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Preschool education as the great equalizer? A cross-country study into the sources of inequality in reading competence

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Abstract

In this study we examine the extent to which preschool education can reduce social background differentials in learning outcomes across countries; our focus is on whether the benefits of preschool attendance for children depend on other family inputs such as parents' education and their pedagogical involvement during early childhood. We use the 2011 Progress in International Reading Literacy Study, which provides a standardized measure of reading literacy among students in 4th grade. Our sample contains data on 119,008 individuals from 28 developed countries. The presented evidence confirms that preschool is visibly beneficial in most cases, but also that benefits are lower for children who have more involved or more educated parents. Rather than complements to, parental involvement and parental education seem to be substitutes for preschool attendance in children's skill production function. As such, preschool education reduces social inequalities in educational achievement. Yet, its equalizing potential could have been overstated in previous debates.

Keywords

Preschool education, educational inequalities, social background, parental involvement, reading, international comparison

Order is alphabetical; all authors contributed equally.

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Introduction

There is growing public and academic interest in the processes that take place during the first six years of life, because evidence suggests that individual life chances are already determined to a substantial degree at this early stage. The basic idea is very intuitive: people are most permeable at younger ages; thus stimuli received in the initial years will have a great impact on the development of abilities that are relevant not only for academic success but also for a broad range of other outcomes throughout the life course. Then, expanding preschool education is much more efficient than investing in later stages of the educational cycle. For the United States, Heckman (2011) estimates that the societal benefits of this early investment are so high that each dollar devoted to high-quality preschool education draws an annual return rate of seven to ten percent. The effectiveness of early interventions has also been shown for low-income countries (Berlinski et al., 2008). Although such estimates are not an exact science (Currie, 2001), the emerging consensus about the crucial role of early stimulation has promoted academic interest in the topic and drawn attention to preschool programs that boost learning and potentially reduce social inequality.

Since a great proportion of the inputs that young children receive naturally come from the family environment, in particular their parents, it is inevitable that the quality of those stimuli depends on the 'quality' of parenting, including household resources, parenting skills and human capital. The relationships between parents and children is, however, hard to modify through public policies. Although there is evidence that such intervention could reduce social inequalities in learning outcomes (Crosnoe et al., 2010) whether and to what extent it would be legitimate or normatively desirable to do so is a sensitive subject. Areas more susceptible to public intervention are the amount of time that children spend in formal education, as well as the organization, curricula, and human and material resources devoted to childcare institutions. If the assumption of higher efficiency of early learning holds (Esping-Andersen, 2008; Heckman, 2006), then the years before compulsory education are crucial in avoiding the emergence of social inequalities. In this vein, the 'Barcelona objectives' set by the European Council in 2002 targeted a preschool participation rate of 90% between age 3 and the age of compulsory school and of 33% for children under age 3, an objective still to be met in the majority of European Union countries (European Commission, 2013). At the same time, there are wide differences in parental educational practices according to socio-economic background. For example, parents with low levels of sociocultural resources disproportionally expose their children to television and free play, following a parenting style called "accomplishment of natural growth" by Lareau (2003) as opposed to a style of "concerted cultivation" involving the more frequent use of books and formalized activities typically adopted by parents with higher levels of resources (Cheadle, 2009). Accordingly, the stimuli that disadvantaged children are exposed to in (pre)school will partly offset the advantage that better-off children enjoy because of the stimuli received in their home environment. The literature on the summer learning loss (Downey et al., 2004) has established that the longer children from poorer origins spend in educational institutions rather than at home, the better are their learning results. In short, schooling fosters equality.

In this paper we examine the impact of preschool education on later school performance. Specifically, we focus on the extent to which preschool education mitigates or, on the contrary, augments inequalities in children's learning outcomes generated within the family context. We analyze the benefits, for cognitive skills, received from preschool attendance by the offspring of families with different levels of resources; in particular, we concentrate on the moderating effects of parents' level of involvement in children's educational activities as well as their socio-economic background, measured through parental education. We consider these to be different types of stimuli and ask whether they are substitutes for or rather complements to, vis-à-vis preschool attendance, the skills production function. We further adopt a cross-country approach to detect international similarities in the effect of preschool attendance on cognitive outcomes for those from different social backgrounds and family environments. While most previous attempts to tackle these issues have consisted in single-country studies (mostly on the United

States), this is the first contribution to assess this question pooling standardized data from a large number of developed countries.

Previous research

There appears to be sufficient consensus at this point about preschool attendance improving the short-term cognitive outcomes of children, including early literacy (Bassok, 2010), pre-reading, early number concepts and language competence (Sammons et al., 2004), or health (Currie, 2001). The available evidence on the effect of preschool on outcomes in the longer-run is less conclusive (Barnett, 1995). Generally, however, the positive effects of preschool attendance stand up when using different research designs such as experimental and evaluation studies (Doyle et al., 2013) or large-scale longitudinal studies such as those based on birth cohorts (Bassok, 2010). For example, Belsky et al. (2007) reported an association between preschool attendance and behavioral problems before 6th grade, but they also found positive effects on various other factors, and later analyses of the same sample of children remained inconclusive (Vandell et al., 2010). An ongoing evaluation study carried out in Tennessee (US) has raised doubts regarding the effectiveness of preschool programs, as initial positive effects for children from disadvantaged children were found to fade away already in elementary school (Lipsey et al., 2013). This led to a heated debate between critics of preschool programs (Whitehurst, 2014) and others who question the methodology used in the study and point to the low-quality nature of the Tennessee program, and therefore question the validity of the findings (Barnett, 2014).

More than the potential benefits of preschool attendance per se, our primary interest in the present study lies with the moderating roles of social background on the one hand and parental involvement on the other. There is a great amount of empirical literature showing the effect of social background on children's cognitive and non-cognitive abilities (Burton et al., 2013). These differences proved robust to the use of various different measures of education and skills, and already are distinguishable at a very early age (Ermisch, 2008). For example, Feinstein's (2003) findings showed a positive influence of parental socio-economic status on the development of British children ranging in age from two to ten.

Several mechanisms have been suggested to explain this association between social origin and children's skills at young ages. The list of potential explanations includes genetic factors, an adequate provision of nutrition, housing and healthcare to cover basic needs, parents' emotional support, parental response to stressful situations as well as parenting styles (Bradley and Corwyn, 2002). More resourceful parents seem to offer their children a more stimulating environment: they use more diverse and complex language (Hoff, 2003), provide better quality home environments, including stimulating toys and books, spend more time reading stories, and are more responsive when addressed by their children (Bradley et al., 2001). Richer home environments clearly correlate with important outcomes – such as language acquisition and emerging literacy skills (Roberts et al., 2005) – that are in turn relevant in predicting later school success. More resourceful parents also tend to participate more in playgroups, take their children to libraries more (Becker, 2010) and provide them with more support in general (Mistry et al., 2008). However, when exposed to intense 'developmental care' low-socio-economic status children have been found to benefit from these parental investments to a greater extent than high-socio-economic status children (Thomsen, 2015).

The central aspect for our study is whether there are differences in the benefits that preschool can offer to children from different backgrounds. The empirical literature offers two sets of results. Some studies show that this beneficial effect of preschool is homogeneously distributed across social backgrounds (Vandell et al., 2010). However, the majority finds that the effect is systematically stronger among children from disadvantaged origins. This latter result has been confirmed in countries such as the US (Bassok, 2010), the UK (Becker, 2011), and Germany (Felfe and Lalive, 2012). In addition, it does not seem to depend on the indicator of background used, be it family income (Bassok, 2010) or parental education (Becker, 2011). In short, most prior research suggests that preschool actually compensates, at least to some extent, for less stimulating home environments that would, in principle, limit children's

opportunities for cognitive and personal development. However, the available evidence suggests that this compensation is not complete, that is, that deficits remain among those from disadvantaged backgrounds, even after exposure to the stimuli offered by preschool education and care (a review in Burger, 2010).

As already mentioned, the quality of childcare programs (typically measured through classroom characteristics or teacher behaviors and expectations) is important for their effects on child development (Abner et al., 2013). Although there is evidence of the positive influence of preschool quality in relation to achievement (Burchinal et al., 2010), the fact that children from disadvantaged backgrounds tend to have more limited access to high-quality institutions (National Institute of Child Health and Human Development and Duncan, 2003; Esping-Andersen et al., 2012), suggests that this association needs to be interpreted with caution. The benefits of high-quality care appear to last until at least elementary school and, although they tend to be modest in their size, they are more consequential for children from disadvantaged backgrounds (Dearing et al., 2009).

Hypotheses

It is undeniable that parental involvement has positive effects on children's cognitive development. Likewise, there is little doubt that preschool education has a beneficial influence on children. What is much less obvious is in what form, if at all, the two sources of stimulus for children, family versus schooling, are interdependent. Is there an interactive relationship between parental involvement or education and preschool education?

One crucial function of the education system is the provision of learning opportunities for disadvantaged children. Given the immense importance of cognitive development during early childhood, preschool education may be especially effective in terms of equalizing subsequent educational outcomes. Children who receive few stimuli at home may benefit disproportionally from attending pre-primary school because they can profit from interacting with children who are ahead of them on the learning curve. Conversely, given the lax and playful nature of most preschool programmes, children who are already richly stimulated by their parents may be unable to take advantage of the basic skills provision offered at childcare institutions. In contrast, less stimulated children may thrive on being exposed for the first time to certain contents and activities. Inputs that are new and exciting for such children are lacking in interest and newness by children with more active parental involvement. The latter may still benefit from the process of repetition, but their marginal gains will likely be lower.

Applying the basic notion of the learning curve to early stimulation, the decreasing rate of learning over time would imply that children with a lower level of prior knowledge have broader scope for improvement. Our first hypothesis, H1A, thus states that attending preschool is more beneficial in terms of learning for children with less involved parents. Parental involvement and preschool attendance would, in this scenario, be regarded as substitutes in their effects on cognitive development.[1]

H1A: The learning benefits of attending preschool education are lower for children whose parents are highly involved than for children who receive fewer stimuli from their parents.

The early-childhood production function may also look very different, with parental involvement and preschool education being complementary rather than alternative elements. There are two main reasons for this: firstly, parents who are heavily involved in the education of their children can be expected to send their children to better-quality childcare institutions than parents who do not dedicate much time to their children in general or who have not gathered enough information to select a good preschool institution. Children with active parents would tend to cluster together at the same institutions, prompting positive peer-group effects. Due to segregation and school effects, learning benefits would thus be greater for children who are already advantaged in terms of level of parental involvement. Secondly, active parents may also be expected to closely monitor their children's development and integration at

the center, communicate with the instructors and intervene when necessary. They may also delve into or complement the learning activities undertaken at the institution with adequate parenting at home or through externalization, thereby maximizing the cognitive gains from preschool education for their children. In brief, parental involvement and preschool education may, under this scenario, yield cumulative benefits.

H1B: The learning benefits of attending preschool education are higher for children whose parents are highly involved than for children who receive fewer stimuli from their parents.

Preschool attendance may also yield differential learning effects depending on children's social backgrounds. In a similar way to what has been argued in H1A for parental involvement, children of poorer social origins may disproportionally benefit from preschool because of their less advantageous starting point. Due to genetic and epigenetic reproduction or to inequalities that are already visible at the earliest stages of development, children from less advantageous social origins have a lower baseline level of skills, making it easier to increase their knowledge and capacities through preschool education. If the learning curve model adequately describes early child development, preschool attendance may thus be more effective for children from less educated parents than for children from parents with high levels of education. Conversely, children from highly-educated parents already have a solid level of skills, not only because of their genetic inheritance, but also because of their privileged social surroundings. To the extent that there are diminishing returns to skills acquisition, attending preschool should therefore have more impact on children from lower social origins whose living environments tend to be less stimulating to begin with.

H2A: Preschool attendance is more beneficial for children of less advantageous social origins.

Analogous to what has been argued for parental involvement in H1B for parental involvement, there may be selection effects at work prompting children from more privileged social origins to benefit more from preschool attendance. Parental school choice and residential segregation likely lead to variation in school composition and quality, which would tend to reinforce pre-existing inequalities in children's abilities. In fact there is evidence that children from disadvantaged backgrounds have lower rates of preschool attendance (Schober and Spiess, 2013; Van Lancker and Ghysels, 2012). These factors may engender a "Matthew effect" in preschool education, with already privileged children reaping the greatest benefits from organized childcare. In other words, the complementarity hypothesis holds that preschool attendance yields better outcomes for children from advantageous social backgrounds.

H2B: Preschool attendance is more beneficial for children of more advantaged social origins.

The four hypotheses discussed thus far can be summarized in Figure 1. They are presented in pairs of hypotheses and, in order to simplify the illustration, the two types of home stimuli/resources (active parental involvement and parental level of education) are considered jointly. H1A and H2A stipulate the substitutive nature of the different inputs, while H1B and H2B describe that relationship as complementary.

Methods, data and variables

We use data from the most recent available edition (2011) of the Progress in International Reading Literacy Study (PIRLS) which is administered by the International Association for the Evaluation of Educational Achievement (IEA, 2011). PIRLS represents a unique tool for the international evaluation of school performance both at the macro level and micro level (more information on the quality of this data in Johansone, 2011). The data from 2011 constitute the third round of the study. PIRLS is based on a

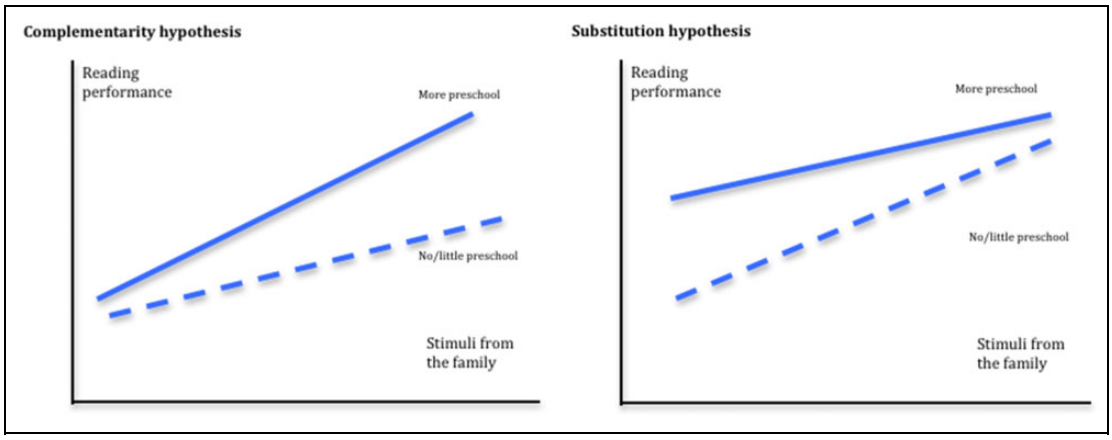

Figure 1. Complementarity and substitution hypotheses.
Source: own elaboration.

stratified sample that includes, within each country, a representative subset of schools and students (Martin and Mullis, 2012). The study collects an objective and internationally comparable measure of educational performance called reading literacy achievement of students in primary education (4th grade). The children in the sample are around ten years old and come from a wide range of countries. From the original fifty countries we dropped those with low levels of gross domestic product per capita as well as oil producing countries, giving us a final sample of 28 developed societies.

Reading skills are of key interest as a dependent variable because they are undoubtedly highly consequential for academic success at later stages of educational careers, and have fundamental importance as a basic competence that is required in work and daily life during adulthood. Reading literacy is defined as the ability to comprehend and utilize linguistic forms and was assessed using two 40-minute tests. In each of them, students were provided with a 750-word text and had to answer twelve questions about it, including multiple choice, semi-structured and open questions. In most cases, one of the texts is literary (e.g. a short tale) and the other non-fictional (e.g. an information brochure). Figure A.1 in the Appendix shows the distribution of our dependent variable. Although the theoretical range of the variable is between 0 and 1000, the large majority of students attain scores between 300 and 700. In the first edition of PIRLS (in 2001), the cross-country grand mean score was calibrated to 500 (with a standard deviation of 100). The average score in our sample is slightly higher (540.92).

Additional information on the individual student, family and school context is gathered using survey questionnaires that include retrospective information about students and their families before the start of compulsory education. Table A.1 in the Appendix displays more detailed information about sample sizes across countries.

Our central independent variable is attending a preschool institution before compulsory (primary) education. The data include retrospective information not only on whether children attended preschool, but also the number of years they spent in such institution (scale used: Did not attend = 0; one year or less = 1; between one and two years = 1.5; two years = 2; between two and three years = 2.5; three years or more = 3.5; see section on sensitivity analyses for further details). Table A.2 in the Appendix shows the pooled distribution of this variable. In our sample, only a small fraction of children (less than 6%) never attended preschool. Although most children spent at least some months in formal care, there are remarkable differences as regards the time they stayed: one in ten stayed for a year or less, and one in two remained for at least three years. In accordance with existing evidence (European Commission, 2013) there is significant cross-country variation in this distribution.

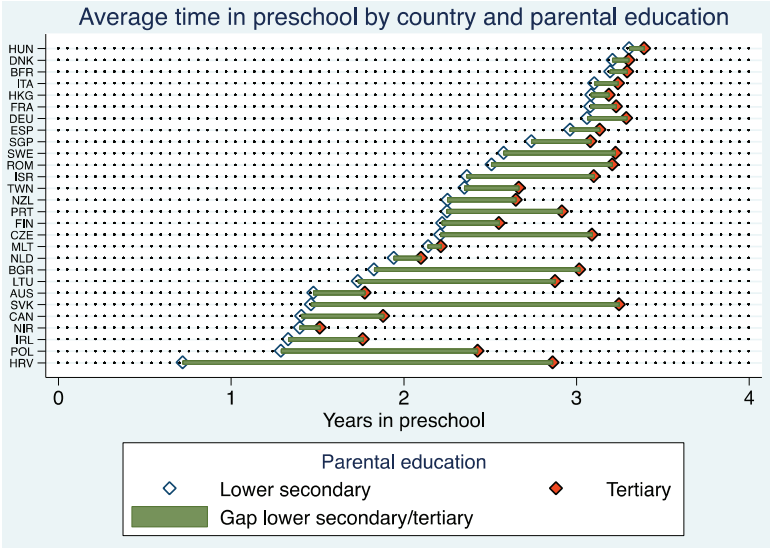

Figure 2. Differences in participation in preschool education by social background across countries.
Note: Source variable is top-coded. For information on country labels refer to Table A.1 in the appendix.

Figure 2 reports the average duration of preschool education among students in primary school whose parents have lower secondary and tertiary education (country-specific average durations of preschool attendance are provided in Table A.1). The general trend described in the graph suggests that, in accordance with the literature described above, attendance rates are higher among children from more educated families. In addition, inequality by social background is larger in countries where attendance is less common such as Croatia, Poland, Slovakia, Lithuania or Bulgaria as opposed to countries with more universal participation such as Hungary, Denmark, Wallonia (Belgium), Italy, Hong Kong, France, Germany or Spain.

Our two moderating variables of interest are parental involvement and family socio-economic background. We want to examine the extent to which these variables modify the relationship between attending preschool and later school performance.

The first variable measures the frequency of parental involvement in early educational activities with their children. There is substantial consensus in the field of psychology on the influence of early reading skills on later academic achievement and on the fact that considerable differences are found in these early skills across socio-economic groups (a review in Arnold and Doctoroff, 2003). We built a synthetic multi-item indicator of parental involvement using a number of questions from the home questionnaires. Collected retrospectively, they capture how often parents engaged in activities with educational content in the early childhood of their offspring. The wording of the question is: "Before your child began primary/elementary school, how often did you or someone else in your home [ACTIVITY] with him or her?" The full list of activities can be found in the Appendix Table A.3. The reported frequencies were transformed, through factor analysis, into a single continuous measure, which was subsequently normalized. The second moderating variable is parental education, which we take as an indicator of social background. PIRLS provides this information using ISCED (*International Standard Classification of Education*). We apply the dominance principle to assign the highest level of education among the parents, linearize the resulting variable and rescale the values of each category (range 1–8; mean = 5.37; SD = 1.80).

The data show a hierarchical structure, with students clustered within countries. Since we are primarily interested in the effect of individual-level factors, we used country fixed-effects models for linear

Table 1. Linear multi-level models with country-level fixed-effects for reading competences.

		Model 1	Model 2	Model 3
Female		11.70***	11.70***	11.70***
		(0.35)	(0.35)	(0.35)
Main effects	Time in preschool	4.63***	4.45***	7.06***
		(0.20)	(0.20)	(0.51)
	Parental involvement	10.10***	14.40***	10.00***
		(0.19)	(0.43)	(0.19)
	Parental education	12.80***	12.7***	14.00***
		(0.11)	(0.11)	(0.27)
Interactions	Parental involvement*time in preschool		−1.75***	
			(0.16)	
	Parental education*time in preschool			−0.48***
				(0.094)
Constant		459.6***	460.2***	453.2***
		(0.74)	(0.74)	(1.45)
Model information	*N*	119,008	119,008	119,008
	Sigma(u)	19.5	19.4	19.5
	Sigma(e)	60.7	60.6	60.7
	F	6104.1	4913.4	4889.6

Source: PIRLS (2011), own elaboration. *p<0.05; **p<.01; ***p<.001.

dependent variables to estimate the correlates of reading ability while controlling for any cross-country differences in average literacy. This approach neutralizes any effects of potentially relevant country features such as the age at which education becomes compulsory, selection in access to preschool, the intensity of investment in preschool education or the standardization of the curriculum organizing pre-compulsory education.

Results

Table 1 shows the results obtained from our models in which the factors contributing to reading skills of fourth-graders are analyzed. All models control for the sex of the student, with the well-known result that girls are better readers than boys.

In Model 1, the objective is to find out the average effect that attending a preschool institution has on reading competences. Country heterogeneity is discounted from our results by using fixed-effects. The results from this model suggest that the longer the time spent in a preschool institution, the higher students' scores in reading in fourth grade of compulsory schooling are. Accordingly each year of preschool attendance is accompanied by an increase in reading skills of around five points, which corresponds to seven percent of a standard deviation.

The remaining models in Table 1 enable us to empirically test the substitution and complementarity hypotheses formulated above. Model 2 confirms that the interaction term between time in preschool and parental involvement is negative. This supports hypothesis H1A, according to which the two types of resources – parental involvement and preschool – are substitutes of each other. Figure 3 illustrates the results graphically. The panel on the left plots the marginal effect of attending preschool for parental involvement in pedagogical activities on reading scores. The panel on the right shows the total effect of attending preschool for the children of parents with low and high levels of involvement (those at the 10th and 90th percentiles, respectively). The marginal effect of parental involvement, as estimated in Model 2, clearly diminishes for increasing durations of preschool education. In sum, although attending pre-school is beneficial for most children, the slope is negative, with shrinking returns as we move up in the

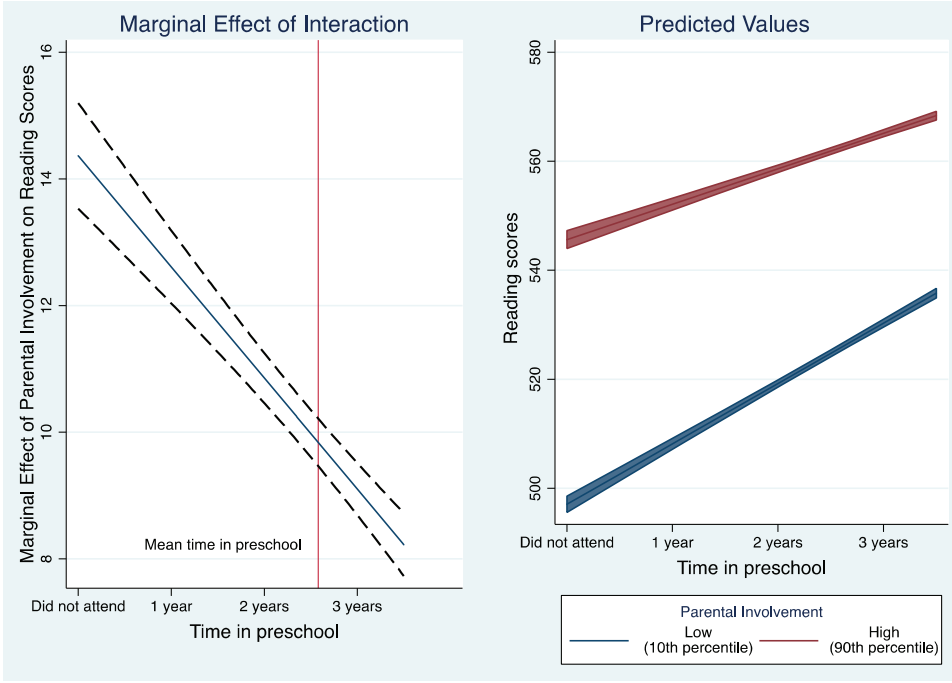

Figure 3. Marginal effect of the interaction between parental involvement and time in preschool and final predicted values in reading scores.
Notes: Auxillary lines in both plots give 95% confidence Interval. Estimated from Model 2 in Table 1.

distribution of parents' educational involvement. We see from the right-hand panel of Figure 3 that preschool education reduces, but not completely eliminates, the inequalities that emerge from different levels of parenting.

Model 3 shows the interaction of parental education with time spent in preschool. This interaction term yields a negative effect that is highly significant. This is evidence that it is children of less educated parents that obtain a greater relative advantage from having attended a preschool institution. With parental education being a proxy for social background, this means that the more advantaged their socio-economic origins are, the smaller the returns children obtain from preschool education. Put differently, the empirical evidence supports H2A, which stipulates that these two sources of stimuli are also, essentially, interchangeable.

Figure 4 further illustrates this nexus. The left panel plots the marginal effect of attending preschool on reading scores, by parental education (in other words, the interaction term). The panel on the right shows the overall influence of attending preschool for the children of parents with lower secondary (ISCED-2) and tertiary education (ISCED-5A), respectively. As the left-hand plot shows, although preschool is consistently beneficial (all relevant values on the Y axis are above 0) and statistically significant, the size of this benefit decreases as we move towards higher levels of parental education. This implies that the children of more educated parents have relatively less to gain from preschool attendance than the children of less educated parents.

The right-hand panel highlights that the overall impact of attending preschool is positive and, from a substantive point of view, that its substitutive relationship with respect to parental education implies an equalization of outcomes. However, by itself, pre-compulsory schooling is not capable of neutralizing pre-existing social background inequalities in test scores, even though it significantly reduces them.

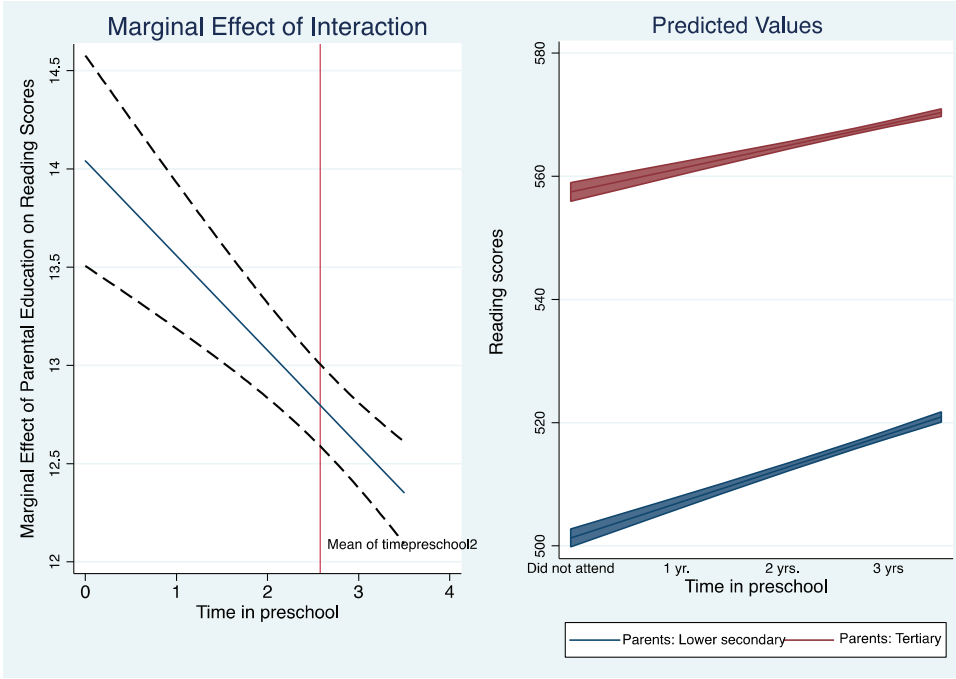

Figure 4. Marginal effect of the interaction between parental education and time in preschool and final predicted values in reading scores.
Notes: Auxillary lines in both plots give 95% confidence Interval. Estimated from Model 3 in Table 1.

Taken together, these results suggest that these two sources of stimuli (the family versus the school) appear to be substitutes rather than complementary. As we argued above, one plausible reason underlying this finding is the decreasing slope of the learning curve: because children from less stimulating families have greater untapped potential to improve their knowledge and abilities when they first enrol in formal non-compulsory education, they learn, on average, more quickly than their counterparts from more stimulating homes who start from a higher baseline.

Country heterogeneity

Up to this stage, we have used a country fixed-effects approach to analyze the factors contributing to children's literacy at the individual level. In this way, we eliminated international differences from the picture. We now seek to assess whether there are notable country differences in the benefits of preschool attendance or in the substitutive relation with family stimuli that we discovered above. Therefore, we estimate a multi-level model with random intercepts and random slopes on the preschool attendance predictor that allows us to model variation at the country level. Detailed estimation results are displayed in Table A.4 in the Appendix. Figure 5 shows that with few exceptions, the average effect of preschool attendance on reading scores in the 28 countries in our sample is consistently positive, albeit with varying magnitude. Curiously, Finland and Hong Kong, the two only exceptions, are precisely two countries that consistently show excellent results in terms of average student performance in international surveys such as the Organisation for Economic Co-operation and Development Program for International Student Assessment. Further analyses also confirmed that the main effects of both parental involvement and parental education yield the expected positive – strong and statistically significant – coefficients in almost all countries.

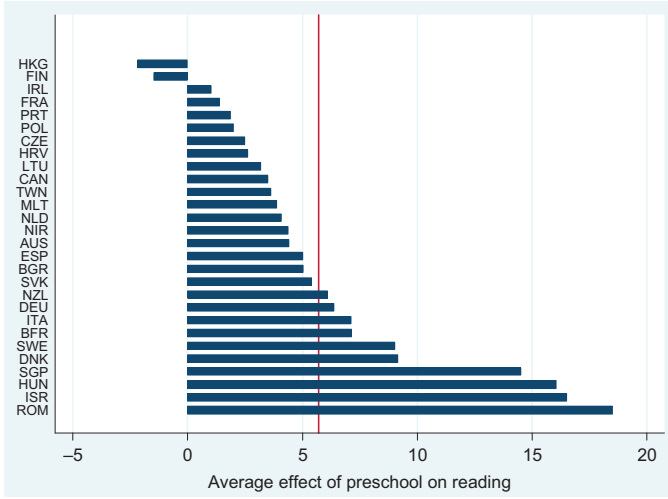

Figure 5. Average influence of years of preschool attendance on reading scores across countries (random-effects multi-level model). *Note*: Estimated from Model A.0 in Table A.4.

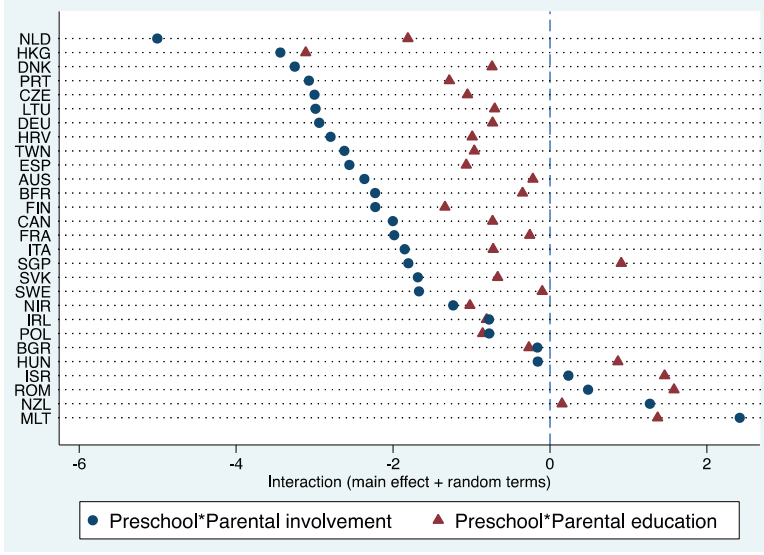

Figure 6. Substitution/complementarity between time in preschool and household resources across countries. Dependent variable is reading scores (random-effects multi-level model).
Note: Estimated from Models A.1 and A.2 in Table A.4.

Sharing the growing scholarly interest in cross-national differences in the sources of inequality in outcomes among children (Burton et al., 2013), we also replicated Models 2 and 3 in Table 1 but using multi-level random-effects models, thereby allowing for country-level corrections in the size of the interaction between time in preschool and parental involvement (Model A.1 in Table A.4) and time in preschool and parental education (Model A.2 in Table A.4) respectively. By doing so, we allow for a separate exploration of our hypotheses in each country that is included in the analyses. Figure 6 ranks

countries according to the amount of substitution between time in preschool and parental education (red triangles) or parental involvement (blue circles). These markers sort countries according to the overall amount of substitution (obtained by adding the random correction that specifically modifies its impact in each country to the main interactive term associated with time in preschool). In the plot, $x = 0$ is marked by a dashed blue line to set the threshold that separates the existence of substitution versus complementarity of time in preschool. As one can easily see from the plot, substitution is the dominating rule in almost all countries included in the analysis. The exceptions to this pattern are Israel, Romania, New Zealand and Malta for both interactions (preschool and parental education; preschool and parental involvement) as well as Hungary and Singapore for the interaction between preschool and parental education.

Although it goes beyond the scope of this study to systematically account for the reasons behind this country heterogeneity, it should be noted that our principal results at the individual level are also stable when controlling for a number of country-level features related to the spread of preschool attendance (although those were not available for all countries in the sample). There is previous research examining the timing – that is, age at entry (Loeb et al., 2007) – and amount (number of hours) of exposure to different types of childcare (Phillips and Lowenstein, 2011). Our main results were not altered substantially by the inclusion in multi-level random-effects models of cross-national characteristics such as the standardization of school curricula or the age at which schooling becomes compulsory.

Sensitivity analyses

A number of sensitivity analyses were conducted. Firstly, to ascertain that our results do not critically hinge on the specific set of rich countries sampled, we furthermore have replicated our analyses using the whole original data set comprising 43 countries ($N = 180{,}106$ students). Even with this comprehensive approach including both rich and poor countries together, the main results are essentially the same (results not shown for lack of space but available upon request).

Secondly, Models A.3 and A.4 in Table A.4 replicate the analyses, decomposing time in preschool into dummies ("not having attended preschool" being the reference category), thus allowing for possible non-linearities (Rao et al., 2012). There are no changes in the general conclusions to be reported as a result of this robustness check.

Thirdly, because there exists evidence that mothers' education may be more influential than fathers' education for early learning, we have carried out a sensitivity analysis that uses the mother's level of education instead of the joint level determined using the dominance principle. Again, results were almost identical and are available on request.

Finally, our conclusions stand after inserting additional controls into the model, including parental (father's and/or mother's) employment status (full time, part time and "other" situations are originally codified in the parental questionnaire). Unfortunately, these situations were registered at the time of the literacy test, and not at the time the family decided on enrolling their children in preschool education. Thus, these controls only reduce potential omitted variable bias but do not to solve the issue of endogeneity (i.e. self-selection into preschool education), which is a notable limitation of this study.

Discussion

This study is the first to analyze the benefits of preschool attendance across a large number of developed countries. The evidence presented here has replicated the common finding that preschool education is positively associated with later academic performance for almost all countries in the sample. One additional year of enrolment in preschool is accompanied by an average increase of five points in reading competence (seven percent of a standard deviation), measured in fourth grade of primary school.

While parental involvement in pedagogical activities stimulates children's abilities and co-determines early cognitive outcomes, social background (measured as parental education) is a more subtle but no less powerful driver of school performance. Our paper has systematically explored the

ways in which household-based inputs and preschool education interact in determining school outcomes. We have demonstrated that while the time spent in preschool appears to positively influence future reading competences among all children, the benefit is stronger for the offspring of less advantaged households and those whose parents have had a less active involvement in their children's education before starting primary school. In other words, the presented evidence suggests that preschool education is a significant equalizer of educational opportunities. Consistent with previous research, the characterization of preschool and household resources as substitute inputs in the education function of children is valid for the large majority of societies analyzed here. The fact that the results hold across developed countries in a consistent manner for both types of resources – parental education and parental involvement – provides solid evidence of what we called the substitution effect.

As already mentioned, further research is needed to tap into the reasons behind differential preschool benefits across nations. Even if PIRLS includes a set of country-level contextual dataset reporting on the preschool system, the indicators are rather coarse and do not seem to measure the relevant properties well enough. Some other limitations of this contribution should also be noted. In order to carry out this large-scale comparative study and achieve a maximum level of external validity, certain concessions had to be made in terms of internal validity and data quality. For example, the measure used on the time children spent in preschool is top-coded, and like the measures of parental involvement, based on retrospective information. We are furthermore unable to control for baseline levels of cognitive ability or quality differences in preschool centers. As a consequence, the estimates of preschool benefits reported here are of associational nature and do not strictly represent causal effects. The policy-oriented debate has emphasized that high quality center-based care has the potential to significantly reduce social background inequalities in early cognitive outcomes (Leseman, 2009). Since peer effects and quality differences in childcare due to residential segregation would theoretically weaken any equalization that preschool might engender, it seems likely that the presented results provide lower-bound estimates of the magnitude of the true substitution taking place between preschool education and family background.

In any event, the evidence here provided also reveals that the equalizing potential of preschool education is far from being large enough to level out pre-existing background inequalities among primary school children. The children of less educated parents who have accumulated more preschool education do not catch up with children from better-off families, not even with those that spent no time in preschool. In a nutshell, promoting access to preschool is probably indeed an equalizing public intervention, but its overall potential to reduce social background inequalities should not be overstated.

Interestingly, the kind of extra stimuli that preschool provides to disadvantaged children appears to be more similar to the benefits obtained from active parental involvement before primary school than to the benefits derived from a privileged social origin, that is, preschool and involvement are more direct substitutes of each other than preschool and parental background. This can be deduced from the fact that the differences in test scores in 4th grade between students whose parents have been less involved but have attended more preschool education, and those whose parents were more active but did not attend preschool, are smaller than the corresponding differences arising from social background inequality. This finding has two intertwined implications. Firstly, parental education once again proves to be a strong and largely inalterable channel through which school success is reproduced across generations. More research is needed to determine the weight of factors such as primary school selection or family economic resources targeted at improving school performance in explaining the size of the gap. Secondly, the effectiveness of possible political interventions in the family environment on the achievement gap should be analyzed with care: according to previous studies, the total influence of parenting practices is greater than that of preschool itself (Melhuish et al., 2008). Our research has contributed to this literature by further showing that preschool attendance has the capacity to partially fill in for lacking parental stimuli (especially for early parental involvement) in the skills production function. Nonetheless, the triangulation of active involvement and universal enrolment in high-quality center-based care, such as so-called "model-combination programs" (Leseman, 2009: 23–25), would promise

the highest expected impact on equality in cognitive outcomes. If public intrusion in the family sphere is deemed illegitimate, the expansion of preschool education is thus a viable policy alternative in order to achieve greater (albeit by no means absolute) cohesion among future generations of children.

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Note

1. Note that in microeconomics, two goods are perfect substitutes when one of them can be consumed instead of the other. Sociologists refer to these as functional substitutes. Classical examples of substitute goods include butter and margarine. Alternatively, two goods can be said to be perfect complements if they need to be consumed simultaneously to enjoy their utility. Typical complementary goods are left and right shoes.

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Appendix A

Table A1. Description of the sample and distribution of preschool across countries.

Country	Label	*N*	%	Mean(time preschool)	SD
Australia	AUS	2,996	2.52	1.68	0.89
Belgium (Wallonia)	BFR	2,931	2.46	3.23	0.56
Bulgaria	BGR	4,697	3.95	2.69	1.19
Canada	CAN	17,609	14.80	1.78	0.97
Croatia	HRV	4,213	3.54	2.09	1.48
Czech Republic	CZE	4,116	3.46	3.048	0.76
Denmark	DNK	3,781	3.18	3.27	0.54
Finland	FIN	4,097	3.44	2.58	1.03
France	FRA	3,658	3.07	3.23	0.52
Germany	DEU	2,753	2.31	3.16	0.66
Hong Kong	HKG	3,067	2.58	3.15	0.55
Hungary	HUN	4,428	3.72	3.34	0.45
Ireland	IRL	3,942	3.31	1.64	0.86
Israel	ISR	2,680	2.25	2.99	0.71
Italy	ITA	3,413	2.87	3.18	0.64
Lithuania	LTU	3,928	3.30	2.54	1.33
Malta	MLT	2,701	2.27	2.17	0.55
Netherlands	NLD	2,119	1.78	2.06	0.56
New Zealand	NZL	3,140	2.64	2.56	0.92
Northern Ireland (UK)	NIR	1,812	1.52	1.49	0.67
Poland	POL	4,520	3.80	2.03	1.41
Portugal	PRT	3,450	2.90	2.52	1.13
Romania	ROM	4,001	3.36	2.85	0.97
Singapore	SGP	5,719	4.81	3.01	0.73
Slovakia	SVK	5,131	4.31	2.91	0.97
Spain	ESP	6,872	5.77	3.06	0.77
Sweden	SWE	3,439	2.89	3.07	0.86
Taiwan	TWN	3,795	3.19	2.59	0.82
Total		119,008	100.00	2.58	1.08

Table A2. Distribution of preschool education in the sample.

	N	%
Did not attend preschool	6,573	5.52
1 year or less	11,997	10.08
Between 1 and 2 years	7,695	6.47
2 years	15,712	13.20
Between 2 and 3 years	17,759	14.92
3 years or more	59,272	49.81
Total	119,008	100.00

Table A3. Factor analysis on parental involvement scale (method: principal factors).

Item (parental activity at preschool ages)	Factor loadings (eigenvalue: 4.4797)
Read books	0.51
Tell stories	0.54
Sing songs	0.46
Play with alphabet	0.63
Talk about what has been done	0.44
Book discussion	0.47
Play word games	0.52
Write letters/words	0.54
Read aloud signs	0.55
Counting songs	0.59
Number toys	0.67
Count things	0.62
Game with shapes	0.62
Building blocks	0.54
Play board or card games	0.44

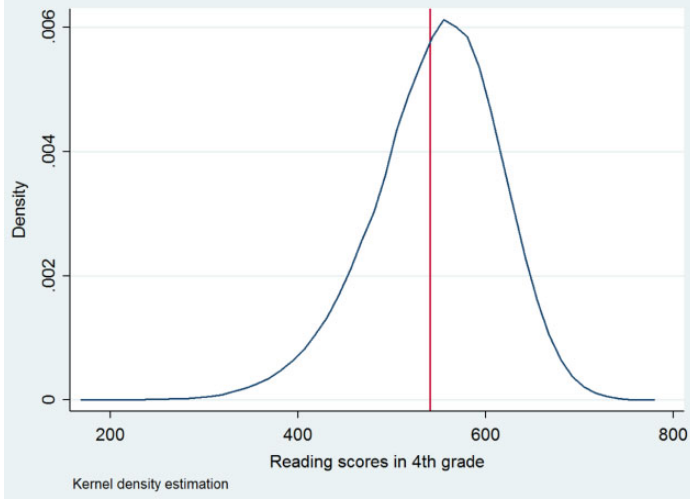

Figure A1. Description of the dependent variable: reading scores.

Table A4. Random-effects multi-level models (A.0, A.1, A.2) and country fixed-effects models (A.3 and A.4).

		Random constant+slope (preschool)	Random constant+slope (interactions)		Country fixed-effects	
		A0	A1	A2	A3	A4
Female		11.6***	11.70***	11.63	11.70	11.68
		(0.35)	(0.35)	(0.35)	(0.35)	(0.35)
Time preschool		5.74***	4.34***	7.73***		
		(1.03)	(0.20)	(0.55)		
Parental involvement		−9.78***	13.99***	9.64***	15.21	10.03
		(0.19)	(0.44)	(0.19)	(0.62)	(0.19)
Parental education		12.7***	12.71***	13.95***	12.75	14.56
		(0.11)	(0.11)	(0.28)	(0.11)	(0.45)
Parental involvement * Time preschool			−1.59***			
			(0.33)			
Parental education * Time preschool				−0.48*		
				(0.22)		
Time in preschool (ref. is no preschool)	One year or less				2.89**	10.75***
					(0.98)	(2.84)
	Between 1 year and 2 years				3.83***	10.01**
					(1.06)	(3.15)
	Two years				8.66***	13.86***
					(0.95)	(2.67)
	Between 2 and 3 years				9.65***	19.96***
					(0.93)	(2.59)
	3 years or more				14.52***	26.19***
					(0.86)	(2.32)
Preschool * parental involvement (ref. is no preschool)	One year or less				−3.53***	
					(0.82)	
	Between 1 year and 2 years				−2.69**	
					(0.91)	
	Two years				−3.92***	
					(0.78)	
	Between 2 and 3 years				−6.29***	
					(0.77)	
	3 years or more				−6.80***	
					(0.68)	
Preschool * parental education (ref. is no preschool)	One year or less					−1.51**
						(0.55)
	Between 1 year and 2 years					−1.19*
						(0.60)
	Two years					−1.02
						(0.52)
	Between 2 and 3 years					−1.97***
						(0.51)
	3 years or more					−2.21***
						(0.47)
Constant		456.9***	461.44***	452.79***	461.37***	451.96***
		(5.08)	(3.62)	(5.57)	(0.95)	(2.19)

(continued)

Table A4. (continued)

		Random constant+slope (preschool)	Random constant+slope (interactions)		Country fixed-effects	
		A0	A1	A2	A3	A4
Random terms	Preschool:	5.24				
	Interaction:		2.267	1.024		
	Constant:	26.60	351.573	802.401		
	Residual:	60.52	3665.604	3640.901		
Model information	*N*	119008	119008	119008	119008	119008
	F				1891.96	1882.26
	Chi^2	21026.1	19766.99	9288.75		