical programming, has evolved considerably since it first appeared in the seminal paper of Charnes, Cooper and Rhodes (1978). Specifically, multiple extensions of the initial model have attempted to adapt the

[8] We select those variables from the previous Section that have been proved as statistically influential in the academic results and are no categorical. Each input has been defined in such a way that its relationship with the output variable was positive.

mathematical formulation and the process of obtaining efficiency indexes to the peculiarities of the particular sector analysed, to the nature of the variables which make up the analysis, or to the aim sought in the research (see Cooper *et al*., 2004a and 2004b and Thanassoulis, 2001).

From the different proposals found in the literature, the approach of Silva Portela and Thanassoulis (2001), based on Charnes *et al*. (1981), is of particular interest for the task which concerns us. This approach decomposes the overall measure of efficiency, computed using DEA, into managerial and programme components. The attractiveness of this approach lies in the fact that it makes it possible to differentiate between inefficiencies attributable to the individual management of a decision-making unit (hereafter DMU) and those attributable to a unit's actual management programme –an aspect of great interest in this research, since we attempt to compare the behaviour of schools which work with different management models. We shall explain this approach using Figure 1.

Figure 1. Efficiency decomposition according to Silva Portela and Thanassoulis (2001)



This represents an organisation Z which plays its productive role according to a specific management model (model A). Its efficiency is to be evaluated for a set of organisations of which one part shares the same management model and the rest works under another model (model B). The application of DEA to both subsamples will identify the two frontiers which can be seen in the figure.

The assessment of the output of organisation Z in relation to all the schools in the sample (regardless of the management model for each), through the DEA, will attribute an overall rate to this organisation with a value of Z'Z'''/Z'Z (maximum output in the sector/ real output used by Z). This rate, as it is the result of the comparison with all the schools in the sector, includes the effects due to the school's individual management and those attributable to the structural differences between the two management programmes which coexist in the sample.

In order to ascertain the part of Z's efficiency which is attributable to individual management (managerial efficiency), its production must be compared with that of the rest of the schools which run under the same management model, i.e. with frontier model A. The value of the index of efficiency which DEA will now attribute to Z will be Z'Z''/ Z'Z (maximum output in model A/ real output used by Z). This efficiency, as it is the result of comparison with organisations functioning under the same management model, is only attributable to the individual practices of the school.

Finally, the programme efficiency which Z works under will be the residual part of the global efficiency not attributable to individual management. Graphically, this is determined by the index Z'Z'''/ Z'Z'' (maximum output in the sector/ output which Z would use, if its individual management were efficient). We can thus immediately confirm that:

Overall Efficiency = (Managerial Efficiency) x (Programme Efficiency) (6)

From this relationship the different indexes of efficiency may be computed by resolving three DEA models: one for the DMUs acting under model A (managerial efficiency of type A units); another for those working under model B (managerial efficiency of type B units); and another for all the schools (overall efficiency of each organisation). The programme efficiency is obtained using a simple quotient between overall and managerial efficiency.

5. Results of the efficiency analysis

Table 4 exhibits the results from the efficiency analysis carried out according to the previously established criteria[9].

Table 4. Efficiency scores of inefficient schools.

	Mean efficiency			ANOVA test		
	PSPS	**PS**	**Total**	**Dif. on means**	**Standard error**	**Test**
Managerial efficiency	0.930	0.926	0.928	0.004	0.009	0.478
Programme efficiency	0.962	0.982	0.964	-0.020	0.005	-3.996[a]
Overall efficiency	0.919 (20.05)	0.925 (43.64)	0.923 (37.20)	-0.006	0.008	-0.764

[a] indicates statistically significant differences between PSPS and PS at a 1% significance level. Figures in brackets are the percentage of schools with maximum efficiency (>0.99).

The first row shows efficiency rates due exclusively to the individual performance of each school. Results of PS in this column cannot be compared to those results of PSPS, since both of them have been obtained in an independent way and the reference frontier used in each case is different. The second row displays the efficiency that can be attributed to structural differences between management models, public or private, under which each school acts. This value is the one that presents the highest interest for the aims pursued in this paper. Finally, the third row shows the estimates of the overall efficiency, corresponding to the comparison of all the schools of the sample, independently of their ownership. Therefore, this value includes the effects of individual performance (managerial efficiency) and those effects coming from the managerial model followed in PS and PSPS (programme efficiency).

Results in Table 4 indicate that the difference between overall efficiency in PS and PSPS is very slight and statistically non significant. That is to say, once the differences in the type of pupil and resources in each school are taken into account, the advantages that PSPS present in gross educational results disappear. However, overall efficiency comprises the effects of individual school performance and those attributed to the management model followed by the school, to such an extent that overall efficiency

[9] Efficiency estimations have been computed using ONFRONT software. The DEAs solved has applied the variant of variable returns to scale (Banker, Charnes and Cooper, 1984) and the orientation to maximizing output.

rates do not allow us to correctly visualise the result pursued in this paper. Namely, it could happen that, even though differences in overall efficiency between PS and PSPS were not detected, the management model of the first ones could negatively affect themselves and the individual performance of each public school compensated the disadvantage of adopting a much more bureaucratised management model with regard to PSPS (or vice versa).

To solve this question, we must consider the results provided in the second row in Table 4, that is, efficiency due to structural differences between management models (programme efficiency). Although overall efficiency values do not show large divergences, the differences found in this case become statistically significant in favour of PS. On the other hand, if the percentages of schools with the maximum overall efficiency are considered (values in brackets in Table 4), we conclude that this percentage is considerably larger among PS than among PSPS, what leads us to conclude that best practices in the sample are developed in a higher proportion by PS rather than PSPS.

6. Conclusions

In this paper a non-parametric efficiency analysis of the Spanish PS and PSPS has been carried out using as reference the data supplied by PISA-2006. In order for this analysis to be accomplished in a rigorous way, a detailed study of the determinants of educational outcomes of students has been implemented by means of a multilevel model. Given the absence of a generalized empirical consensus about the variables which promote academic success of pupils, we think that any evaluation of school efficiency requires a thorough analysis of the empirical relationship between the variables selected as inputs and outputs.

The main results obtained in this regard point to a very special relevance of household socio-economic and cultural characteristics for explaining the performance of students in science competencies. Other variables showing a great influence on educational results at the individual level are gender, grade repetition and household educational resources such as books and computers and their use by the students. Nearly 85% of the variance in scores can be attributed to differences of the characteristics in students within schools.

At the school level, peer effects are the most important variables in the promotion of results in science competencies (education level of mothers, proportion of girls at school and proportion of immigrant students). The only significant variables among the school resources factors included in our analysis were the class size and the ratio of computers for instruction to school size.

These results, which are in concordance with a number of previous studies, allowed us to develop the analysis of efficiency of PS and PSPS. The most relevant result was that PS are more efficient than PSPS, once differences in pupil body and individual management inefficiencies have been eliminated. PSPS' better crude scores in science competencies as measured in PISA-2006 vanish when those influences are removed from analysis.

These results confirm the conclusions obtained in others international studies where publicly-granted private schools are shown to be inefficient relative to public ones (Barbetta and Turati, 2003 and Kirjavainen and Loikkanen, 1998).

In the context of PISA data, conclusions from comparative efficiency analyses of public and private schools are mixed. While Calero and Waisgrais (2009) show that Spanish private schools (PSPS and private independent) present a negative influence in science competencies measured in PISA-2006, other papers employing Spanish PISA-2003 data do not point out a superiority of neither PS nor PSPS (Calero and Escardíbul, 2007 or Perelman and Santín, 2008). The main conclusion of these latter authors is that, once the effects related to the social composition of schools are discounted, the differences in educational performance shift to statistically non significant, which permits to suppose that these differences are more related to the type of pupils in each school and differential characteristics between these schools than to school quality.

Since Calero and Escardíbul (2007) focus their analyses in the results from the mathematics assessment in PISA-2003, the explanation of the divergences with regard to our work and to Calero and Waisgrais (2009), where PISA-2006 is used, could be found in a certain specialisation of public schools in science, subject in which PSPS prove to be less efficient[10]. The empirical testing of this hypothesis is definitely beyond the limits outlined in this paper and could be a specific issue for further research.

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[10] In any case, it is neither so flashy that PS seems to be more efficient than PSPS. In Finland, which represents an ideal reference country in all PISA editions, almost all schools are public.

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Appendix. Table A1.Students profile in Spanish PS and PSPS

Type of variable	Questionnaire item[a]	PSPS	PS	Total	ANOVA test
Results	Repeated grades	1.20	1.18	1.18	0.94
Expectations - aspirations	Students' expected occupational status (BSMJ)	62.24	57.92	59.17	5.79***
Attitudes toward science	Plausible value in interest in science (PVINTR)	526.23	539.47	535.86	-3.51***
	Plausible value in support for scientific inquiry (PVSUPP)	530.53	526.94	527.92	0.77
	General interest in learning science (INTSCIE)	-0.17	-0.19	-0.19	0.64
	Enjoyment of science (JOYSCIE)	-0.11	-0.17	-0.15	1.87*
	Science self-efficacy (SCIEEFF)	-0.01	-0.13	-0.10	3.49***
	General value of science (GENSCIE)	0.34	0.26	0.28	2.65***
	Personal value of science (PERSCIE)	0.05	0.03	0.03	0.81
	Science activities (SCIEACT)	-0.14	-0.16	-0.15	0.76
Personal	Age (AGE)	15.83	15.82	15.82	0.36
Occupational status of parents	Mother's occupational status. SEI index (BMMJ)	41.22	36.07	37.59	4.34***
	Father's occupational status. SEI index (BFMJ)	44.56	38.15	39.93	7.00***
	Highest occupational status of parents. SEI index (HISEI)	47.82	41.11	42.96	6.85***
Educational level of parents	Mother's years of schooling (MEDUYEAR)	10.39	8.80	9.24	5.79***
	Father's years of schooling (FEDUYEAR)	10.60	8.72	9.24	7.33***
	Highest years of schooling of parents (PARED)	11.90	10.32	10.75	6.78***
Household possessions scale indices	Index of family wealth possessions (WEALTH)	-0.07	-0.23	-0.18	4.87***
	Index of cultural possessions at home (CULTPOSS)	0.19	0.00	0.05	5.30***
	Index of home educational resources (HEDRES)	0.32	0.17	0.21	4.51***
	Index of home possessions (HOMEPOS)	0.22	-0.02	0.04	6.74***
	Index of economic, social and cultural status (ESCS)	-0.08	-0.57	-0.44	7.30***

* and *** indicate statistically significant mean differences between PSPS and PS at 10% and 1% significance level, respectively

[a] Name of the variable in the PISA database between brackets

Source: Own elaboration from PISA 2006

Appendix. Table A2. Variables used in the multilevel regression

	N	Min.	Max	Mean	Standard Dev.
Individual					
AGE (age of the student, in years)	18.283	15.33	16.33	15.84	0.29
WOMEN (gender dummy: 1 if women)	18.283	0	1	0.50	0.50
REPMORE (1st-2nd year of ESO)	18.283	0	1	0.06	0.23
REPONE (3rd year of ESO)	18.283	0	1	0.26	0.44
NOREPET (4rd year of ESO)	18.283	0	1	0.68	0.47
Household 1. Socioeconomic and cultural characteristics					
NATIONAL (born in Spain, Spanish parents)	18.283	0	1	0.95	0.21
SECGEN (born in Spain, immigrant parents)	18.283	0	1	0.01	0.07
FIRST3 (born abroad; in Spain for 3 or less years)	18.283	0	1	0.02	0.12
FIRST4 (born abroad; in Spain for 4 or more years)	18.283	0	1	0.03	0.16
LANG1 (national; national language at home)	18.283	0	1	0.94	0.23
LANG2 (national; non-national language at home)	18.283	0	1	0.01	0.08
LANG3 (foreign; national language at home)	18.283	0	1	0.04	0.20
LANG4 (foreign; non-national language at home)	18.283	0	1	0.13	0.11
ACTIVE (both parents economicaly active)	18.283	0	1	0.72	0.44
QWHITEC (white collar; high skilled father)	18.283	0	1	0.33	0.45
NQWHITEC (white collar; low skilled father)	18.283	0	1	0.14	0.34
QBLUEC (blue collar; high skilled father)	18.283	0	1	0.33	0.45
NQBLUEC (blue collar; low skiled father)	18.283	0	1	0.20	0.38
MOTSCY (years of schooling: mother)	18.283	3.5	16.5	10.53	3.96
FATSCY (years of schooling: father)	18.283	3.5	16.5	10.55	3.98
Household 2. Educational resources and their uses					
NCOMPUT (dummy: 1 if no computer at home)	18.283	0	1	0.10	0.30
REGUSECO (student uses computer frequently)	18.283	0	1	0.70	0.42
SPUSECOM (student uses computer sporadicaly)	18.283	0	1	0.24	0.24
NUSECOM (student never uses computer)	18.283	0	1	0.06	0.46
REGWRITE (uses word processors frequently)	18.283	0	1	0.15	0.35
SPOWRITE (uses word processors sporadicaly)	18.283	0	1	0.76	0.42
NEVWRITE (never uses word processors)	18.283	0	1	0.09	0.28
25BOOKS (0-25 books at home)	18.283	0	1	0.17	0.37
100BOOKS (26-100 books at home)	18.283	0	1	0.33	0.47
200BOOKS (101-200 books at home)	18.283	0	1	0.22	0.41
500BOOKS (more than 200 books at home)	18.283	0	1	0.27	0.44

Appendix. Table A2. Variables used in the multilevel regression (cont.).

	N	Min.	Max	Mean	Standard Dev.
School 1. School characteristics					
PUBLIC (public school)	18.283	0	1	0.62	0.48
PRIVPUBF (private school; publicly funded)	18.283	0	1	0.38	0.48
SCHSIZ (school size)	18.283	50	2.539	675.49	389.59
CITYSIZ1 (population <100.000)	18.283	0	1	0.61	0.49
CITYSIZ2 (population 100.000-1,000.000)	18.283	0	1	0.36	0.48
CITYSIZ3 (population >1.000.000)	18.283	0	1	0.03	0.16
NOTHERSC (maximum, 2 centers near the school)	18.283	0	1	0.32	0.46
School 2. Student characteristics					
ORINMIG0 (school without immigrants)	18.283	0	1	0.48	0.50
ORINMIG1 (0,1-10% immigrant students)	18.283	0	1	0.36	0.48
ORINMIG2 (10-20% immigrant students)	18.283	0	1	0.10	0.31
ORINMIG3 (>20% immigrant students)	18.283	0	1	0.05	0.23
SCEDMO (average years of schooling of mothers)	18.283	6.29	15.98	10.53	1.71
PCGIRLS (proportion of girls at school)	18.283	0.49	0.08	0	0.91
SCQWHITE (white collar, high skilled -mode-)	18.283	0	1	0.40	0.49
SCNQWHIT (white collar, low skilled -mode-)	18.283	0	1	0.02	0.13
SCQBLUE (blue collar, high skilled -mode)	18.283	0	1	0.45	0.50
SCNQBLUE (blue collar, low skilled -mode-)	18.283	0	1	0.13	0.34
School 3. School resources					
STRATIO (student-teacher ratio)	18.283	1.19	30.55	11.74	4.37
PTEACH (proportion of part-time teachers)	18.283	6.73	6.98	0	79
CLSIZ (class size)	18.283	13	53	25.94	10.13
COMPWEB (proportion of computers with Internet)	18.283	0.07	1	0.89	0.17
IRATCO (computers for instruction/ school size)	18.283	0.01	0.72	0.11	0.08
School 4. Educational practices					
NCOUNS (1=no school counselors at the center)	18.283	0	1	0.20	0.39
AUTCONT (autonomy for selecting teachers for hire)	18.283	0	1	0.37	0.48
AUTBUDG (budgetary autonomy)	18.283	0	1	0.60	0.49
AUTEXT (autonomy for selecting textbooks)	18.283	0	1	0.95	0.23
AUTCONTE (autonomy for selecting contents)	18.283	0	1	0.57	0.49
AUTOCU (autonomy for modifying the curriculum)	18.283	0	1	0.54	0.50
CRITADMI (religious or philosophical issues are used as an admitance criterion)	18.283	0	1	0.30	0.45
STREB (ability grouping between classes)	18.283	0	1	0.48	0.47
STREW (ability groupong within classes)	18.283	0	1	0.44	0.46

Source: Own elaboration from PISA-2006.

Appendix. Table A3. Variables used in the DEA model

Variable	Definition	PSPS		PS		Total	
		Mean	S.D.	Mean	S.D.	Mean	S.D.
Output: PVS	Outcome in science (plausible value)	502.86	85.69	475.08	90.07	488.14	90.60
Input 1: NATIONAL	Percentage of students born in Spain	95.19%	0.76	90.04%	0.96	91.88%	0.68
Input 2: PCGIRLS	Proportion of girls at school	52.11%	2.01	48.64%	0.68	49.46%	0.72
Input 3: NOREPET	Percentage of students not repeating any grade	72.43%	1.26	51.19%	1.07	59.84%	0.85
Input 4: MOTSCY	Mother's years of schooling	10.39	4.43	8.80	4.67	9.63	4.73
Input 5: REGWRITE & SPOWRITE	Percentage of students who use the computer frequently or sporadically to write documents	89.64%	0.77	84.51%	0.87	86.82%	0.60
Input 6: QWHITEC	Percentage of pupils whose father's job is white collar high skilled	38.21%	2.07	22.30%	1.10	30.69%	1.00
Input 7: LANG1	Percentage of native students who speak national language	93.32%	0.79	87.19%	1.05	89.16%	0.75
Input 8: 500BOOKS	Percentage of students with more than 200 books at home	28.32%	1.48	17.99%	0.86	23.95%	0.86
Input 9: ACTIVE	Percentage of students whose both father and mother are active working population	73.83%	1.24	65.12%	1.02	68.98%	0.76
Input10: IRATCO	Ratio of computers for instruction to school size (reverse)	15.93	0.04	8.36	0.10	9.96	0.09
Input 11: CLSIZ	Average class size	30.43	10.91	26.29	8.33	27.78	9.67

Note: Variables have been re-defined in such a way that their relationship with output was positive, basic requirement in DEA models to estimate efficiency

Source: Own elaboration from PISA 2006