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Joint Analysis of Preschool Education and School Performance in Public Schools in Montevideo

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Abstract

This paper aims at explaining the academic performance of a sample of children starting their first year at public schools in Montevideo, Uruguay, during 1999. We are mainly interested in the effect of preschool education on the children's academic results. Previous probit and OLS estimations suggested that preschool education has a positive impact on short and long term school performance. However, these results could be biased because a rather strong endogeinity of the preschool education variable. We solved this problem using bivariate probit and treatment effects estimations. The results confirmed the bias and suggested that our previous estimations underestimated the positive effect of preschool educations. Thus, we found fairly strong empirical evidence suggesting that preschool education has a short and long term positive effect on these children's results

Palabras claves: preescolaridad, resultados escolares, probit bivariado, efectos de tratamiento, Uruguay.

Resumen

Este articulo pretende evaluar los resultados escolares de la cohorte de alumnos que cursaban primer año en las escuelas públicas de Montevideo en 1999. Estamos interesados en identificar el impacto de la preescolaridad en dichos resultados. Trabajos previos mediante funciones de producción, por estimaciones probit y de MCO, sugieren que la preescolaridad tuvo un impacto positivo y significativo en los resultados escolares de corto y largo plazo. Sin embargo, esas estimaciones podrían estar sesgadas por problemas de endogeneidad de la variable asistencia a preescolar lo que en este trabajo se pretende subsanar mediante estimaciones probit bivariado y de efectos de tratamiento, las que permiten confirmar que el sesgo de la estimación era a la subestimación del impacto positivo de la preescolaridad, tanto en el corto como en largo plazo. Los resultados constituyen una importante evidencia empírica que confirman el impacto positivo de la preescolaridad en los resultados escolares, tanto en el largo como en el corto plazo.

Keywords: preschool education, school results, bivariate probit, treatment effects model, Uruguay

JEL classification: I21

1. Introduction

There is increasing concern about the results of public education policies. As more and more countries achieve extensive primary school coverage, quality of education becomes the key issue. Thus, the focus of the analysis is shifting towards the impact that educational policies have on academic outcomes. Among these policies the value and importance of preschool education has been often discussed. However, few if any empirical evidence from developing countries has been published.

Clearly, Uruguay is in this situation; it is a small, middle-income country with a long tradition of social inclusion and with education that is mainly provided by the state. Primary schooling has been compulsory since the end of the 19th century, and today the country has a combination of public and private teaching institutions from preschool right through university. In the past, preschool education was mainly provided by private institutions but now public preschools are playing an increasing role (Berlinski et al., 2007).

In 1995 the government launched a comprehensive educational reform, affecting the public system from preschool up to and including secondary education. A main feature of this reform was to universalize preschool education for four and five years old children. According to the education authorities, this was achieved for five-year-old children in 1999 (Magnuson et al., 2004). A recent World Bank publication (2007) suggested that preschooling in Uruguay contributes to improve education outcomes and to reducing the inequalities that emerge in primary and secondary education. It concluded that preschool education fosters good outcomes among children from a disadvantaged socioeconomic context, contributing at reducing the gap between these children and those from a more privileged socioeconomic background.

Our main hypothesis is that preschool attendance has a positive effect on the later academic performance of the children. In this study we focus on the factors that determine the first year school performance of pupils at public primary schools in Montevideo, but we also consider the factors that determine their school performance after six years at school in

order to capture the long term effects. The data used for testing our hypothesis is a sample of the cohort of children that started primary school in 1999. This sample could be followed during six years, which is the prescribed length of primary school in Uruguay.

Conditions at home seem to be the most important component of the child's social environment, and there is some kind of general agreement about the impact of these conditions on school results (see Velez et al., 1993; and Wößmann, 2005). More specifically, it has been suggested that educational and cultural levels at home have a large influence on a child's development (Wößmann, 2005). There is a broad opinion in the sense that the school a child attends to also has an influence on academic outcomes, but there are different opinions about how important this factor is, and in particular about the extent at which school can compensate for influences at home (Harbison and Hanushek, 1992; Hanushek, 1995; Rivkin et al., 2005; and Wößmann, 2005). The importance that is assigned to these various factors will affect decisions about educational policy and will be especially important in the evaluation of the costs and benefits of different policies (Hanushek, 1986; Prichett and Deon, 1997; and Fuller, 1986).

In recent studies Nagle and Tansini (2000) and Moreira et al. (2007) found significant differences in the academic outcomes of children in primary education at public schools in Montevideo, Uruguay. These differences are linked to educational and cultural levels at home and to whether or not the children had preschool education. However, this was a partial analysis that did not consider the joint effects of the different factors on school results. Moreover, these studies did not take account of other aspects related to the school itself that could have an influence on children's performance. It has been pointed out in many studies that institutional variables like the ratio of pupils to teachers and the teacher's education and experience are quite important in explaining school results, but there are also authors who suggest that these variables have a lesser influence. We should also notice that the production function approach makes it possible to improve the evaluation of the impact of different variables on school results (Prichett and Deon, 1997).

A main problem when modeling school results is finding an appropriate measure of school performance. Academic performance is basically a broad multidimensional idea, including a number of unobservable elements. It is quite difficult to define a quantitative representation for this variable, and every attempt is an easy target for criticism. Thus, we used different definitions, including a varying content of information. The measures of school performance that we use include the probability of passing the first school year and the probability of passing the sixth year on schedule, as well as indicators built upon the marks obtained by the children. We focus our analysis on the importance of variables that characterize the child's household, whether or not the child had preschooling, and the impact of the school on pupil outcomes.

The paper is organized as follows. The next section gives a brief description of Uruguay's school system and summarize some descriptive results published elsewhere (Tansini, 1999; Moreira et al., 2007; and Nagle and Tansini, 2000). A second section describing the models, the variables, and the data sources follows. Next we present the estimation results. A section with conclusions ends the paper.

2. School performance in Montevideo

In this section we present a few basic elements of Uruguay's school system. These elements are necessary for understanding the specification of our models and for understanding the meaning of our results.

Uruguay's school system includes a six-year Primary School and a six-year Secondary school. Primary School is mandatory for children starting at six year age. The children get yearly marks from 1 to 12 for their performance, and from the beginning at First Year. A mark of 1 to 5 is a Fail, a mark of 6 is considered a Pass and the grade Good is given.[1] Children failing to get a mark greater than five should repeat the year. Thus, the repetition rate could be considered a proxy index for the general performance of the system. Education is provided mainly by the public sector, with a significant contribution from private schools. The government introduced an extensive reform in 1995. One of the main goals of this reform, universal preschool for children of age four and five years, was finally achieved in 1999.

[1] A mark of 7 corresponds to Good Very Good, an 8 is Very Good Good, and a 9 is Very Good. Then, we have the top bracket: a 10 is Very Good Outstanding, an 11 is Outstanding Very Good, and a 12 is Outstanding.

The achievement of universal preschool implied a large scale expansion of public preschool institutions focused on children from a socioeconomic context where the rate of coverage was rather low. According to the Continuous Household Survey[2], public preschool education expanded greatly in Montevideo: the proportion of children from four to six in preschooling increased from 71 percent in 1995 to 84 percent in 1998. It is worth noting that the greatest increase (from 58 to 73 percent) occurred in the three lowest income deciles, while in the higher deciles the rate was around 90 percent in both years (Tansini, 1999). It was expected that one of the consequences of bringing children into education at an early age would be to improve academic performance in the midterm, particularly among children from the most disadvantaged sectors of society. Berlinski et al. (2007), working with the 2001-2005 Uruguayan Household Survey, found *"...small gains from preschool attendance at early ages that magnify as children grow up. By the age of 15, children who have had preschooling have accumulated 0.8 extra years of education and are 27 percentage points more likely to have remained in school than children who have not."* Furthermore, they found that *"...going to pre-primary school positively affects pupils' self-control in the third year as measured by behavior such as attention, effort, class participation and discipline"*.

In Table 1, based on the sample of children in their first year at public primary schools in Montevideo in 1999, we can see that 55 percent passed that year with grades between Good and Very Good (this also includes pupils who passed the year because they were over the age limit and other special cases), some 23 percent passed with a final grade above Very Good and 23 percent failed.

These results are certainly influenced by the characteristics of the school, by socioeconomic factors at home, and by the social environment in which the child grew up. The socioeconomic context of the school in particular seems to have a considerable influence on children's outcomes. The socioeconomic contexts are defined by the National Administration of Public Education (ANEP) on the basis of the mother's education and the level of house equipment of the household. (ANEP, 1999). Table 1 shows that the highest repetition rate occurs in schools in the lower socioeconomic context (30 percent) followed by those in the middle context (20 percent), and then by those in the higher context (10 percent).

2 This is a regular household survey taken by the National Institute of Statistics.

However, these are not the only factors that seem to influence children's performance. Nagle et al. (2000) and Moreira et al. (2007) reported that the first year children in public schools who achieved better results in 1999 "*...are generally those who went to preschool, and especially those who began preschool education at an early age*". In fact, the first year failure rate among children who did not have preschooling was more than double the rate of those who did go to preschool. About 90 percent of the children in the 1999 cohort had preschooling, but there were significant differences between schools in the different socioeconomic contexts. The preschooling rate among pupils at schools in the high socioeconomic context was 97 percent, in middle context schools it was 96 percent, but in schools in the lower context it was only 81 percent. Moreover, when we analyze preschool education by the mother's education, we find that children whose mothers are better educated are more likely to go to preschool. Some 81 percent of children whose mother did not finish primary school went to preschool, while 98 percent of children whose mother had more than 12 years of formal education did so.

An analysis of the data about the children in their first year in Primary School in 1999 shows that those who attended preschool achieved better results not only in terms of low repetition rates, but they also passed the year with higher marks. This relation was found at the aggregated level for the sample as a whole and also in the three socioeconomic contexts of the schools. Schools in the lower and higher socioeconomic context showed a large difference regarding these results. We can see in Table 1 that some 80 percent of pupils in the 1999 cohort that had preschooling passed their first year of primary, whereas only 51 percent of those that had not preschooling passed the year. This situation is even worse in schools in the lower and middle socioeconomic context, where in 1999 some 74 and 81 percent of pupils who had preschooling passed their first year of primary but the pass rate among children who had not been to preschool was only 50 and 33 percent, respectively, even when a much smaller share of children in the middle and higher strata did not have preschooling.

Table 1. Final grades of first year pupils in 1999 by socioeconomic context and preschool attendance (percentages)

Socioeconomic Context	Pre-schooling	Failed	Good and Very Good	Better than Very Good	Total
Lower	No preschool	50	47	3	100

	Preschool	26	56	19	100
	All Children	30	54	16	100
Middle	No preschool	67	33	0	100
	Preschool	19	53	28	100
	All Children	20	53	28	100
Higher	No preschool	29	71	0	100
	Preschool	10	59	32	100
	All Children	10	59	31	100
Entire Cohort	No preschool	49	48	3	100
	Preschool	20	56	25	100
	All Children	23	55	23	100

A main goal of Uruguay's educational system is that pupils should finish the primary school cycle in six years. The 1999 school records for pupils in the sample show that only slightly over half of them (56 percent) kept up with the expected school schedule and reached the sixth year in 2004 (see Table 2). The situation is even worse in schools in the lower socioeconomic context as only 41 percent of pupils reached the last curricular year on schedule, which contrasts sharply with 65 percent from the middle socioeconomic context and 76 percent from the higher socioeconomic context. Repetition generated large differences in the length of the school cycle. More specifically, up to 2004 some 23 percent of the children repeated one year and 28 percent repeated more than one year. Another characteristic of this high failure rate is that most pupils that repeated, did so in their first year.

We suggested above that good academic results in the first year at public schools were positively associated with attending preschool, and especially with an early start to preschool education. When we analyze the whole school cycle up to 2004 we find that some 59 percent of the children in the cohort who had pre-schooling reached the sixth year in 2004 but only 26 percent of those who did not go to preschool reached the sixth year on schedule. In addition, while 45 percent of the children at schools in the lower socioeconomic context that went to preschool reached the sixth year on schedule, only 25 percent who had no pre-schooling did.

Table 2. Results in 2004 of pupils of the 1999 cohort, by socioeconomic context and pre-school attendance. (Percentage)

Socioeconomic context	Pre-schooling	Attended 6th year in 2004			No Attended 6th year in 2004	Total
		Failed	Good & Very Good	Better than Very Good		
Lower	No Attended	0.0	21.9	3.1	75.0	100
	Attended	0.7	27.2	16.9	55.2	100
	All Children	0.6	26.3	14.4	58.8	100
Middle	No Attended	0.0	0.0	0.0	100.0	100
	Attended	1.7	36.9	27.3	34.1	100
	All Children	1.7	36.3	26.8	35.2	100
Higher	No Attended	0.0	42.9	14.3	42.9	100
	Attended	0.4	43.5	32.6	23.5	100
	All Children	0.4	43.5	32.1	24.1	100
Entire Cohort	No Attended	0.0	22.3	3.7	74.0	100
	Attended	0.9	34.1	23.9	41.0	100
	All Children	0.8	32.9	21.8	44.4	100

The fact that a child goes to preschool, and the age at which he starts it,seems to have an effect on pupils' outcomes but, as we shall see in the following section, we should consider that the decision to send a child to preschool is not independent of the educational level of the mother, or the parents, or of the household socioeconomic situation. Moreover, Moreira et al. (2007) found that the mother's education, or the household's education, seems to be also related with school results. From an analysis of first year school outcomes, these authors concluded that better results are associated with mothers with higher educational levels. Particularly, the repetition rate falls systematically as the mother's educational level rises. A similar result was observed for the share of children obtaining better marks.

3. The Data and the Model Specification

We have data, for the period 1999-2005, on the schools and on the households of a sample of children that were in their first year at public schools in Montevideo in 1999. The information on households comes from two household surveys of the sample of first year pupils at public schools in Montevideo. These surveys were carried out in June 1999 and November 2006 on a sample of 950 households out of the 17,430 first-year pupils at these schools. The sample was stratified into three groups according to the socioeconomic context of the school that the child was attending: Lower, Middle and Higher (see Nagle and Tansini, 2000; and Moreira et al., 2007) for a more comprehensive description of the sam-

ple). The information about schools, teachers and academic results was gathered directly from each school. Note that the information about teachers and final grades used in this study is for the whole academic year, so the final marks for each child reflects an evaluation made by the teacher of that child's performance over the whole year.

We built different variables to measure the children's academic performance. For their first year at school, the obvious measure is given by the final grades the children obtained. Grades obtained at school, and especially in the first year of primary education, have been often criticized as an inadequate measure of academic performance. We felt that in this study we should not enter this debate so we also used a dummy variable, "*passed or failed the first year*", as a more general measure of academic performance. In order to measure the children's long-term performance we first focused on their grades in sixth year in 2004. Note that this variable is censored because not all the children in the sample reached sixth year in 2004. We considered a linear measure of performance whereby the grade obtained in the year the child passed in 2004 is multiplied by a factor equal to one for the sixth year, five-sixths for children that only passed the fifth year, four-sixths for those that only passed the fourth year, and so on.

With this data we constructed the following explanatory variables:

- **Parents' Education**. This variable is equal to the average years of formal education of the parents.
- **Mother Education more than 6**. A dummy variable equal to one if the mother had more than six years of formal education, and zero otherwise.
- **Mother Education more than 9**. A dummy variable equal to one if the mother had more than nine years of formal education, and zero otherwise.
- **Attended Preschool**. This variable equals one for pupils who had preschool education, and zero otherwise.
- **Living with both Parents**. A dummy variable equal to one if the pupil is living with both biological parents, and zero otherwise.
- **More than 10 Books**. A variable equal to one for pupils with more than 10 books at home and equal to zero otherwise.
- **More than 20 Books**. A variable equal to one for pupils with more than 20 books at home and equal to zero otherwise.
- **More than 50 Books**. A variable equal to one for pupils with more than 50 books at home and equal to zero otherwise.
- **Persons per room**. This is an index of crowding at home.

- **Substitute Teacher**. This is a binary variable equal to one if a substitute teacher was in charge of the class in 1999, and zero otherwise.
- **Other Child Aged 4 to 6.** This is a binary variable taking the value 1 if there were other children aged 4 to 6 in the household in 1999.
- **Other Child Aged 8 to 15.** This is a binary variable taking the value 1 if there were other children aged 8 to 15 in the household in 1999**.**
- **Average Repeaters.** Average annual percentage of repeaters in the school during the period 1999 to 2004.

We analyzed these data with the help of regression models aimed at identifying the effects of different factors on the children's academic performance, but with a main focus on the effect of pre-schooling. We designed these models oriented in two main dimensions. First, we aimed to separate short from long term effects, the former attempting to explain children's performance in the first year of primary school (in 1999) and the latter trying to explain their performance after six years at primary school (in 2004). In our second analytical dimension we considered the effects of different kinds of factors that could explain children's academic performance in both the short and the long term. We included factors related to school characteristics and factors pertaining to the children's background, their households and the socioeconomic context where they grew up.

In order to capture these effects we used a production function approach. That is, we assumed that the children received a number of inputs from their households, the socioeconomic context where they live, and their school. Naturally, we measured the output of this production process (the learning process) by the children's academic performance. That is, we assumed that there is a function

$$y = f\left(x_1, x_2, \ldots, x_k\right),$$

where $x_1, x_2, \ldots, x_n$ are variables measuring the different factors acting on the children to produce an academic performance level indicated by *y*, using the measures outlined above.

This approach suggests that in order to test our hypothesis we should regress an indicator of school performance on a number of factors that contribute to the determination of that performance, including attendance to preschool. We did this using a binary indicator of school performance, passed or failed in a given year, or a continuous performance variable based on the marks obtained by the children. In the first case the appropriate model is a

probit and, in the second case, one can hope that OLS estimation would be possible. This was done for the first year at Primary School, in order to capture short term effects, and for the sixth year, in order to capture long term effects.

However, the estimation of these models is not trivial. The basic problem is that a crucial regressor, *attendance to preschool*, is a stochastic variable, most likely determined by factors that also contribute to the determination of school performance. Thus, we have a case of stochastic regressors likely to be correlated. This would lead to biased estimators.

Our approach to overcome this difficulty is the joint estimation of an equation for preschool attendance and an equation for school performance. Our strategy for the new specification of these models starts with the estimation of preschool attendance. The appropriate specification is a probit, where we assume the existence of a latent variable representing assistance to preschool and linearly dependent of a set of independent variables. That is, we assume that

$$y_{1i}^{*} = \boldsymbol{\beta}_1^{'}\mathbf{x}_{1i} + \varepsilon_{1i},$$

Where $\mathbf{x}_i$ is a $k \times 1$ vector of explanatory variables, $\boldsymbol{\beta}$ is a $k \times 1$ vector of parameters, and ε_1 is an independently and identically normally distributed stochastic term with zero mean and variance σ_1. We observe an associate binary variable:

$$y_{1i} = \begin{cases} 1 \text{ if the child attended preschool } \left(y_{1i}^{*} > 0\right), \\ 0 \text{ otherwise } \left(y_{1i}^{*} \le 0\right). \end{cases}$$

Thus, we estimated the probit:

$$\mathrm{P}\left[y_{1i} = 1 \mid \mathbf{x}_i\right] = F\left(\boldsymbol{\beta}_1^{'}\mathbf{x}_{1i}\right), \quad \forall i \in \{1, 2, \ldots, n\},$$

where *F* stands for the normal probability distribution. Table 3 shows the results of the estimation of this probit. Notice that all parameters could be estimated with a level of statistical signification better than one percent (the critical one percent value is |*t*|=2.33).

Table 3. Probability of preschool attendance. Probit estimation

	Coefficients	t	**Marginal Effect**
Parents' education	0.113	3.85	0.013
Persons per room	-0.100	-2.48	-0.012
Other child aged 8 to 15	-0.527	-3.21	-0.056
More than 20 books	0.433	2.53	0.049
Intercept	1.087	3.75	—
Obs. Percentage	0.9039		
Pred. Percentage	0.9436		
Obs.	770		
Pseudo R^2	0.1528		
Log-likelihood	-206.42		
Wald χ^2	61		

These results show that there is a strong association between preschool assistance and a number of variables characterizing the household that could be important later on for the determination of the children's school performance. Thus, we need a simultaneous estimation of preschool attendance and school performance. Fortunately, both decisions are sequential which makes the probit option treatable. For details, see Maddala (1983).

Thus, we specified the following simultaneous model, with a latent variable for attendance to preschool, associated to a binary observed variable, as before. To this auxiliary equation we add a second equation determining school performance. Thus, the model becomes,

$$y_{1i}^{*} = \boldsymbol{\beta}_1^{'}\mathbf{x}_{1i} + \varepsilon_{1i},$$
$$y_{2i}^{*} = \delta y_{1i}^{*} + \boldsymbol{\beta}_2^{'}\mathbf{x}_{2i} + \varepsilon_{2i}.$$

The latent variable y_{1i}^{*} has again an associated and observable binary variable, attended to preschool education or not. Variable y_{2i}^{*} stands for school performance. The stochastic terms $(\varepsilon_{1i}, \varepsilon_{2i})$ are independent across observations and identically normally distributed with mean $\mathrm{E}(\varepsilon_{1i}, \varepsilon_{2i}) = (0,0)$ and variance

$$\mathrm{var}(\varepsilon_{1i}, \varepsilon_{2i}) = \begin{bmatrix} \sigma_1^2 & \rho \\ \rho & \sigma_2^2 \end{bmatrix}.$$

When we assume that the variable y_{2i}^{*} has associated an observable variable $y_{2i}=1$ if $y_{2i}^{*}>0$ and zero otherwise, passed or not passed, this become a bivariate probit, and $\sigma_1=\sigma_2=1$. Following Maddala (1983), we can estimate this model using maximum likelihood.

If we have a continuous observable variable y_{2i} such that $y_{2i}=y_{2i}^{*}$, we can assume

$$\operatorname{var}\left(\varepsilon_{1i},\varepsilon_{2i}\right)=\begin{bmatrix}1 & \lambda\\ \lambda & \sigma^2\end{bmatrix}.$$

This model, often called treatment effects model, can also be estimated using maximum likelihood. Maddala (1983), also presents a two-step procedure for its estimation.

4. Estimations

Both models above were first estimated considering the results of the children in 1999, when they were at first year. We assume that these results will reflect short term effects of preschool on academic performance. These models were also estimated for 2004, when the children have been six years at school. We expect that these results would reflect long term effects of preschool attendance.

A. Short term effects

In order to capture short term effects we observed the performance of the children in 1999. That is, we observed the children at their first year at school. We used two different variables for performance. First, we used a binary variable, passed or non-passed in first year in 1999. The first three columns of Table 4 show the results of the corresponding bivariate probit estimation. Then, we used the marks obtained by the children as a continuous variable hopefully capturing school performance. The last two columns of this table show the results of the treatment effects estimation of this model.

Table 4. Performance of the children in 1999. Bivariate probit and treatment effects estimation

	Bivariate probit Passed/non-passed in 1999			Treatment effects Marks in 1999	
	Coefficients	t	Marginal Effects	Coefficients	t
Attended preschool	1.600	5.40	0.559	4.476	10.35

Other child aged 4 to 6	-0.551	-3.91	-0.123	-0.357	-1.91
Substitute teacher	-0.427	-3.70	-0.122	-0.571	-2.86
Mother Education more than 6 years	0.348	3.02	0.092	0.836	4.67
Living with both parents	0.237	2.14	0.064	0.619	3.61
More than 10 books	0.380	3.34	0.107	0.679	3.63
Intercept	-0.642	-2.06	—	2.393	5.15
Auxiliary function: Preschool attendance					
Parents' education	0.121	4.25	0.057	0.105	3.90
Persons per room	-0.102	-2.71	-0.010	-0.132	-3.90
Other child aged 8 to 15	-0.510	-3.12	-0.047	-0.544	-3.76
More than 20 books	0.417	2.53	0.050	0.369	2.32
Intercept	1.021	3.64	—	1.216	4.71
ρ	-0.608	-3.78	—	—	—
λ	—	—	—	-1.580	-8.44
Obs.	770			770	
Log-likelihood	-537.81			-1903.39	
Wald χ^2	203.70			271.33	
Wald test with $\rho = 0$ or $\lambda = 0$	7.673			65.35	
Prob. > $\chi^2(1)$	0.049			0.00	

Let us consider first the results for the binary performance variable. Notice that, for the bivariate probit estimation, our estimate of $\boldsymbol{\rho}$, the covariance of the stochastic disturbances of both equations of the model, equals -0.608 with a level of statistical significance better than one percent. It can also be seen from the Table 4 that the Wald test, a likelihood ratio test assuming $\boldsymbol{\rho=0}$, allows us to reject the null-hypothesis at least at one percent level of statistical significance, rejecting the exogeneity hypothesis. Thus, a simultaneous estimation is appropriate. However, there is a surprise here because $\boldsymbol{\rho}$ has a negative sign and we would have expected a positive sign given that we might suppose that the factors that affect preschool attendance would have a positive impact on school results, as mentioned above. In any case it worth noting that $\boldsymbol{\rho < 0}$ or $\boldsymbol{\lambda < 0}$ indicates that probit or Ordinary Least Squares (OLS) estimations significantly underestimate the effect of preschooling in the two models in Table 4. All parameters were estimated at a level of statistical significance better than one percent (the critical value is 2.58) but for *living with both parents* and the *intercept*, estimated at level of statistical significance better than five percent (critical value is 1.96).

All the parameters have the expected signs. Looking at the estimated marginal effects we can conclude that attending at preschool is by large the most important variable explaining the children's performance in their first year at Primary School. However, it has to be noticed that a substitute teacher has a strong negative effect on school performance as well as

the presence of another child sharing the parent's attention because of a similar age. It is interesting to see that living with both parents seems to be less important.

When we consider our continuous performance variable, we got again a rather large estimate for λ, the covariance between the stochastic disturbances of both equations, and with a quite high level of statistical significance. Most parameters were estimated at one percent level of statistical significance or better. The exception is *other child aged 4 to 6*, which was estimated at almost five percent level of statistical significance. These results are quite similar to the bivariate probit model. The effect of preschool attendance seems to be relatively much stronger than in the case of the bivariate probit. The negative effect of a substitute teacher seems to be a bit stronger than in the bivariate probit case.

Probably, none of these variables is a really good proxy for school performance. However, quite similar results obtained with performance indicators that differ in the quantity of information captured by the variables, allow us to suggest that our main conclusion is robust: Namely, preschool attendance is a quite important factor for a good performance in first year at Primary School.

B. Long term effects

In order to capture long term effects we followed the children up to 2004. Once again we created two different performance variables. First, we used a binary variable equal to one if the child passed sixth year in 2004, and equal to zero otherwise. That is our variable equals zero if the child failed sixth year in 2004, or if he/she was unable to reach sixth year within the prescribed period. The three first columns of Table 5 show the results of the corresponding bivariate probit. Second, we used a continuous variable constructed upon the marks obtained in 2004, weighted in accordance with the highest grade reached during the period (see section 3 for a detailed description). The last two columns of Table 5 show the results of the treatment effects estimation. Notice that both the parameter ρ and the parameter λ were estimated as negative and at a significance level better than one percent. These results also shows that the joint modeling is suitable and that the importance of preschool-

ing would be underestimated ($\lambda < 0$) if the joint estimation were not carried out. Thus, in both case we can assume that the simultaneous estimation was relevant.

Notice that there are small changes in the definition of some variables, representing the educational environment at home. We assumed that a higher educational an intellectual level is more relevant when following the children's education over a longer period. Moreover, we introduced a new variable, which is the average percentage of repeaters during the period 1999-2004 at that school. We assume here that repetition qualifies not only the performance of the children, but also the quality of the school and the general environment of the children.

We could estimate all parameters at a one percent level of statistical significance or better. There are a few interesting differences with the previous results based on the performance at first year in 1999. Considering the bivariate probit results we can see that the preschool parameter is somewhat smaller, but still is the most important variable with positive marginal effect in the probability of passing sixth year on schedule. On the other hand we got somewhat larger effects associated to the education of the mother or the cultural level at home (*more than 50 books* at home). This is not surprising because we are also considering variables associated to a higher educational level at home in 2004. The most interesting result is, probably, that we found that the strongest effect was a negative one of the *average repeaters of the school* during the period 1999-2004.

When we consider our continuous performance variable, the results of the treatment effects estimation follow more or less the same results. Once again, these results seem to be robust. The parameter associated to attendance to preschool education is still quite important. Once again, the parameter associated to the variable *average repeaters of the school* in 1999-2004 is the most important, with a negative effect.

Table 5. Performance of the children in 2004. Bivariate probit and treatment effects estimation

	Passed sixth year in 2004	**Performance**

	Coeff.	t	Marginal Effect	Coeff.	t
Attended preschool	1.569	8.21	0.526	0.418	10.38
Other child aged 4 to 6	-0.261	-2.36	-0.100	-0.254	-1.11
Mother Education more than 9 years	0.375	3.21	0.143	1.248	5.43
Live with both parents	0.286	2.91	0.112	0.793	3.92
More than 50 books	0.458	3.55	0.172	0.841	3.47
Average Repeaters of the school	-3.881	-4.15	-1.517	-6.551	-3.40
Intercept	-0.991	-3.84		3.061	5.83
Auxiliary function: Preschool attendance					
Parents' education	0.112	3.77	0.014	0.114	3.61
Persons per room	-0.117	-3.27	-0.014	-0.124	-3.44
Other child aged 8 to 15	-0.579	-3.82	-0.064	-0.702	-4.63
More than 20 books	0.451	2.90	0.053	0.427	2.74
Intercept	1.142	3.98	—	1.262	4.35
ρ	-0.708	-7.02	—	—	—
σ	—	—	—	2.672	35.25
λ	—	—	—	-1.656	-9.14
Obs.	770			770	
Log-likelihood	-653.08			-2,005	
Wald χ^2	272.40			378.44	
Wald test with $\rho = 0$ or $\lambda = 0$	19.067			60.79	
Prob > $\chi^2(1)$	0.00			0.00	

These results suggest that pre-schooling plays a positive role and is also highly significant both in the short and the long run, when the pupil's situation is considered six years after he started primary school. Another point to note is that in the long run a bad performance of the school has a negative effect on pupil outcomes, but this can be partially compensated by the capability of the child's home to supplement (educational and cultural level) the school's efforts and give attention to the learner.

5. Conclusions

Preschool was not universal or compulsory in Uruguay until 1999, but according to information from the Household Survey of the National Institute of Statistics, in 1995 the proportion of children between 4 and 6 years old in preschool education was just over 70 percent. The educational reform program launched in 1995, introduced the universalization of preschool for five and four-year-old children as one of it most important goals. However, in practice, preschool education only became universal for five-year-old children in 1999. This measure was mainly aimed at enhancing children's readiness to start school as many

children, especially in disadvantaged socioeconomic groups, seemed to be insufficiently prepared.

An evaluation of the results of the cohort of first year pupils at primary school in Montevideo in 1999 suggested that preschool education makes an important contribution to pupil performance at state schools in Montevideo. This was confirmed by a production function analysis of the cohort for the long as well as the short run. However, previous Probit and Ordinary Least Squares estimations of marks suggested that the preschool effect seemed to be somewhat lower in the long run; that is, after six years of schooling (Aguilar and Tansini, 2010). When we take in consideration that the decision of whether or not to send a child to preschool is also taken in the home emerges the suspicion that estimations might be biased because of possible significant degree of endogeneity of this variable. In order to deal with this problem we made bivariate probit and treatment effects estimations as these would allow us to test the exogeneity of the preschool variable in the modeling of pupil performance in the short and long run.

When we analyzed the performance of the children in first year in 1999, we found that the academic results are explained by a number of factors related both to the school and to the characteristics of the household. The corresponding parameters were estimated with a reasonable level of statistical significance and with the expected signs. It is important to note that the variable attendance to preschool education has a paramount effect among the factors explaining school performance at first year.

When we examine the results of the same children in 2004, after six years at school, we found a similar picture, with attendance to preschool as one of the main factor explaining school performance. It is important to note that the variable average percentage of repeaters during the period 1999-2004, measuring the general performance of the children at the school, resulted to be the most important factor in explaining children's school performance in 2004.

Our main conclusion is that preschool and the children's performance in the first year at school are crucial for the long term academic results. Particularly that preschooling plays a positive role and is also highly significant both in the short and the long run, that is when the pupil's situation is considered six years after he started primary school. The policy implications are obvious. A main target for public policies should be to improve quality of preschool and the first few years of Primary School.

6. References

Aguilar, R. and R. Tansini, 2010. *Preschool Education and School Performance. The Case of Public Schools in Montevideo.* WP 434, School of Business, Economics and Law at University of Gothenburg, Sweden.

ANEP, 1999. *National Evaluation of learning in mathematical language and 6th year primary education. First Report*. UMRE Project, Mecaep, Anep-BIRF, Uruguay.

Berlinski, S., S. Galiani, and P. Gertler, 2006. *The Effect of Pre-Primary Education on Primary School Performance.* Institute for Fiscal Studies, England, WP06/04.

Berlinski, S., S. Galiani, and M. Manacorda, 2007. *Giving Children a Better Start: Preschool Attendance and School-Age Profiles.* University College London and Institute for Fiscal Studies, WP 618.

Fuller, B., 1986. *Raising School Quality in Developing Countries: What Investments Boost Learning?* World Bank, Discussion Paper, WDP 2, Washington.

Goodman, A. and Barbara S., 2005. Early education and children's outcomes: How long do the impacts last? *Fiscal Studies*, vol. 26, 4, pp. 513-548.

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

Hanushek, E., 1995. Interpreting Recent Research on Schooling in Developing Countries. *World Bank Research Observer*, 10, 2, pp. 227-246.

Harbison, R. and E. Hanushek, 1992. Educational Performance of the Poor: Lessons from Northeast Brazil. New York: Oxford University Press.

Maddala, G., 1983. Limited-Dependent and Qualitative Variables in Econometrics. Cambridge University Press, England.

Magnuson, K.; C. Ruhm and J. Waldfogel, 2004. *Does prekindergarten improve school preparation and performance? NBER* Working Paper 10452.

Moreira, M., R. Patrón, and R. Tansini, 2007. *La Escuela Pública: Puede y debe rendir más."* Department of Economics at the University of Uruguay and Sida, Sweden.

Nagle, A. and R. Tansini, 2000. *Resultados Académicos de los Alumnos de Primer Año de las Escuelas Públicas de Montevideo y Características de los Hogares.* Department of Economics, FCS-UdelaR. Documentos de Trabajo 15, Uruguay.

Prichett, L. and F. Deon, 1997. *What Education Production Functions Really Show: A Positive Theory of Education Expenditures.* World Bank, Working Paper 1795, Washington.

Rivkin, S. E. Hanushek and J. Kain, 2005. Teachers, Schools, and Academic Achievement. *Econometrica*, vol. 73, 2, pp. 417-458.

Tansini, R., 1999. *Impacto económico, educativo y social de la incorporación de niños de 4 y 5 años a la educación inicial pública.* Departarment of Economics at the University of Uruguay, mimeo, 17.

Velez, E., E. Schiefelbein and J. Valenzuela, 1993. *Factors Affecting Achievement in Primary Education*, Working paper 12186, World Bank, Washington.

The World Bank, 2007. Uruguay. Equidad y Calidad de la Educación Básica. *Unidad de Gestión del Sector de Desarrollo Humano*, Informe Nº 38082 – UY.

Wößmann, L., 2005. *Families, School, and Primary-School Learning: Evidence for Argentina and Colombia in an International Perspective.* The World Bank, Policy Research Working Paper 3537.

Statistical Appendix

Table A1. Summary statistics of variables

Variables	Obs.	Mean	Std. Dev.	Min.	Max.
Passed first year in 1999	770	0.8013	0.3993	0	1
Marks in 1999	770	7.4403	2.4863	3	12
Passed sixth year in 2004	770	0.5662	0.4959	0	1
Performance	770	7.0110	2.8830	0	12
Attended preschool	770	0.9039	0.2949	0	1
Parents' education	770	8.0136	3.4933	0	18
Mother Education more than 6	770	0.5649	0.4961	0	1
Mother Education more than 9	770	0.2766	0.4476	0	1
Live with both parents	770	0.7013	0.4580	0	1
More than 10 Books	770	0.7455	0.4359	0	1
More than 20 Books	770	0.4403	0.4967	0	1
More than 50 Books	770	0.2286	0.4202	0	1
Persons per room	770	2.1211	1.4676	0.5	10
Substitute teacher	770	0.2325	0.4227	0	1
Other child aged 4 to 6	770	0.7805	0.4142	0	1
Other child aged 8 to 15	770	0.6182	0.4861	0	1
Average Repeaters	770	0.1105	0.0554	0.0208	0.1913