

# MODELLING THE VARIABLES THAT INFLUENCE THE SCHOOL PERFORMANCE IN THE MADRID MUNICIPALITIES

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**JEL:** HO, H4, I2, I3

## ABSTRACT

The evaluation of the school performance is a very important strategic field due to the great amount of public and private resources invested by the society in the non-university education. State and regional governments undergo several tests and surveys which try to measure the levels of learning attained by their students. While there is a rich literature on the main inputs that explain the school performance at the State level, the concrete determinants at the municipality level –as immigration and the local budget in education– have not been widely addressed. In this respect, the Autonomous Community of Madrid (ACM) can be an excellent frame to analyze these factors. To illustrate these ideas, this paper estimates a cross-section data model using the results of the specific test developed by the ACM in the academic course 2007-08. Our cross-sectional dataset includes 617 schools in 130 municipalities in the surrounding area of Madrid, using data at municipal and school levels.

## INTRODUCTION

The economy of education and the investment in human capital is one of the most important determinants of the economic development in modern countries, and the education is the most important public expenditure immediately after health. The non university education represents more than two third of the total amount (MECD, 2006). This explains the great interest of governments and society in evaluating the efficiency of the investment that they are making in their school educational system. Although the efficiency of the educational process and school performance is very difficult to quantify because of its intangible character,

most of the researches uses as a *proxy* variable measure: the results of scholastic tests related to different abilities.

With these academic measures, in the last few years some international organizations, mainly the organization for Economic Cooperation and Development (OECD), which focuses its efforts on the evaluation and diffusion of information about the level of the different OECD countries educational systems, the most important, the “Programme for International Student Assessment” (PISA), report carried out in 2000, 2003 and 2006. The most important characteristic of these tests and surveys is that they use variables at the student level.

Education framework is regulated in Spain by the law 2/2006 (LE), and one of its main objectives is to reduce the high rates of academic failure and abandon before finishing the secondary school (the mandatory study is until sixteen years old). The competences in education has been transferred from the central state to the regional governments, and therefore they are developing specific quality measurement school tests as a wider indicator about the educational level in the autonomous regions and a key success return rate of the investment that they are making. Therefore, investment in education has an important public and social component, and local governments earmark an important part of its resources in building public schools and grant some of the private schools (the so-called “concertados” schools); with these grants the government pays the cost of tuition but also they control many of the school characteristics such as average size of students per group, number of groups per academic year, rate students-teachers, academic background of teachers, fields of study and subjects, and so on.

Local governments are using these tests to evaluate the student’s and school performance, but they have to be very careful with these evaluations because this information can be used sometimes by the parents to choose the school or the place to live or their investment decisions (Hoxby, 1999).

The aim of this study is to explain the main factors that explain the school performance at the municipality level, through not only traditional variables as the socioeconomic context of the student and the school resources, but other variables related to the importance of the municipality where the student live, and some other factors that are in the special context of the regional education system such as the ownership of the school and the number of immigrants at the school

To illustrate these ideas this paper conducts an empirical analysis using a special test developed by the Autonomous Community of Madrid. This test evaluates the knowledge and capabilities of Mathematics and Language and capabilities of students in the last year of the primary school. This test has been done during four years, 2004 to 2008, gather the average mark in most of the schools, public and private, of the total that exists in the ACM. In particular we are going to use the academic results of this test in the previous year 2008, with 729 schools of the Madrid municipalities, not including schools from Madrid City, with the objective of analyzing the main factors that can influenced the level of learning attained by the students of all the Madrid municipalities in the sixth year of the primary school.

From our study we detect two variables that have an important impact in the scholastic results. On one side, the specific characteristics of each school, where the number of foreign students and the ownership of the school stand up. On the other side, there is a very relevant variable in the municipality, its expenditure effort in education, which shows that this complementary expenditure allow to overcome the specific problems that the schools have in that place. The analysis shows the capacity of the government, regional and local, to overcome the education outcomes by compensating the differences between schools and students.

## LITERATURE SURVEY

There are a lot of variables that can have a positive or a negative influence in the school performance. The most direct variables are those concerning the individual characteristics of each student. Psychological studies try to connect the school performance with their personality related to their manners, their parents' manners, their motivation, if they failed the previous course, personal educational background, parents' homework help, distance home-school, personal opinion about the school, personal opinion about the teachers, personal opinion about their selves, social skills and family implication with the studies, overall the mother educational expectancies concerning to the children, and health circumstances.

An indirect way to prove the influence of the student's personality in their performance is to show how the

knowledge and grades obtained in the previous academic years is a very good indicator of the marks expected, as it was proved by Bacdayan (1997) and Goldhaber (1997).

Another direct variables that affect the student outcome are the characteristics of the school, such as the average size of the students group, the rate of students per teacher, the size of the school, if it is public or private, rural or city school, half-time or boarding school, unisex school or school for boys and girls, and morning or afternoon shifts school.

Other determinants are those related with the school infrastructures, the experience of the school director and the availability of educational materials, like computers or the students access to text books and reading materials.

Teacher's characteristics are another factor to take into account. In this sense, the most relevant characteristics that affect the student performance are his/her experience, update courses, economic incentives, home-school distance, knowledge of the subjects, full time / half time worker, and motivation through teaching (Rivkin, 2005).

The influence of the ownership of the school (public or private) on the student's performance is one of the most important topic of discussion within this field of study. On the other hand, while some authors find a positive influence between using more economic resources to the school and the outcomes of the students (Hedges et al. 1994; Dewey et al. 2000; Krueger 1999), others defend that dedicating more economic resources to the school doesn't have influence on the results of the students (Hanushek 1986, 1997, 2003; Deller and Rudnicki 1993, 2003; Pritchett and Filmer 1999).

For example, Hoxby, 1999, suggest that between 1970 and 1997 the expense per pupil in USA in the non-university education was double, the academic results remain the same.

But as the differences between public and private schools change among countries, the most interesting studies for this article are those related to the Spanish case. Sancho (2008) highlights that the academic outcomes cannot explain the choice of a public or private school. To support this argument he is based on the 2000 PISA Report, where it is observed that the public schools obtain better academic results that the private ones. Calero (2003) also studies the relationship between the student's performance and the ownership of the school. The differences in outcomes observed in private schools are not explained by the ownership of the school, but by other variables referred to the students (their social and family context), to their classmates, and to the own school. Espadas et al. (2003) study the efficiency of the different ownerships in schools, with a

Value-added modeling and a collection of complex statistical techniques which use multiple years of students' test score data to estimate the influence of individual schools. This model attempts to isolate the contributions of schools to student learning development.

One of the main topics in this area is the relationship between the student performance and the economic level of the student, his/her family or the school. The classical report "Equality of Educational Opportunity Study", published in 1966 by Coleman, established that there is no relationship between both variables, and Mella and Ortiz (1999) developed a research about the external factors that could determine the student's performance in Chile, concluding that the purely economic variables, like familiar incomes, have a poor significance. However, most of the studies on the Spanish education find a close relationship between the student's socioeconomic level and the student's performance: Modrego y San Segundo (1988), San Segundo (1991), Mancebón (2000) and Muñiz (2000). Maradona and Calderón (2004) demonstrate that the most important input to explain the academic achievement is the socioeconomic background of the student. Santín (2006) explains that certain family characteristics, in particular the level of the student's parents' studies and their economic level, predetermine the academic result of the students from the earliest stages. Family conditions determine in this way the probability of school failure, the access to superior levels of education, and finally their future income.

Very related with the economic level is the immigration influence on educational performance. In 2005-2006 the number of pupils from immigrant origins ascended to 101.257 students, of those 77,6% were in public schools and 22,4% in private schools (CCOO, 2007). The impact of the immigration in the Spanish educational system has been studied by Salinas and Santín, 2007. This topic has been also indirectly studied by Ruggiero (1999) that included in his research model the variable "language problems".

The present article studies the variables that influence the student's outcome in an official test made by the regional government of Madrid since 2005 in all the schools of the region. The only study about this test is Crespo et al. (2006), and they find an important influence of the economic characteristics of the student's district or neighborhood, and the immigration through their massive presence in the public schools in some districts.

## METHODOLOGY

By developing a cross-section data model, this paper tries to explain –on a school-by-school basis– the potential variables which can explain the variability of the results of the 6<sup>th</sup> course of primary education exam.

Cross-section models can be used to analyze the data of a broad sample of individuals, families, enterprises, countries –or, in this specific case, the primary schools in Madrid– in a given year. Therefore, we don't have a temporal dimension.

While the time series analysis must adopt a broad set of econometric tools which are also used in the cross-section analysis, the first one is more complicated because of the usual existence of trends, correlations (and autocorrelations), dynamics, or stationarity, in economic time series.

On the other hand, although some econometric models derive from formal economic models and theories, other studies are based on non-formal economic reasonings and the intuition. It is the case of the present paper.

Some of the most frequent problems that are observed in the cross-section data analysis are heteroskedasticity, multicollinearity, endogeneity or stochastic regressors. As can be proved, the model developed in this paper, and the results derived from it, are robust enough to the previous problems.

## THE MODEL

The present study is based on the 2008 test of the 6<sup>th</sup> course of primary education in the schools of the Madrid region. Given the lack of some relevant data, the analyzed sample includes 617 schools.

The developed model, tries to explain the variability of the grades of the examination of the sixth course of primary (*grade*) as a result of a set of variables. These variables can be classified in two broad groups:

1) Particular characteristics of each of the schools: available educational resources, students composition (immigrants versus domestic students), and ownership of the educational centers. Under this group we include the following variables per school:

- The student-teacher ratio (*stud/teacher*)
- The student-computer ratio (*stud/computer*)
- The foreign students (immigrants)/total students ratio (*foreign/total*)
- A dummy-variable (0,1,2) which reflects the titularity of the educational centers (*titul*): public schools, private schools that receive public funds or charter schools ("colegios concertados"), and private schools, respectively.

2) Economic, geographical and political characteristics of the municipality where the schools are placed: per capita income (*Yp*), public spending on education over the total public spending of the municipality (*edspending*), municipality's distance to Madrid City (*dist*), and two dummy variables which represent the political party in power: *PP* (that adopts the value of 1 under a Popular Party government and 0

otherwise) and *PSOE* (which adopts the value of 1 under a Socialist Party government and 0 otherwise).

The econometric specification of the model is the following:

$$\begin{aligned} \log(\text{grade})_i = & c + \beta_1(\text{stud} / \text{teacher})_i + \\ & + \beta_2(\text{foreign} / \text{total})_i + \beta_3(\text{stud} / \text{computer})_i + \\ & + \beta_4(\text{titul})_i + \beta_5 \log(Yp)_i + \beta_6(\text{edspending})_i + \\ & + \beta_7(\text{dist})_i + \beta_8(PP)_i + \beta_9(PSOE)_i + \varepsilon_i \end{aligned} \quad (1)$$

The empirical analysis is based on the "Knowledge and Capabilities of Mathematics and Language" test developed by the Madrid Autonomous Community in the last four years. We have used the last test made in the course 2007/2008 to 1,270 schools, 541 in Madrid City, and 729 in the rest of the municipalities of Madrid Region. The first objective is to compare the municipalities' differences, so we have to erase the schools of Madrid City because they introduce distortions in the analysis. The option of dividing the Madrid's schools into districts is not possible because there are no so many data at this level.

The data set at the municipality level comes from the National Statistics Institute (INE) and the Municipal Database of the Statistics Institute of the Community of Madrid (ALMUDENA): population age, distance to Madrid City, political party governing the municipality, and per capita income level.

Education expenditure of each municipality (data from the Minister of Finance) is also included. Although the competence in education expenditure is at the regional level (Community of Madrid Government), each municipality can add expenditures to increase the education effort in its municipality. We have used education expenditure as a percentage of total municipal budget.

Besides the municipality level data, we have introduced other data at a school level: number of total students and foreign students, number of teachers, classes and computers. All these data come from the Education Services in the Autonomous Community of Madrid.

Students/teacher ratio ( <i>stud / teacher</i> )	(-)
Foreign students/total students ( <i>foreign / total</i> )	(+) or (-)
Students/computer ratio ( <i>stud / computer</i> )	(-)
Titularity ( <i>titul</i> )	(+) or (-)
Per capita income ( <i>Yp</i> )	(+)
Education spending/total spending ( <i>edspending</i> )	(+)
Distance from the capital ( <i>dist</i> )	(-)
Popular Party government ( <i>PP</i> )	(+) or (-)
Socialist Party government ( <i>PSOE</i> )	(+) or (-)

Table 1. Expected signs for the model regressors.

Table 1 shows the *a priori* expected signs for each of the previous variables. On the other hand, Table 2 reports the results of the estimation of equation (1) using WLS.

Dependent Variable:  $\log(\text{grade})$   
Method: Weighted Least Squares  
Sample: 1 617  
Included observations: 617  
Weighting series:  $1/\log(Yp)$

Variable	Coefficient	t-Statistic	Prob.
C	2.888500	28.07290	0.0000
<i>stud/teacher</i>	-0.001937	-2.266731	0.0238
<i>foreign/total</i>	-0.264828	-5.108807	0.0000
<i>stud/computer</i>	-0.022902	-2.049431	0.0408
<i>titul</i>	0.107198	3.740950	0.0002
$\log(Yp)$	0.121600	3.587913	0.0004
<i>edspending</i>	0.424691	1.924220	0.0548
<i>dist</i>	-0.002171	-3.795475	0.0002
<i>PP</i>	0.017882	0.787789	0.4311
<i>PSOE</i>	-0.008827	-0.377415	0.7060

Weighted Statistics			
R-squared	0.642858	Mean dependent var	3.072436
Adjusted R-squared	0.637554	S.D. dependent var	0.270132
S.E. of regression	0.162629	Akaike info criterion	-0.778587
Sum squared resid	16.02766	Schwarz criterion	-0.706781
Log likelihood	249.8047	F-statistic	16.01080
Durbin-Watson stat	1.961593	Prob(F-statistic)	0.000000

Table 2. Regression results.

Let us first mention that all the variables, except the dummy variables for the political party governing the municipality (*PP* and *PSOE*), show the expected sign and are significant at the 5% level. Secondly, it is very relevant to underlie the very high significance of variables like the *foreign students/total students* ratio, the titularity of the school (public, private...), the per capita income level of the municipality, and the municipality's distance to Madrid City. Finally, the weighted fit of the model is relatively good ( $R^2=0.64$ )

A simple reading of Table 2 shows that:

- The higher the *student-teacher ratio*,
- The higher the *student-computer ratio*,
- The higher the *foreign students/total students ratio*,
- The lower the *per capita income level* of the municipality,
- The lower the *education public spending/total municipal budget ratio*,
- The greater the *municipality's distance* to the capital...

...the lower is the average mark for the exam.

On the other hand, it is relevant to emphasize the existence of a positive and significant relation between private/charter schools and the average mark of the examination.

Therefore the estimated model is as follows:

$$\log(\text{grade})_i = 2,8885 - 0.0019(\text{stud} / \text{teacher})_i + \\ -0.2648(\text{foreign} / \text{total})_i - 0.0229(\text{stud} / \text{computer})_i + \\ +0.1071(\text{titul})_i + 0.1216\log(\text{Yp})_i + 0.4246(\text{edspending})_i + \\ -0.0021(\text{dist})_i + \varepsilon_i$$

Figures 1 and 2 show that model residuals do not show any obvious patterns that seem inconsistent with the assumptions of the model.

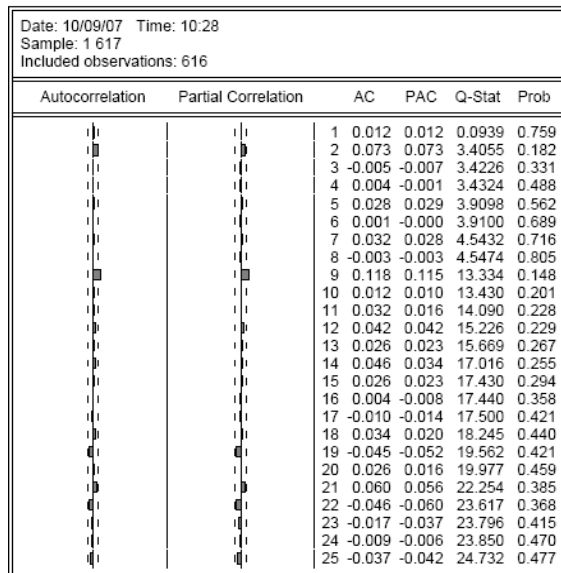


Figure 1. Model residuals

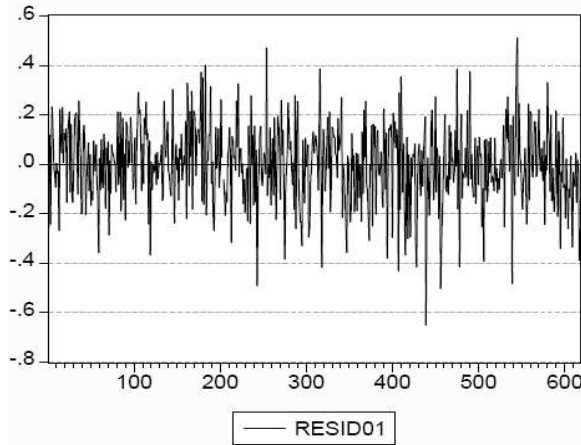


Figure 2. Model residuals

## CONCLUSIONS

This article tries to develop a model to explain the variability of the examination marks of the sixth course of primary as a result of two broad set of variables: 1) particular characteristics of each of the schools (available educational resources, students composition, and ownership of the educational centers), and 2) economic, geographical and political characteristics of the municipalities where the schools are placed (municipality's per capita income level, public spending on education over the total public spending of the

municipality, municipality's distance to Madrid City, and the influence of the political party in power).

By developing a cross-section data model which is estimated under a Weighted Least Squares (WLS) method for correcting heteroskedasticity, it is possible to observe that the examination results of the sixth course of primary education in the schools of the Madrid region, are negatively related to the available educational resources of each of these schools (*student-teacher ratio* and *student-computer ratio*).

On the other hand, we can observe the existence of a negative and significant relation between the proportion of foreign students in the total number of students of each of the schools and the examination grades.

The third point to be considered, is the existence of a positive and significant relation between *private/charter schools* and the results of the examination.

Additionally, it must be emphasized the existence of a clear and significant positive relation between municipalities' economic factors (per capita income level and public spending on education over total public spending) and the results of the exam.

Finally, we can characterize as a surprising result the existence of a statistically significant relation between the municipalities' distance to Madrid City and the results reached by the primary school students. Is it maybe the proximity to the capital a factor of major and better access to education and culture for the students of primary schools in the Community of Madrid?

## APPENDIX

	ALUMEXT	ALUMORD	ALUMPROF	TITUL
ALUMEXT	1.000			
ALUMORD	-0.032	1.000		
ALUMPROF	-0.315	-0.029	1.000	
TITUL	-0.458	-0.132	0.443	1.000
LOGYP1	-0.152	-0.030	0.160	0.326
GASTOED	-0.037	0.031	-0.049	-0.191
DIST	0.072	-0.027	-0.019	-0.113
PP	-0.031	-0.007	0.042	0.066
PSOE	0.072	-0.015	-0.080	-0.055

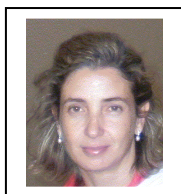
	LOGYP1	GASTOED	DIST	PP	PSOE
ALUMEXT					
ALUMORD					
ALUMPROF					
TITUL					
LOGYP1	1.000				
GASTOED	-0.152	1.000			
DIST	-0.127	0.253	1.000		
PP	0.317	0.103	0.322	1.000	
PSOE	-0.300	-0.183	-0.267	-0.799	1.000

Table 3. Regressor correlation matrix.

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