

Does the contribution made by early education to later academic achievement differ in Latin America?: PISA 2009-2012

Luis Fernando Gamboa and Natalia Krüger

ABSTRACT

This article provides evidence regarding differences in the performance on academic tests in secondary school between students who had attended preschool and those who had not. A non-parametric method based on the generation of counterfactuals to decompose gaps between observable and unobservable factors is used to analyse data gathered by the Programme for International Student Assessment (PISA) between 2009 and 2012 for a number of Latin American countries. This analysis reveals the existence of socioeconomic segregation in terms of access; considerable score differentials (conditional on the controls used), which increase in line with the length of time spent in early childhood education; and significant differences across countries with regard to those differentials, which also tend to be greater in the case of reading test scores than in mathematics test scores.

KEYWORDS

Education, preschool education, secondary education, equality, academic achievement, Latin America

JEL CLASSIFICATION

I24, C14, O15

AUTHORS

Luis Fernando Gamboa is an associate researcher at the Colombian Institute for the Promotion of Higher Education (ICFES). lfgamboa@gmail.com

Natalia Krüger is an assistant researcher at the Institute of Social and Economic Research of the South (National Scientific and Technical Research Council (CONICET)) and a teaching assistant at the Department of Economics of the National University of the South, Argentina. natalia.kruger@uns.edu.ar

I

Introduction

The delivery of comprehensive care during early childhood, which is recognized as one of the rights of the child and as a social investment of key importance, is now promoted by a wide range of international agencies, agreements and standards. The commitments assumed by signatories of the World Declaration on Education for All, which was adopted in Jomtien in 1990, and the formulation of the Education for All Goals in Dakar in 2000 reflect the existence of a consensus regarding the importance of education during the early years of life.

This stage is considered to be crucial for the physical, mental and emotional development of individuals (ECLAC, 2008; SITEAL, 2010), and ensuring that all children receive quality care is therefore essential for social justice. A variety of disciplines have highlighted the positive impact that the cognitive and non-cognitive skills acquired in preschool have on people's educational performance in later years (Ministry of Education of Brazil, 2013). According to Heckman (2000), these effects translate into high rates of return on investments in early education. Likewise, interventions during childhood would result in future resource savings in social policy, as well as facilitate women's integration into the workforce and foster economic and social development globally.

Early education is closely linked to social equity because of its intrinsic and instrumental value.¹ Inequality in access to early education constitutes a violation of the rights of the child, especially in settings marked by a high degree of heterogeneity. It is also a source of future inequity, given its repercussions on a wide array of social and economic outcomes.

The differences in socioeconomic, cultural and institutional contexts between and within countries translate into very different conditions in terms of the supply and demand for preschool education in Latin America. In addition, it is not at all clear to what extent inequalities in access may undermine equality of educational opportunities over a person's lifetime, since, at the regional level, the empirical literature on the influence exerted by early education on later learning is quite scant.

This article aims to illustrate the degree of equity in access to preschool education and to evaluate the way in which this affects academic achievement in the medium term. Our empirical strategy involves quantifying the performance differentials at the secondary level — conditional on a series of control variables— between students who attended preschool and those who did not. The objective is not only to gauge the size of these differentials in the Latin American countries but also to compare them.

Achievement levels are measured using students' scores on the tests administered by the Programme for International Student Assessment (PISA) of the Organization for Economic Cooperation and Development (OECD). This information is drawn from the 2009 and 2012 rounds for the seven Latin American countries that participated in both series of examinations: Argentina, Brazil, Chile, Colombia, Mexico, Peru and Uruguay.²

In order to identify the benefits of preschool attendance, a non-parametric method developed by Ñopo (2008) is used to compare groups of students who have quite similar personal and contextual characteristics. This method allows us to estimate the performance gap —the average score differential in each domain— between students who attended preschool and students who did not and then to decompose the relevant observable and unobservable factors. This makes it possible to determine how much of the “gross” gap can be attributed to the effect of other variables associated with access to early education and to variables associated with performance on academic examinations and then, on that basis, to calculate the “net” gap (i.e., the extent of the gap that is not associated with the influence of those factors). This type of decomposition offers the advantage, over the traditional Blinder-Oaxaca decomposition, of avoiding any bias that could be conveyed by differences in the supports for the distributions of the characteristics of the two groups.

The analysis indicates that sizeable performance gaps do indeed exist, even after controlling for a comprehensive set of factors associated with the students' family and

¹ Several terms are used to refer to this level of education in different countries based on their varying curricular and institutional objectives (Diker, 2003). In this study, the terms “preschool”, “early” and “early childhood” education are used as synonyms.

² Costa Rica also participated in the programme, but it conducted the PISA examinations for the 2009 round in 2010; it was therefore excluded from this study in order to ensure that the results are fully comparable over time.

school environments. In other words, the results suggest that early education generates a significant differential in the educational achievement of 15-year-olds. The data also indicate that spending more time in preschool yields greater future benefits.

The study is structured as follows. Following this Introduction, section II provides a description of the current situation and recent trends in early education

coverage in Latin America. Section III offers an overview of the available information regarding the impact of preschool attendance on subsequent educational performance. The methodology used in this study is discussed in section IV. Section V describes the data and selected variables. Section VI outlines the study findings and lastly, section VII details the conclusions that have been reached.

II

Preschool attendance in Latin America: goals and inroads

The Educational Goals for 2021, which were adopted by the Ibero-American Conference on Education and reaffirmed in 2010, include ambitious objectives relating to early education, thus reflecting the political importance that the issue has taken on in recent years in the region. As noted by Margarita Poggi (SITEAL, 2013), however, interest in this subject has been growing over the course of several decades.

Historically, the delivery of childcare services was irregular and primarily channelled through private, welfare-based programmes. Then, in the 1960s and 1970s, these services began to be regulated, and greater efforts were made by the State to expand childcare services while placing greater emphasis on their pedagogic aspects (Diker, 2003). The implementation of ongoing comprehensive programmes during that period paved the way for considerable progress in expanding access to such services, responding in part to demand pressure generated by women's entry into the labour market.

It was not until the 1990s, however, that the universalization of at least the final year of preschool spread as a goal throughout Latin America (Albergucci, 2006), which increased the supply of early childhood services and preschool enrolment significantly. In general, school attendance is now mandatory from the age of 5 onward—as is the case in Colombia, for example—although in some countries mandatory attendance begins at the age of 4 (Argentina, Uruguay and Brazil) or even at the age of 3 (Mexico and Peru). In Chile, on the other hand, attendance is not compulsory until children begin first grade (SITEAL, 2009). Generally speaking, the laws on compulsory education continue to focus on the age groups immediately preceding entry into the primary

education cycle, thereby leaving aside the child population between the ages of 0 and 3 (Ministry of Education of Brazil, 2013).

These initiatives have fostered a steady increase in educational coverage for children between the ages of 3 and 5. According to information drawn from the Socio-Economic Database for Latin America and the Caribbean (SEDLAC), in the early years of this decade, approximately 70% of children in this age group were attending school in the seven countries covered by this study, with a somewhat lower figure being recorded for Colombia (52%). In the past 20 years, an increase in attendance of nearly 10% has been achieved in Mexico, for example, but the expansion has been greater than 100% in countries such as Argentina and Chile.

The existence of a diverse array of formal and informal programmes and the lack of sufficient information have interfered with efforts to implement policies designed to improve the quality of preschool education. It is often the case that the conditions under which initiatives are developed in terms of physical, human and pedagogical resources result in limited and poorly targeted outcomes (Cordero, 2004; SITEAL, 2009). In fact, the evidence points to a failure to attract highly qualified human capital to this sector, largely because of the low wages received by preschool teachers (Mizala and Ñopo, 2012).

Sharp differences in access continue to be linked to socioeconomic status and area of residence in the region. Table 1 shows the attendance rates for different groups of 5-year-olds around the year 2000—which is approximately when the students who participated in the 2009 or 2012 PISA examinations were that age—and around 2011.

TABLE 1

**Gross school enrolment rates, by related factors, for children
5 years of age, 2000 and 2011**
(Percentages)

	Gender		Learning environment in the home ^a			Per capita household income ^b			Area	
	Female	Male	Low	Intermediate	High	Low	Middle	High	Rural	Urban
Around 2000										
Argentina	73.6	73.8	64.3	72.9	81.3	70.8	80.6	86.9	...	73.7
Brazil	66.9	65.0	57.4	70.3	85.3	62.1	74.9	87.9	48.3	70.1
Chile	70.6	73.0	52.3	69.1	82.0	70.9	76.9	86.3	45.1	76.4
Colombia	...	...	...	...	...	...	...	...	...	...
Mexico	85.0	85.5	71.0	91.0	97.8	83.1	93.4	93.3	76.6	88.6
Peru	70.6	79.4	61.2	80.2	93.4	74.6	78.1	94.3	66.1	80.9
Uruguay	91.9	91.8	89.0	91.1	97.1	90.0	92.5	99.0	...	91.9
Around 2011										
Argentina	93.5	93.7	76.3	93.1	97.1	92.0	94.9	98.5	...	93.6
Brazil	87.3	85.9	80.7	88.7	94.5	84.8	91.4	95.4	78.8	88.3
Chile	86.9	87.0	89.7	94.1	94.3	93.1	97.7	95.2	88.3	94.8
Colombia	92.8	94.9	79.6	89.3	98.6	89.9	90.0	93.7	73.4	90.7
Mexico	97.3	98.6	89.8	97.5	99.7	95.4	98.6	99.5	93.9	97.3
Peru	91.0	92.0	80.6	92.8	99.0	94.2	94.7	99.4	79.5	95.7
Uruguay	96.8	95.8	93.3	96.6	96.3	95.4	96.1	97.4	98.3	96.0

Source: Organization for Economic Cooperation and Development (OECD), *PISA 2012 Results: What Students Know and Can Do: Student Performance in Mathematics, Reading and Science (Volume 1)*, Paris, OECD Publishing, 2014; and *PISA 2012 Results: What Students Know and Can Do: Student Performance in Mathematics, Reading and Science (Volume 1)*, Paris, OECD Publishing, 2014.

^a Average years of education of household members aged 18 or over: Low: Fewer than 6 years; Intermediate: 6-12 years; High: 12 years or more.

^b Low: Households with incomes in the bottom 30% of the distribution; Middle: Households with incomes in the thirtieth to sixtieth percentiles; High: Households with incomes in the top 40% of the distribution.

During both periods, the cultural capital of the students' families, measured in terms of the learning environment in the home, was of pivotal importance in determining school enrolment. While significant inroads have been made since the start of this century, large attendance differentials associated with the educational level of household members continue to exist, and this is especially true in Argentina, Colombia and Peru. A similar, if somewhat less marked, trend is observed in relation to per capita household income, showing Brazil with the largest gaps.

Place of residence has historically been a significant factor, since 5-year-olds in rural areas tend to have lower school attendance rates. This is mainly due to the more limited supply of educational services in many rural areas, although socioeconomic and cultural factors also come into play. Coverage has certainly improved in rural areas during the period under study, but access continues to be more limited in

rural zones, especially in the cases of Colombia, Peru and Brazil.

There does not appear to be a gender bias in preschool attendance, as the differentials between boys and girls are quite small, with the rates for girls being slightly higher in some cases and the rates for boys being slightly higher in others.

In sum, the expansion of early education coverage in recent decades has been driven mainly by the introduction of new laws in Latin America, yet the persistence of segregation in terms of access shows that the impacts of legislative initiatives and policy commitments are constrained by existing social and economic inequalities. As things now stand, there are three major challenges to be met: (i) incorporating younger children (those between 0 and 4 years of age) into early education; (ii) raising attendance rates among children in vulnerable social sectors and children residing in rural areas, and (iii) improving and assessing the quality of the educational services being offered.

III

Recent evidence and a survey of the literature

Access to early education is one of a child's fundamental rights, but it is also a means of establishing a first link with the school system. During the first years of life, children develop the main cognitive and non-cognitive skills that will influence their academic performance (Glewwe and Jacoby, 1995; Burchinal and others, 1997; Currie, 2001; Berhman, Cheng and Todd, 2004; Barnett and Lamy, 2006; Cunha and others, 2006; Nores and Barnett, 2010; Skibbe and others, 2011; and Hazarika and Viren, 2013). The impact of early education may vary in the short and long terms owing to variations in the quality of the corresponding programmes. Ultimately, therefore, the main obstacle to be overcome in analysing the types of effects associated with preschool attendance has to do with the available information on the quality of instruction.³

An examination of the literature shows that a number of different methodologies analyse the influence exerted by early education. Employing a meta-analysis to synthesize the various studies' findings, Camilli and others (2010) find that early childhood education has an immediate effect equivalent to approximately 0.50 standard deviations in terms of cognitive development,

which equates with an increase from the thirtieth percentile to the fiftieth percentile on standardized achievement tests. The social and emotional effects were smaller but still significant (0.33 standard deviations). These findings provide support for the argument advanced by Heckman (2000 and 2008), who maintains that the biggest gains in investment in education are realized during the first years of life.

A particularly notable study conducted by Arteaga and others (2014), who used inverse propensity score weighting to analyse data for a cohort of 1,500 students in the Chicago Longitudinal Study who were enrolled in the 1980s, shows that children who had attended a preschool programme for two years were less likely to require special education assistance and less likely to commit crimes later on in life than those who had attended preschool for just one year. These findings strengthen the evidence on the beneficial long-term effects of preschool attendance for longer periods of time. Magnuson, Ruhm and Waldfogel (2007a and 2007b) use data from the Early Childhood Longitudinal Study to analyse the effect of preschool attendance on children's academic skills. They find that those who attended such programmes had stronger reading and mathematics skills when they started school (0.18-0.12 deviations) —although those effects tended to dissipate during the first year— but that they also had a greater tendency to exhibit behavioural problems that persisted for some time after school entry. These authors do not provide any evidence of causation, however, and their conclusions should therefore be viewed with caution.

³ The kind of information needed in order to evaluate the quality of these programmes is generally unavailable in Latin American countries. This is not the case in developed countries such as the United States, where data on programmes such as State Pre-K, Head Start and Preschool Special Education make it possible to track the progress of complete cohorts while controlling for unobservable factors.

IV

Methodology

In this study we use a methodology based on the non-parametric approach devised by Ñopo (2008). As well as allowing us to quantify the existing gap in terms of the outcome variable (for example, PISA scores), this method yields a decomposition based on the characteristics of the target populations that are being compared. In the absence of an experimental or

quasi-experimental design, a methodology based on the generation of counterfactuals reduces possible biases, but the results must be interpreted with caution, since there are observable and unobservable factors (such as the quality of preschool programmes or changes in the faculty) that may influence them. This method reduces the bias generated by unobservables but it does not have

the scope that an experimental exercise using a random sample would, and a causal effect, in a strict sense, can therefore not be identified. Unlike propensity score matching systems, this approach matches up individuals based on certain characteristics rather than their scores.

Let Y represent the score obtained by a student on a test as a function of a vector of characteristics X . The expected score for a student, conditional on his or her characteristics and the fact that the student had attended preschool (P), would be given by $E[Y|P, X] = g^P(x)$, while the expected score for students who had not attended preschool (NP) will be $E[Y|NP, X] = g^{NP}(x)$. Thus, the performance gap between those who attended preschool and those who did not (the score differential) will be given by equation (1):

$$\Delta = E[Y|P, X] - E[Y|NP, X] \tag{1}$$

Assuming that $F^P(\cdot)$ and $F^{NP}(\cdot)$ represent the conditional distribution functions of individual characteristics X and that they are functions that extend from vector space R^n to R , it is possible to define the probability measure over the support of distribution S in $dF^P(\cdot)$ and $dF^{NP}(\cdot)$ as:

$$\mu^P(S) = \int_S dF^P(x)$$

$$\mu^{NP}(S) = \int_S dF^{NP}(x)$$

Bearing these two expressions in mind and substituting them in equation (1), we obtain:

$$\Delta = \int_{S^P} g^P(x) dF^P(x) - \int_{S^{NP}} g^{NP}(x) dF^{NP}(x) \tag{2}$$

The main challenge in obtaining the unbiased score differential stems from the fact that the support of the distributions of the characteristics may be different⁴ and therefore they have to be made comparable. To this end, Ñopo (2008) proposes splitting each integral

into two parts: one on the intersection of the supports (the common support) and the other out of this support. This step consists of replacing S^P with $S^P \cap S^{NP}$ and $\overline{S^{NP}} \cap S^P$ and doing the same thing for S^{NP} .

$$\Delta = \left[\int_{\overline{S^{NP}} \cap S^P} g^P(x) dF^P(x) + \int_{S^{NP} \cap S^P} g^P(x) dF^P(x) \right] - \left[\int_{S^{NP} \cap S^P} g^{NP}(x) dF^{NP}(x) + \int_{S^{NP} \cap \overline{S^P}} g^{NP}(x) dF^{NP}(x) \right] \tag{3}$$

In addition, given that $dF^P(\cdot)$ y $dF^{NP}(\cdot)$ are by definition null values out of the support, the domain of the integrals extends to $\overline{S^P}$ and $\overline{S^{NP}}$. By replacing $\mu^{NP}(S^P)$ with $1 - \mu^{NP}(\overline{S^P})$ and $\mu^P(S^{NP})$ with $1 - \mu^P(\overline{S^{NP}})$, we obtain an expression that can be used to decompose the total gap. The final step is to add and take away the necessary element in order to be able to evaluate the counterfactual, i.e., the score that the student who did not attend preschool would have obtained if he or she had actually done so.

The total expression is therefore:

$$\Delta = \left[\int_{\overline{S^{NP}}} g^P(x) \frac{dF^P(x)}{\mu^P(\overline{S^{NP}})} - \int_{S^{NP}} g^P(x) \frac{dF^P(x)}{\mu^P(S^{NP})} \right] \mu^P(S^{NP}) + \int_{S^P \cap S^{NP}} g^P(x) \left[\frac{dF^P(x)}{\mu^{NP}(S^{NP})} - \frac{dF^{NP}(x)}{\mu^{NP}(S^P)} \right] (x) + \int_{S^P \cap S^{NP}} [g^P(x) - g^{NP}(x)] \frac{dF^{NP}(x)}{\mu^{NP}(S^P)} + \left[\int_{S^P} g^{NP}(x) \frac{dF^{NP}(x)}{\mu^{NP}(S^P)} - \int_{\overline{S^P}} g^{NP}(x) \frac{dF^{NP}(x)}{\mu^{NP}(\overline{S^P})} \right] \mu^P(\overline{S^{NP}}) \tag{4}$$

Bearing each of these terms in mind, we have:

$$\Delta_p = \left[\int_{\overline{S^{NP}}} g^P(x) \frac{dF^P(x)}{\mu^P(\overline{S^{NP}})} - \int_{S^{NP}} g^P(x) \frac{dF^P(x)}{\mu^P(S^{NP})} \right] \mu^P(S^{NP}) \tag{5}$$

Δ_p is the part of the gap that derives from differences in the characteristics of two groups of students who attended preschool: those who are in and those who

⁴ In other words, there may be students who attended preschool and who have values for a given characteristic X , such as the parents' level of education, for which there is no match in the group of students who did not attend preschool, and vice versa.

are out of the common support (that is, those whose characteristics can be matched up with those in the *NP* group and those whose characteristics cannot be matched up).⁵

The second term, Δ_x , is the portion of the total gap between those who attended preschool and those who did not that can be explained by differences in the distribution of the characteristics of the population that is in the common support. Formally, this portion will be:

$$\Delta_x = \int_{S^P \cap S^{NP}} g^P(x) \left[\frac{dF^P(x)}{\mu^{NP}(S^{NP})} - \frac{dF^{NP}(x)}{\mu^{NP}(S^P)} \right] (x) \quad (6)$$

The third term of equation (4), Δ_0 , is defined over the common support—which contains the students from the two populations that are being compared—and is of the greatest interest for this study. As in the case of a traditional Blinder-Oaxaca decomposition, Δ_0 (defined in equation (7)), this is the portion of the score differential that cannot be accounted for by differences in the observable characteristics of the students who did and did not attend preschool. In other words, this is the portion of the score differential that remains when the two groups *P* and *NP* are compared, taking into account those persons who have very similar values for a series of attributes *X*, and to which it is therefore possible to attribute the actual effect of having attended preschool, along with any remaining unobservables (level of effort, genetic factors, physical condition, faculty changes, quality of the education received and so forth).

$$\Delta_0 = \int_{S^P \cap S^{NP}} [g^P(x) - g^{NP}(x)] \frac{dF^{NP}(x)}{\mu^{NP}(S^P)} \quad (7)$$

The last term, Δ_{NP} , accounts for the differences in the characteristics of the two groups of students who did not attend preschool: Those who can be matched up with students who did attend preschool and those who cannot.

$$\Delta_{NP} = \left[\int_{S^P} g^{NP}(x) \frac{dF^{NP}(x)}{\mu^{NP}(S^P)} - \int_{S^P} g^{NP}(x) \frac{dF^{NP}(x)}{\mu^{NP}(S^P)} \right] \mu^P(S^{NP}) \quad (8)$$

⁵ Δ_p would be zero (0) if all the students who attended preschool could be matched up with students who did not. For further information about this method, see Nopo (2008).

Bearing these definitions in mind and rearranging the terms to represent the portion of the gap that is explained by the method and the portion associated with unobservables, the aggregate or gross gap is as follows:

$$\Delta = (\Delta_P + \Delta_x + \Delta_{NP}) + \Delta_0 \quad (9)$$

A five-step matching algorithm underlies the empirical procedure used in order to arrive at this decomposition. This algorithm is designed to compare individuals who attended preschool and ones who did not but whose observable characteristics are as alike as possible.

First of all, a student in the comparison group of people who attended preschool (*P*) and who is taking the PISA exam is selected at random. Then, all the individuals who did not attend preschool but who are similar to the student chosen in the first step, because they share a given characteristic with that student, are selected. The third step is to create a synthetic individual (*NP*) based on the sample of people who did not attend preschool; this individual has a performance equivalent to the average score obtained by all individuals in that sample on the corresponding PISA test (mathematics or reading). When a student who attended preschool and another who did not do so exhibit similar characteristics, they are matched up. In the final step, this process is repeated for all the other students who attended preschool so that each of them is matched with a synthetic individual for purposes of comparison. This last step is done with replacement, thereby avoiding order-based biases. The matched sample is then used to find the average differential in the expected score and hence the outcome gap.

The main advantage of this methodology over the traditional Blinder-Oaxaca decomposition (Blinder, 1973; Oaxaca, 1973) is that it takes into account the differences in the supports of the distributions of attributes *X*, thereby avoiding possible biases in the estimation of the gap between the two groups. This estimate is not conditional on a specific functional form, with all the requirements that this imposes on the variables in question.

There is also a drawback to this method, however. On the one hand, a comparison of students who attended preschool and students who did not will be more accurate if the set of variables used in the matching exercise is larger. Yet, on the other hand, if a large number of attributes *X* are used, then, given the size of the sample, the number of students used to create the synthetic individual will be smaller and the result

may therefore be less reliable. In other words, there is a trade-off between the two objectives, and the control variables therefore need to be chosen carefully in order to end up with a small but highly informative set. Given this limitation, no direct reference to a causal effect of preschool education can be made. In order to be as sure as possible that the results have not been skewed

by sample biases, a simulation exercise was undertaken in order to assess the significance of the size of the performance gaps.⁶

⁶ The bootstrapping exercise used 200 random subsamples corresponding to 95% of the original sample.

V

Data and variables

The PISA test evaluates 15-year-olds who are in grade seven or above. The programme's sample is arrived at using a two-step process: first, a stratified sample of schools is obtained and, then, a group of students in each school is randomly selected. This design ensures that the sample will be representative of the target population in each country, although the coverage will vary. For the participating Latin American countries, the coverage of the sample of students—once it has been weighted appropriately—ranges from 58.5% of the total population of 15-year-olds as of 2009 (Colombia) to 85.2% (Chile) (OECD, 2012 and 2014).

PISA tests in mathematics, science and reading have been administered once every three years since the year 2000, with the primary focus shifting from one to the other of these domains on a rotational basis (with each one being referred to as a “wave”). In addition, supplementary questionnaires are filled out by students and school administrators that supply information about the personal and family situations of the students and about the various schools' characteristics (Adams and Wu, 2002).

These data can be used to construct the *Preschool variable*, which signals whether the student: (i) never attended preschool; (ii) attended preschool for one year or less, or (iii) attended preschool for more than one year. Preschool access for persons in the sample clearly

differed across countries, with access being greater in Argentina, Mexico and Uruguay (see table 2).⁷

The performance gaps are measured using the PISA reported “plausible values,” which represent the range of skills that a student may have in the various subject areas and are comparable across countries and years. The 2009 and 2012 rounds were selected for this study because information on preschool attendance was not compiled in earlier rounds. The mathematics and reading tests were chosen because the programme waves for those years were focused on these subject areas.

A comparison of the PISA test scores using the *Preschool variable* with no controls reveals a positive correlation between early education—and its duration—and academic performance at the secondary education level in all the countries (see table 3). The margin by which students who had attended preschool for more than one year out-performed the group of students who did not was generally greater in Argentina, Uruguay and Peru, both in 2009 and in 2012. At the other extreme, the countries with the smallest average differentials were Chile, in 2009, and Colombia, in 2012.

⁷ Since the PISA tests are administered only to young people who are in secondary education and are close to the appropriate grade level, the results for the sample overestimate the actual attendance rate for the total population.

TABLE 2

Description of the preschool variable, 2009 and 2012
(Percentages)

	2009				2012			
	Valid values			Lost or missing values	Valid values			Lost or missing values
	Did not attend	Attendance ≤ 1 year	Attendance > 1 year		Did not attend	Attendance ≤ 1 year	Attendance > 1 year	
Argentina	4.7	29.1	66.2	2.6	6.2	22.6	71.2	2.3
Brazil	21.3	33.4	45.3	6.8	19.1	33.6	47.3	3.5
Chile	15.0	52.8	33.2	3.5	9.2	56.5	34.3	2.3
Colombia	18.5	53.3	28.2	1.6	14.2	52.4	33.3	1.7
Mexico	10.3	19.5	70.2	1.5	9.5	18.7	71.8	1.1
Peru	15.1	26.3	58.6	7.3	13.8	25.0	61.2	2.9
Uruguay	12.8	15.9	71.3	2.9	16.2	14.1	66.7	4.3
Total	15.7	31.7	52.6	4.4	14.1	31.0	54.9	2.5

Source: Organization for Economic Cooperation and Development (OECD), *PISA 2012 Results: What Students Know and Can Do: Student Performance in Mathematics, Reading and Science (Volume 1)*, Paris, OECD Publishing, 2014; and *PISA 2012 Results: What Students Know and Can Do: Student Performance in Mathematics, Reading and Science (Volume 1)*, Paris, OECD Publishing, 2014.

TABLE 3

Average PISA test scores, total and by category of preschool variable, 2009 and 2012

	Argentina	Brazil	Chile	Colombia	Mexico	Peru	Uruguay
	2009						
Mathematics							
Total	388.1 (0.74)	385.8 (0.82)	421.1 (0.69)	380.8 (0.82)	418.5 (0.42)	365.1 (1.27)	426.7 (1.07)
Did not attend	334.7 (2.21)	358.0 (0.93)	392.9 (1.56)	349.2 (1.23)	375.1 (0.91)	335.7 (2.03)	373.1 (2.13)
Attendance ≤ 1 year	369.6 (0.87)	386.4 (1.13)	419.9 (0.83)	386.1 (1.42)	416.2 (0.82)	363.7 (2.12)	410.8 (2.05)
Attendance > 1 year	403.3 (1.06)	407.8 (0.97)	441.2 (1.23)	394.5 (1.02)	426.9 (0.33)	383.5 (1.06)	442.8 (1.15)
Reading							
Total	398.3 (0.99)	411.7 (0.55)	449.4 (0.83)	413.2 (0.55)	425.3 (0.65)	369.7 (0.95)	425.8 (0.61)
Did not attend	331.5 (4.02)	378.9 (0.78)	418.5 (1.50)	380.1 (1.04)	378.2 (1.24)	336.9 (1.78)	368.4 (1.33)
Attendance ≤ 1 year	379.1 (1.41)	414.1 (1.16)	452.4 (1.19)	418.8 (0.87)	424.2 (0.91)	367.8 (1.41)	404.7 (1.23)
Attendance > 1 year	415.7 (1.21)	438.7 (0.57)	465.3 (1.02)	428.7 (1.36)	434.2 (0.55)	391.5 (0.98)	444.5 (0.85)
	2012						
Mathematics							
Total	388.4 (1.16)	388.5 (0.66)	422.6 (0.69)	376.5 (0.40)	413.3 (0.33)	358.1 (0.71)	409.3 (0.45)
Did not attend	337.2 (2.25)	365.6 (0.74)	381.4 (2.54)	350.5 (1.01)	378.0 (0.99)	327.5 (1.60)	369.7 (0.73)
Attendance ≤ 1 year	365.8 (1.44)	382.7 (0.69)	422.6 (0.76)	379.5 (0.94)	411.2 (0.45)	360.4 (1.46)	389.9 (1.07)
Attendance > 1 year	402.8 (1.28)	404.9 (0.91)	435.7 (0.90)	384.8 (1.08)	419.3 (0.38)	383.6 (0.81)	426.3 (0.77)
Reading							
Total	395.9 (1.24)	406.5 (0.62)	441.4 (0.71)	403.4 (0.44)	423.5 (0.42)	384.1 (1.11)	411.3 (0.55)
Did not attend	336.7 (3.11)	378.9 (1.04)	401.4 (2.97)	374.4 (1.63)	383.3 (1.27)	342.1 (2.07)	367.7 (1.82)
Attendance ≤ 1 year	372.7 (1.94)	400.9 (0.83)	442.6 (0.69)	406.6 (0.30)	422.4 (0.68)	374.4 (2.14)	396.1 (1.46)
Attendance > 1 year	411.9 (1.26)	425.9 (0.88)	452.5 (1.10)	413.5 (1.16)	430.2 (0.48)	401.8 (1.11)	430.2 (0.56)

Source: Organization for Economic Cooperation and Development (OECD), *PISA 2012 Results: What Students Know and Can Do: Student Performance in Mathematics, Reading and Science (Volume 1)*, Paris, OECD Publishing, 2014; and *PISA 2012 Results: What Students Know and Can Do: Student Performance in Mathematics, Reading and Science (Volume 1)*, Paris, OECD Publishing, 2014.

Note: The mean differences between the categories “Attendance ≤ 1 year” and “Did not attend” and between “Attendance > 1 year” and “Did not attend” are statistically significant at 1% in all cases; the standard errors for the estimates are shown in brackets.

In view of the fact that the differentials are determined by personal and contextual factors linked both to preschool access and secondary-school performance (which are, generally speaking, beyond an individual's control), the following control factors are used in the matching process:^{8,9}

- Individual characteristics:

Nuclear family: this variable (denoted as 1 if the student lives with both parents and 0 otherwise) may be related to cognitive achievements (Calero and others, 2007; Krüger, 2013) and non-cognitive ones (Krüger, Formichella and Lekuona, 2015). In a number of countries, there was a greater likelihood of preschool attendance for students from nuclear families.¹⁰

In order to control for the families' socioeconomic level, the PISA index for economic, social and cultural status is used. This index synthesizes information on three main aspects of the household: the highest level of education attained by both parents; the highest occupational ranking; and access to wealth and to cultural and educational assets (OECD, 2012). All these factors are significantly related to prospects for scholastic success (Krüger, 2013), and they also appear to be significant determinants of access to early education and continued preschool attendance.

- School characteristics:

Public school: students attending private schools generally perform better on standardized tests. It is not clear, however, that their stronger performance is specifically attributable to the type of school management; in fact,

it seems more likely that test performance is associated with the types of student populations in these two kinds of educational establishments (Formichella and Krüger, 2013). This variable is included to represent a wide range of school- and family-related factors that could influence students' performance and could also have had a significant impact on their earlier educational path.

Urban location: access to preschool is usually associated with a person's area of residence, as can be observed from an analysis of the PISA sample. This is also a proxy for the availability of physical and human resources, which tend to be more abundant and of better quality in urban areas.

Average score of peers: this last variable is used in an attempt to capture qualitative differences between schools. Given the possibility that families that decide—or are able—to send their children to preschool may then be able to send them to better secondary schools, it is necessary to control for this factor in order to avoid erroneously attributing this effect to preschool attendance. The quality of the school attended by a given student is approximated by computing the average score on the PISA mathematics or reading test obtained by that student's classmates. This score ought to reflect both the influence exerted by classmates' academic level and the correlation between the school's practices and resources and the student's own test performance. Given the methodology used, this variable is expressed in quintiles.

There are two drawbacks associated with the use of this database. First, no information is available on the type of preschool or primary school that was attended. Second, there is a selection problem in that students (whether they attended preschool or not) who dropped out before reaching 15 years of age, or who are in a grade below seventh grade, are excluded from the sample. If preschool attendance also influences the progress or completion of a student's education, then the assessment of PISA score differentials will be underestimating the total effect on academic attainment, and this point needs to be stated explicitly.

⁸ While gender is often regarded as a possible determinant of academic achievement, it has been omitted here because prior estimates indicate that it is not an explanatory variable for preschool access.

⁹ The description is available upon request.

¹⁰ The database includes observations with missing data which, in the case of the controls that were used here, tend to predominate in the *nuclear family* variable. However, when a number of simulations were run with and without this variable, the results were statistically equivalent. Full information on these simulations may be obtained from the authors.

VI

Findings

This analysis of the PISA sample indicates that 15-year-olds in the region have had differentiated access to early education as a function of socioeconomic status (with the assumption that their socioeconomic level is similar

to what it was during their early childhood). Those who attended preschool for one year or more are more likely to belong to a family in a high-status socioeconomic group, followed by those who attended for one year or less. In

addition, preschool attendance and the duration of that attendance are positively associated with residence in an urban area and with attendance at a private school, or a better-quality school, as reflected by the average score of students' classmates.

These influences are reflected in a reduction in the size of the common support and in an increase in the explained component of the performance gap (Δ_x) as more and more matching variables are added. The analysis of the individual effect of each control shows that average peer scores explain more than 50% of the gap, with this impact being stronger in 2012; the inclusion of the families' socioeconomic level (SEL) explains more than 30%. The public/private school variable alone appears to explain between 15% and 30% of the gap except in Mexico. Location is a significant factor in Peru, Colombia and Mexico but is less influential in the rest of the region. Finally, family structure is the least influential factor, accounting for less than 10% of the initial difference in most cases, although it had a considerably greater impact in 2012 than it did in 2009.¹¹

The coefficients of greatest interest are the gross performance gap (Δ , equation (1)) and the unexplained portion (Δ_0 , equation (7)) (see tables 4 and 5). A reading of the estimates in each area involves two components: the first reflects the gross score gap—the average difference between groups—while the second includes the controls, which start with location and then incorporate the other factors one by one. The average performance gap between students who had attended preschool for less than one year and those who had not is 9.9% for 2009 and 7.8% for 2012, with the unexplained difference amounting to 3.5% and 2.3%, respectively (coefficient “+mean peer score” in tables 4 and 5, second-to-last row).

The estimated gross performance gaps are noteworthy in all the countries: on average, students who had attended preschool out-performed those who had not done so on the PISA tests by between 4% and 26%, depending on the year, country and number of years of preschool attendance (greater exposure to educational experiences). The longer the student was exposed to early education, the greater the gap.

After controlling for all the various family and school characteristics, the unexplained portions of the gaps continue to be positive and, in many cases, substantial. Taking all seven countries as a group, the largest gap between those who attended more than one year of preschool and those who did not was in reading (4.2%)

in 2009, while the smallest gap between the results for those two groups was in mathematics (1.9%) in 2012. At the individual level, these gaps (Δ_0 , equation (7)) range between 0.1% and 11% of the scores, with students who had attended preschool achieving the higher score in each case.

The portion of the gross gap that remains unexplained after all the controls have been applied (Δ_0/Δ) averages 30%. The percentage is smaller for preschool attendance lasting more than one year, which indicates that the socioeconomic factors that have been considered are more significant determinants of access when the amount of time spent in school exceeds the mandatory period of attendance.

Substantial differences are found between countries in terms of both the initial size of the gaps and their size after matching. An examination of the gross score differentials indicates that Argentina is generally the country in which students who had access to early education have the greatest advantage. For 2009, it is followed by Uruguay and Mexico, while Chile has the smallest performance gaps. For 2012, Uruguay and Chile have the largest gaps after Argentina, while Colombia and Brazil have the smallest. In other words, apart from Argentina, no set pattern is apparent when comparing the various countries' gross performance differentials.

The net gap, i.e., the portion of the gap that remains unexplained after all the control variables have been applied, is the largest in Argentina and Uruguay for both periods. For example, 10.6% of the score gap in reading in Argentina in 2012 between those who attended preschool for over a year and those who did not must be accounted for by other factors. This difference of approximately 36 points is certainly significant, since it represents 9% of the average score of all PISA participants in the country and is equivalent to nearly one half of its standard deviation.

At the other extreme, Chile, Colombia and, in some cases, Peru display the smallest differentials. For example, for 2009, Chile had the narrowest gap (1.6%) in mathematics between the scores of students who had attended preschool for one year or less and those of other students. This amounts to some six points, or approximately 1.5% of the average score of students in that country on the mathematics tests. These differences in the unexplained portions of these gaps point to the existence of heterogeneous unobservable effects that are resulting in differing sizes of final performance gaps in terms of future cognitive results.

As for the extent of exposure to “treatment” (one year or less as compared to more than one year in early

¹¹ These calculations may be obtained from the authors.

TABLE 4

Decomposition of PISA score gaps, 2009
(Percentages)

“Attended preschool for over 1 year” compared with “Did not attend preschool”								
	All countries	Argentina	Brazil	Chile	Colombia	Mexico	Peru	Uruguay
Mathematics								
Δ (gross gap)	15.0 (0.05)	20.5 (0.59)	13.9 (0.15)	12.3 (0.19)	13.0 (0.24)	13.8 (0.13)	14.2 (0.24)	18.7 (0.23)
Δ_0 (net gap)								
Controls								
Urban location	13.2	18.7	12.7	11.0	9.6	11.9	8.4	17.1
+Public school	11.3	15.0	8.9	8.8	7.6	11.6	7.5	14.3
+Nuclear family	10.7	14.9	8.5	8.8	7.1	10.9	7.4	13.2
+Household SEL	7.8	9.9	6.4	4.0	2.6	8.2	4.6	9.2
+Mean peer score	3.9 (0.04)	6.1 (0.45)	4.6 (0.14)	3.6 (0.21)	1.5 (0.26)	5.1 (0.11)	3.0 (0.19)	6.9 (0.20)
Reading								
Δ (gross gap)	14.5 (0.06)	25.4 (0.77)	15.8 (0.16)	11.2 (0.19)	12.8 (0.26)	14.8 (0.17)	16.2 (0.28)	20.6 (0.28)
Δ_0 (net gap)								
Controls								
Urban location	12.7	23.3	14.4	10.0	9.3	12.7	10.0	18.8
+Public school	10.7	18.7	10.8	7.8	7.3	12.4	9.1	15.9
+Nuclear family	10.2	18.7	10.4	7.6	6.8	11.7	9.1	14.8
+Household SEL	7.1	13.5	7.9	3.2	2.1	8.7	5.9	10.6
+Mean peer score	4.2 (0.05)	7.9 (0.53)	5.8 (0.15)	2.9 (0.21)	1.5 (0.25)	4.9 (0.13)	3.6 (0.21)	8.6 (0.21)
“Attended preschool for over 1 year” compared with “Did not attend preschool”								
	All countries	Argentina	Brazil	Chile	Colombia	Mexico	Peru	Uruguay
Mathematics								
Δ (gross gap)	8.9 (0.05)	10.4 (0.53)	7.9 (0.15)	6.9 (0.16)	10.6 (0.20)	10.9 (0.14)	8.3 (0.26)	10.1 (0.29)
Δ_0 (net gap)								
Controls								
Urban location	8.2	9.5	7.6	6.2	9.3	9.4	5.8	9.8
+Public school	7.1	9.6	6.1	4.9	8.6	9.4	5.4	9.4
+Nuclear family	6.6	9.5	5.4	4.7	8.1	8.6	5.4	8.4
+Household SEL	5.2	8.4	4.6	2.6	5.8	7.9	3.3	7.7
+Mean peer score	3.1 (0.04)	7.5 (0.46)	2.8 (0.12)	1.6 (0.16)	4.6 (0.21)	4.2 (0.12)	2.1 (0.23)	6.5 (0.28)
Reading								
Δ (gross gap)	9.9 (0.06)	14.3 (0.75)	9.3 (0.15)	8.1 (0.17)	10.2 (0.26)	12.2 (0.17)	9.2 (0.32)	9.9 (0.34)
Δ_0 (Net gap)								
Controls								
Urban location	9.1	13.1	8.9	7.5	8.6	10.3	6.3	9.5
+Public school	8.0	13.2	7.5	6.0	7.9	10.3	5.8	9.1
+Nuclear family	7.4	13.2	6.9	5.8	7.4	9.4	5.8	8.0
+Household SEL	5.9	12.1	6.0	4.0	5.2	8.5	3.3	7.5
+Mean peer score	3.5 (0.05)	7.9 (0.59)	4.0 (0.13)	3.1 (0.18)	3.3 (0.24)	3.9 (0.15)	1.3 (0.24)	6.5 (0.30)
N (number of students)	88 683 (7.7)	4 774 (4.6)	20 127 (9.0)	5 669 (13.2)	7 921 (9.1)	38 250 (7.2)	5 985 (1.9)	5 957 (3.7)

Source: Prepared by the authors, on the basis of Organization for Economic Cooperation and Development (OECD), *PISA 2009 Technical Report*, Paris, OECD Publishing, 2012.

Note: The differences in the gross and net gaps across countries are statistically significant at 1% in all cases when using bootstrapping with 200 replications. Both for the gross gap (Δ , equation (1)) and for the final Δ_0 (the net gap after applying all the controls, equation (7)), the standard error for the gap is shown in brackets. N indicates the size of the sample; the percentage of observations lost when all the controls are included is shown in brackets. SEL stands for the socioeconomic level of the household.

TABLE 5

Decomposition of PISA score gaps, 2012
(Percentages)

“Attended preschool for over 1 year” compared with “Did not attend preschool”

	All countries	Argentina	Brazil	Chile	Colombia	Mexico	Peru	Uruguay
Mathematics								
Δ (gross gap)	12.3 (0.08)	19.5 (0.38)	10.8 (0.11)	14.2 (0.23)	9.8 (0.23)	10.9 (0.12)	17.1 (0.25)	15.3 (0.21)
Δ_0 (net gap)								
Controls								
Urban location	11.1	19.0	9.4	12.4	8.3	9.3	13.3	13.3
+Public school	9.4	16.4	7.0	9.4	6.5	8.9	10.1	10.6
+Nuclear family	8.6	15.4	6.2	8.8	6.1	8.0	9.7	9.3
+Household SEL	6.4	11.9	4.7	3.0	2.3	6.0	5.8	6.9
+Mean peer score	3.3 (0.06)	8.1 (0.33)	3.1 (0.09)	0.7 (0.23)	0.9 (0.24)	3.7 (0.09)	3.8 (0.22)	4.6 (0.18)
Reading								
Δ (gross gap)	12.8 (0.08)	22.4 (0.51)	12.4 (0.15)	12.7 (0.23)	10.4 (0.27)	12.2 (0.13)	17.4 (0.23)	17.0 (0.27)
Δ_0 (net gap)								
Controls								
Urban location	11.4	21.7	11.0	10.6	8.8	10.2	12.9	14.6
+Public school	9.8	18.4	8.8	8.0	6.8	9.8	10.1	12.0
+Nuclear family	9.0	17.4	8.0	7.4	6.4	8.9	9.8	10.7
+Household SEL	6.7	14.1	6.8	2.4	2.4	6.7	5.5	8.7
+Mean peer score	3.9 (0.06)	10.6 (0.52)	4.5 (0.12)	0.6 (0.24)	0.1 (0.29)	4.7 (0.12)	2.3 (0.24)	6.6 (0.26)
“Attended preschool for over 1 year” compared with “Did not attend preschool”								
	All countries	Argentina	Brazil	Chile	Colombia	Mexico	Peru	Uruguay
Mathematics								
Δ (gross gap)	6.7 (0.08)	8.5 (0.35)	4.7 (0.12)	10.8 (0.22)	8.3 (0.21)	8.8 (0.14)	10.1 (0.24)	5.5 (0.26)
Δ_0 (net gap)								
Controls								
Urban location	6.0	8.0	4.4	10.4	7.3	7.6	7.9	4.9
+Public school	5.2	8.5	3.6	8.8	7.2	7.5	6.5	3.9
+Nuclear family	4.4	7.5	2.8	8.0	6.4	6.4	6.1	3.3
+Household SEL	3.4	6.8	2.6	4.4	4.1	5.6	3.3	2.7
+Mean peer score	1.9 (0.06)	3.2 (0.44)	0.8 (0.11)	2.6 (0.23)	2.2 (0.21)	2.9 (0.13)	1.7 (0.28)	0.68 (0.26)
Reading								
Δ (gross gap)	7.8 (0.09)	10.7 (0.44)	5.8 (0.15)	10.3 (0.21)	8.6 (0.24)	10.2 (0.14)	9.4 (0.27)	7.7 (0.32)
Δ_0 (net gap)								
Controls								
Urban location	7.0	10.1	5.5	9.5	7.4	8.6	7.0	6.9
+Public school	6.1	10.8	4.8	8.0	7.2	8.5	5.8	5.9
+Nuclear family	5.4	10.0	3.9	7.2	6.5	7.4	5.5	5.4
+Household SEL	4.5	8.7	3.2	3.8	3.9	6.6	2.8	5.0
+Mean peer score	2.3 (0.07)	7.7 (0.53)	1.3 (0.14)	2.1 (0.22)	2.7 (0.25)	4.0 (0.14)	0.15 (0.29)	3.5 (0.30)
N (number of students)	86 197 (18.9)	5 908 (20.4)	19 204 (18.1)	6 856 (14.5)	9 073 (26.5)	33 806 (19.0)	6 035 (13.6)	5 315 (18.6)

Source: Prepared by the authors, on the basis of Organization for Economic Cooperation and Development (OECD), *PISA 2009 Technical Report*, Paris, OECD Publishing, 2012.

Note: The differences in the gross and net gaps across countries are statistically significant at 1% in all cases when using bootstrapping with 200 replications. Both for the gross gap (Δ , equation (1)) and for the final Δ_0 (the net gap after applying all the controls, equation (7)), the standard error for the gap is shown in brackets. N indicates the size of the sample; the percentage of observations lost when all the controls are included is shown in brackets. SEL stands for the socioeconomic level of the household.

education), the results are as expected: the gross gaps were wider when the period of preschool attendance was longer. This could be due both to the direct effect of having been in preschool for a longer period and to the impact of the socioeconomic factors that influence both the duration of attendance in early education and performance on the PISA tests.

With the exceptions of Colombia and Chile, this ratio remains in evidence after controlling for the influence of these factors, as may be seen from the evaluation of the countries' net performance gaps (Δ_0 , equation (7)). For example, in the case of the 2012 round, taking the entire sample into consideration, students who had attended preschool for more than one year scored, on average, 3.3% higher on the mathematics examination than those who had not, while students who had attended preschool for one year or less out-performed the latter group by 1.9%. This lends strength to the argument that not only access to early education, but also the duration of preschool attendance, is important and that school entry at younger ages should therefore be encouraged.

VII

Conclusions

The situation in Latin America with respect to early education coverage and to progress in expanding that coverage in recent decades has been highly variable. A political and academic consensus on the subject has led countries to sign international agreements that have translated into a series of policies designed to open up access to early education. As a result, attendance at this level has become compulsory in most of the countries of the region since the late 1990s, and school attendance rates among younger children have therefore been on the rise.

Nevertheless, many disadvantaged children who reside in rural areas and/or come from families with a low socioeconomic level still do not have access to early education. Addressing these inequalities in access is a priority for any policy designed to attain greater equity, even though differences in access have been slowly narrowing. The analysis presented here suggests that initial estimated score differentials diminish when other selected attributes are included in the assessment. However, not all of the considered factors seem to have the same explanatory power, as the households' socioeconomic level and secondary-school quality

An examination of how the results for the two PISA rounds compare indicates that, with some exceptions, both the gross and net gaps have narrowed. This could be evidence of the fact that the increase in early education programmes seen since the late 1990s in the region (the period of time during which these cohorts were of preschool age) has helped to reduce inequalities in access. On the other hand, it could be that attendance in early education is simply having less of an impact on academic performance. In any event, since the amount of time between the two rounds was fairly short, at this point it would be ill-advised to advance hypotheses leading in either of these two directions.

Finally, a comparison of the explained and unexplained portions of the performance gaps found in the two PISA domains of interest here suggests that the effect of preschool attendance and of its associated factors is generally greater in the area of reading than it is in mathematics. This finding points to the importance of interaction with persons of the same age in the development of language skills during these stages of life.

reduce the unexplained portion of the gap more than family structure or area of residence do.

In response to the scarcity of empirical research on this subject in the region, the analysis presented here provides evidence regarding the influence exerted by early education on later academic achievement. The chief conclusion to be drawn is that, even when controlling for fundamental contextual variables, in many cases the unexplained component of these performance gaps amounts to a sizeable percentage of the total gap and therefore represents a significant score differential. This analysis cannot be described as a causal study because students were not randomly assigned to a treatment group (preschool attendance) or a control group (no preschool attendance), which would have ensured that the estimates were bias-free. This type of exercise is very expensive to conduct, and there have been no earlier initiatives that could pave the way for such an effort. Be that as it may, the controls used in this matching exercise reduced the effect of observables and unobservables that would have skewed the results. The main attributes that could condition early education access

and that, judging from the specialized literature, have an impact on academic performance at the secondary-school level have been taken into account. It should also be pointed out that, assuming that members of the more vulnerable sectors of the population are less likely to have access to early education and more likely to drop out of school, the results underestimate the size of the effect; in other words, they provide a clear indication of the type of effect but demarcate no more than the lower limit of its actual magnitude.

The findings of this study have obvious policy implications. First of all, they lend support to the argument for universalizing early education in the region and for monitoring differences in quality, especially regarding vulnerable sectors of the population. In view of the instrumental value of early education which has been analysed here, as well as its intrinsic value, it is important to pursue efforts to include children in the more vulnerable sectors of the population in the early education system and, once they have entered it, to promote their continued participation in the education system.

Second, the differences in score gaps across countries suggest that the role played by other factors

(institutional arrangements, characteristics of education markets and budget allocations) should also be analysed. The effect of preschool attendance becomes more diluted in some systems than in others as students go on to primary and then secondary school, perhaps because of major differences in the quality of the programmes offered by public and private schools. This points to the need for greater emphasis on improving, standardizing and assessing the various educational programmes on offer at this level. Finally, it was found that not only is preschool attendance important, but the duration of such attendance is influential as well. This finding is in line with the results obtained by Barnett (1995) and Reynolds (1995) and provides support for those who are calling for greater efforts and more effective policies aimed at expanding the coverage of education for children at a very young age.

In conclusion, the commitments made by the Latin American countries in this connection notwithstanding, major challenges remain to be met in order to close the gap between the aspirations embodied in recent legislation and the actual results on the ground.

Bibliography

- Adams, R. and M. Wu (eds.) (2002), *PISA 2000 Technical Report*, Paris, OECD Publishing.
- Albergucci, M. (2006), *Educación inicial. Análisis cuantitativo del nivel*, Buenos Aires, Ministry of Education, Science and Technology.
- Arteaga, I. and others (2014), "One year of preschool or two: Is it important for adult outcomes?", *Economics of Education Review*, vol. 40, Amsterdam, Elsevier.
- Barnett, S. (1995), "Long-term effects of the early childhood programs on cognitive and school outcomes", *The Future of Children*, vol. 5, No. 3, Princeton, Princeton-Brookings.
- Barnett, S. and C. Lamy (2006), *Estimated Impacts of Number of Years of Preschool Attendance on Vocabulary, Literacy and Math Skills at Kindergarten Entry*, New Brunswick, National Institute for Early Education Research.
- Berhman, J., Y. Cheng and P. Todd (2004), "Evaluating preschool programs when length of exposure to the program varies: A nonparametric approach", *The Review of Economics and Statistics*, vol. 86, No. 1, Cambridge, Massachusetts, The MIT Press.
- Blinder, A. (1973), "Wage discrimination: Reduced form and structural estimates", *The Journal of Human Resources*, vol. 7, No. 4, Madison, University of Wisconsin Press.
- Burchinal, M. and others (1997), "Early intervention and mediating processes in cognitive performance of children of low-income African-American families", *Child Development*, vol. 68, No. 5, Wiley.
- Calero, J. and others (2007), "Desigualdades socioeconómicas en el sistema educativo español", *Investigación*, No. 176, Madrid.
- Camilli, G. and others (2010), "Meta-analysis of the effects of early education interventions on cognitive and social development", *Teachers College Record*, vol. 112, No. 3, New York, Teachers College.
- Cordero, T. (2004), "Educación inicial en América Latina: Situaciones y retos. Caso panameño", *Educación*, vol. 28, No. 1, San Jose, University of Costa Rica.
- Cunha, F. and others (2006), "Interpreting the evidence on life cycle skill formation", *Handbook of the Economics of Education*, E. Hanushek and F. Welch (eds.), Amsterdam, North-Holland.
- Currie, J. (2001), "Early childhood intervention programs: What do we know?", *Journal of Economic Perspectives*, vol. 15, No. 2, Nashville, Tennessee, American Economic Association.
- Diker, G. (2003), *Organización y perspectivas de la educación inicial en Iberoamérica: Principales tendencias*, Organization of Ibero-American States for Education, Science and Culture [online] www.oei.es/linea3/diker.pdf.
- ECLAC (Economic Commission for Latin America and the Caribbean) (2008), *Social Panorama Social of Latin America 2007 (LC/G.2351-P)*, Santiago.
- Formichella, M. and N. Krüger (2013), "El fracaso escolar en el nivel medio argentino: ¿Es menos frecuente en las escuelas de gestión privada debido a su administración?", *Regional and Sectoral Economic Studies*, vol. 13, No. 3, Euro-American Association of Economic Development Studies.
- Glewwe, P. and H. Jacoby (1995), "An economic analysis of delayed primary school enrollment in a low income country: The role of early childhood nutrition", *The Review of Economics and Statistics*, vol. 77, No. 1, Cambridge, Massachusetts, The MIT Press.
- Hazarika, G. and V. Viren (2013), "The effect of early childhood developmental program attendance on future school enrollment in rural North India", *Economics of Education Review*, vol. 34, Amsterdam, Elsevier.
- Heckman, J. (2008), "Schools, skills and synapses", *NBER Working Papers*, No. 14064, Cambridge, Massachusetts, National Bureau of Economic Research (NBER).

- _____ (2000), "Policies to foster human capital", *Research in Economics*, vol. 54, No. 1, Amsterdam, Elsevier.
- Krüger, N. (2013), "Segregación social y desigualdad de logros educativos en Argentina", *Archivos analíticos de políticas educativas*, vol. 21, No. 86, Tucson, Arizona State University.
- Krüger, N., M. Formichella and A. Lekuona (2015), "Más allá de los logros cognitivos: La actitud hacia la escuela y sus determinantes en España según PISA 2009", *Revista de Educación*, vol. 367, Madrid, Ministry of Education, Culture and Sports.
- Magnuson, K., C. Ruhm and J. Waldfogel (2007a), "Does prekindergarten improve school preparation and performance?", *Economics of Education Review*, vol. 26, No. 1, Amsterdam, Elsevier.
- _____ (2007b), "The persistence of preschool effects: Do subsequent classroom experience matter?", *Early Childhood Research Quarterly*, vol. 22, No. 1, Amsterdam, Elsevier.
- Ministry of Education of Brazil (2013), *La educación infantil en los países del MERCOSUR: Un análisis comparativo de la legislación*, Brasilia.
- Mizala, A. and H. Ñopo (2012), "Evolution of teachers' salaries in Latin America at the turn of the 20th century: How much are they (under or over) paid?", *IZA Discussion Papers*, No. 6806, Bonn, Institute for the Study of Labor (IZA).
- Nores, M. and S. Barnett (2010), "Benefits of early childhood interventions across the world: (under) investing in the very young", *Economics of Education Review*, vol. 29, No. 2, Amsterdam, Elsevier.
- Ñopo, H. (2008), "Matching as a tool to decompose wage gaps", *The Review of Economics and Statistics*, vol. 90, No. 2, Cambridge, Massachusetts, The MIT Press.
- Oaxaca, R. (1973), "Male-female wage differentials in urban labor market", *International Economic Review*, vol. 14, No. 3, Wiley.
- OECD (Organization for Economic Cooperation and Development) (2014), *PISA 2012 Results: What Students Know and Can Do: Student Performance in Mathematics, Reading and Science (Volume 1)*, Paris, OECD Publishing.
- _____ (2013), *PISA 2012 Results: Ready to Learn: Students' Engagement, Drive and Self-Beliefs (Volume III)*, Paris, OECD Publishing.
- _____ (2012), *PISA 2009 Technical Report*, Paris, OECD Publishing.
- Reynolds, A. (1995), "One year of preschool intervention or two: Does it matter?", *Early Childhood Research Quarterly*, vol. 10, No. 1, Amsterdam, Elsevier.
- Ritblatt, S. and others (2001), "Are two better than one? The impact of years in head start on child outcomes, family environment, and reading at home", *Early Childhood Research Quarterly*, vol. 16, No. 4, Amsterdam, Elsevier.
- SITEAL (Information System on Educational Trends in Latin America) (2013), "Conversación con Margarita Poggi. La agenda educativa latinoamericana", Buenos Aires [online] <http://www.siteal.iipe-oei.org/debates/427/dialogo-con-margarita-poggi>.
- _____ (2010), *Sistema de información sobre los derechos del niño en la primera infancia en los países de América Latina. Marco teórico y metodológico*, Buenos Aires.
- _____ (2009), *Primera infancia en América Latina: La situación actual y las respuestas desde el Estado. Informe sobre tendencias sociales y educativas en América Latina 2009*, Buenos Aires.
- Skipbe, L. and others (2011), "Schooling effects on preschoolers' self-regulation, early literacy, and language growth", *Early Childhood Research Quarterly*, vol. 26, No. 1, Amsterdam, Elsevier.