This is the final pre-publication version of an article submitted to the International Journal of Behavioral Development in November 2015.

Published details:
Tassew Woldehanna (2016) 'Inequality, Preschool Education and Cognitive Development in Ethiopia: Implication for Public Investment in Pre-primary Education' International Journal of Behavioral Development, Published online before print June 17, 2016, DOI: 10.1177/0165025415627700

Inequality, Preschool Education and Cognitive Development in Ethiopia: Implication for Public Investment in Pre-primary Education

Tassew Woldehanna (Associate Professor, Department of Economics, Addis Ababa University, Ethiopia)

Correspondence address: tassew.woldehanna@gmail.com

Abstract

This study used longitudinal data from the Young Lives Project in Ethiopia to examine the main factors relating to preschool access and their potential effects on cognitive performance of children aged 5 and 8 years. The results show that only one-fourth of the preschool age children have the opportunity to attend this vital stage of education, with significant disparities by family wealth, education and regional location. Regardless of its limited coverage, preschool attendance is shown to have statistically significant positive effects on cognitive performance, measured by receptive vocabulary and maths tests. The effects do not also seem to fade away at a later age, implying that inequality among children in cognitive abilities at early ages continues to exist at later ages (7 and above). Furthermore, using mediation analyses, causal chains between family backgrounds and cognitive performance were thoroughly analyzed. Bootstrap results show that preschool attendance significantly mediates the influence of family wealth, education and regional location on child cognitive performance. Nevertheless, despite the importance of preschool education, public investment in this area is currently very limited, with the private sector taking the key role and exacerbating the inequality that exists between children of the rich and poor. These findings thus emphasize the need for government involvement in the form of public investment to this subsector to increase access for all children and reduce future educational inequalities.

Keywords: preschool education, cognitive development, inequality, Ethiopia

Introduction

Society and governments are often interested in reducing economic inequality for both moral reasons and sustained growth. Recent studies conducted in high-income countries show that one way of reducing economic inequality is to provide early childhood education for children from low-income families who are unable to send their children to preschool education and child care programs (see Cunha & Heckman, 2007; Heckman, 2006; Magnuson & Duncan, 2014). Much in the same way, research studies in the fields of health, neuroscience, psychology and cognition indicate that cognitive and non-cognitive stimulation in early life are critical for long-term skill development, as key brain pathways for subsequent learning and that life-long capabilities begin to form during the early stages of life (Bransford, 1979; Hidalgo & Urzua, 2010; Shonkoff & Phillips, 2000). Such causal relations are also supported by other empirical studies in many of the high-income countries (see, Campbell, Ramey, Pungello, Sparling, & Miller-Johnson, 2002; Currie, 2001; Goodman & Sianesi, 2005).

However, although there are over 200 million children in low and middle-income countries that fail to reach their developmental potential in the first five years (Grantham-McGregor et al, 2007), empirical evidence on the factors relating to preschool access and whether there are differences by family backgrounds along with their potential impacts on child cognitive performance are not well studied. Evidence on this issue is particularly lacking in African countries. As far as is known, there are only few studies in this area in Africa (Glicket, 2007; Malmberg, Mwaura, & Sylva, 2010; Zuilkowski, Fink, Moucheraud, & Matafwali, 2012). Glicket (2007) studied the determinants of children's cognitive skills in Senegal by administrating tests to preschoolers and non-preschoolers. The results indicated that preschool education strongly affects cognitive skills, but relations were conditional on parental education

and household wealth. Zuilkowski, Fink, Moucheraud, & Matafwali (2012) also estimated the skill impact of a community-based early childhood education in Zambia and found that preschool access was associated with significantly better performance in an assessment of task orientation. They also indicated that 27% of non-preschoolers were not yet enrolled in primary school at age 7, compared to just 11% of preschoolers, suggesting that preschool attendance encourages a timely transition into first grade.

The major finding of those studies is that only few children do have the chance to attend preschool in low-income countries and many others just start primary education late in their ages skipping preschools. In fact, in many low-income countries, investment in preschool education is not seen as a critical foundation for school readiness and achieving success in school and life (Macours, Karen, Schady, & Vakis, 2008). Limited access to preschool is also widely mentioned as one of the main factors for the high grade repetition and dropout being experienced in low-income countries (UNESCO, 2006b).

Early Childhood Education in Ethiopia

Preschool education in Ethiopia is not compulsory. Neither are any funds allocated by the Government for preschool. Rather, preschool education is dominated by fee-charging kindergartens which mainly supply to the needs of middle class parents living in urban and semi-urban areas. A report from the Ethiopian Ministry of Education (2010) states that the Ethiopian government does not run a preschool education programme so as to maximise its effort at the other levels of the education sector and to encourage the involvement of the private sector. As a result of such limited government intervention, the enrolment rate of the preschool sector is very low and primary education is simply accepted as a substitute for preschool

education. The beginning of first grade without having any exposure to a preschool, in turn results in high school failure and dropout rates, especially for children of the poor and rural areas. For example, the 2013 Ministry of Education Statistical Abstract Report indicated that 22.7% of pupils enrolled in first grade in 2011 had left school before reaching grade two. Such children's school failures lead to a question of whether inequality in preschool access as the result of economic inequality or other factors may result in latter disadvantageous outcomes, either in the form of reduced cognitive performance, school readiness, or even employment opportunities (UNESCO, 2006b).

Research aims

Despite what is known about the benefits of preschool attendance and the factors associated with children's differential access to this vital stage of education in high-income countries, there are few studies in this issue in low-income African countries and particularly in Ethiopia. This study then aims to fill this research gap by (1) identifying the main factors contributing to differential access to preschool in Ethiopia; (2) evaluating how preschool experience in Ethiopia relates to child cognitive development and (3) examining whether preschool access mediates the influence of family backgrounds including regional location on child cognitive performance.

Method

Samples

The data used for the analysis come from the Young Lives Project in Ethiopia, which is part of a longitudinal study of child poverty tracking 12,000 children in four low and middle-income countries (Ethiopia, India, Peru and Vietnam). The Young Lives study in Ethiopia is overseen by the Ethiopian Development Research Institute (EDRI) and University of Oxford, funded by the UK Department for International Development (DFID).

In 2002, as part of the Young Lives study on a Younger Cohort, 1999 children aged around one year were selected from 20 sentinel sites of the five major regions (Addis Ababa (14.23%), Amhara (20.18%), Oromia (20.18%) and SNNP (25.12%) and Tigray (20.29%). While Addis Ababa is dominantly an urban and industrial zone with more than three million inhabitants, the rest are agricultural regions with low level of urbanization, ranging from 10% in SNNP to 20% in Tigray (CSA, 2013).

The Second and third rounds of the survey were carried out in 2006 and 2009, respectively. Table 1 reports the full-sample of the children (urban and rural) over the three rounds. It appears that the sample dropped from 1999 in the baseline survey to 1884 in the third round. At the beginning, there was no refusal from parents of the kids to be part of the long-term study, but once started some children were untraceable (n=33) and some others (n=10) refused to give responses up to round three. Additionally, 72 children died up to the third round. Excluding deaths, the total attrition rate over eight years is 2.15%, resulting in an annual attrition rate of 0.27%, which is extremely low.

“----------
Table 1 about here
----------“

Regarding preschool access, about 25% of the total sample had an opportunity to attend preschool education between the ages of three and five years. But this figure hides considerable disparities between urban (56.91%) and rural (3.33%) areas. Hence, it is worth noting that given the very small number of preschool observation in rural areas (n=38), the scope of this study is restricted to urban areas of each region, with a total number of 745 children at the age of 8.

Measures

Child's cognitive development was measured by the Peabody Picture Vocabulary Test (PPVT-III), the Cognitive Development Assessment–Quantity (CDA-Q) Test and Mathematics Achievement Test. While the first is a widely-used test of receptive vocabulary (Dunn & Dunn, 1997), the other two are common tests used in assessing children's understanding of quantity-related concepts (Cueto, León, Guerrero, & Muñoz, 2009).

All measures were adapted to the Ethiopian context and translated into local languages. In the PPVT test, for example, a child was made hear a word ('boat', 'lamp', 'cow', 'goat' etc) in a local language and was then asked to identify which of these figures correspond with the spoken word. The maximum limit of the PPVT score is 204, but to avoid any bias the raw scores were adjusted into standardized scores by correcting errors in test administration e.g. (1) eliminating items above the ceiling that could not be administered and (2) dropping lower items with poor statistical behavior (for more information, see Cueto, León, Guerrero, & Muñoz, 2009).

The two quantitative tests were also developed based on the criteria from the International Evaluation Association (IEA). There are several cognitive development assessment sub-tests,

including Spatial Relations, Quantity and Time, but only the Quantity sub-tests were administered in the Young Lives study with different set of questions at the age of 5 and 8. While at age 5 the children were asked orally 9 numeracy assessment items, scoring '1' for correct and '0' for a blank or incorrect (CDA-Q5, hereafter), at age 8 a written mathematics achievement test with 20 items was administered (Maths, hereafter). Logarithmic transformations were also applied to all measures of cognitive development to make their interpretations much easier in the kernel matching and mediation analyses.

In addition to the measures of cognitive scores, the data gathered during three rounds covered a wide range of topics on both children's and their families' key characteristics, such as level of parental education, family size and composition, child's short-term and long-term health problems, economic shocks (such as input prices changes), social relationships (separation of family and child mobility) and wealth indexes.

Constructed from the information provided by household heads, the wealth index is an average value of housing quality index, consumer durables index and accessible services index. The measure of housing quality index is based on the type of material the floor, roof and walls were made of, and the number of rooms relative to household size. The service component is the average of the dummy variables on the availability of electricity, piped water, fuel for cooking and toilet facilities. The consumer durables measure is the sum of the dummy variables related to households' ownership of radio, TV, refrigerator, bicycle, motorcycle, car, mobile phone, landline phone and fan. The wealth index and its components range from 0 to 1. While a value close to 1 means the child is from an affluent family, any value near 0 implies the child is a member of a poor family (see Young Lives, 2008).

Procedure

In selecting the study areas, three stages were followed. The first stage was a purposive strategy, where five major regions, namely Amhara, Oromia, SNNR, Tigray, and Addis Ababa were selected out of the country's 11 regions because of their ethnic diversity and size, where all together account for 96% of the 90 million population. In the second stage, between three and five sentinel sites were selected in each region such that the cost of tracking the children in the future was manageable. Finally, in the third stage, 100 households with a child aged around one year were selected randomly in each site.

In each survey round, many of the interviewers and examiners were university degree holders from Addis Ababa University and were screened based on their familiarities with the local languages and customs of each community, so that tests to children and household interviews were administered in their native languages by trained experts. To do this every survey round intensive trainings were given for a month and half by Educationalists, Psychologists, Social Anthropologists and Development Economists. Furthermore, to verify the validity of the survey questionnaires and suitability of the interviewers and examiners, pilot surveys were administered before collecting data. The interviewers and examiners were considered well trained if no error of administrating and scoring was reported by their field supervisors during the piloting. Working with the same supervisors, examiners and interviewers since the baseline survey has enabled us to build stable relations with the families of the children and to minimize errors of administering the interviews and scoring the tests.

Analyses

The study employed several analytic approaches. First, a logit regression model was estimated to identify the main factors that determine child's enrolment in preschool in the context of Ethiopia. The model was constructed based on information as to whether a child ever attended preschool between the ages of 3 and 5 years, for at least six months. The explanatory variables of the model include household wealth, parental education, household composition, child's long-term health status, regional location, family separation and child mobility and economic shocks that the households faced any time between two surveys.

Second, a kernel matching method using a propensity score model was employed to estimate the effect of preschool attendance on cognitive performance. The goal of such estimation is to re-establish experimental conditions in a non-experimental setting (Blundell & Costa Dias 2008), which is done in two steps. Firstly, a propensity score for each individual in the form of conditional probability from the logit model of attending preschool education was estimated. Secondly, the result was then used to create a matched control and treated groups using Kernel matching analysis (see Leuven & Sianesi, 2003). The average treatment effect on the treated (ATT) children of the kernel analysis is given by:

$$ATT \equiv E(CD_{i1} - CD_{i0} \mid d_i = 1)$$

where d_i is preschool enrolment dummy for child i (1 if enrolled and 0 otherwise), CD_{i1} and CD_{i0} are cognitive scores, with CD_{i1} for enrollment and CD_{i0} otherwise.

Third, to examine further whether preschool attendance mediates the influence of family backgrounds on child cognitive performance, mediation analyses were conducted following the work of MacKinnon, Fairchild, & Fritz (2007):

$$Y = \alpha_1 + \beta X + \varepsilon_1$$

$$Y = \alpha_2 + \beta' X + \gamma M + \varepsilon_2$$

$$M = \alpha_3 + dX + \varepsilon_3$$

where Y is the child's cognitive score, X is the predictors (family wealth, education and regional location). M is preschool attendance acting as mediator, β is the coefficient relating the predictors and the cognitive scores, β' is the coefficient relating the predictors to the cognitive scores adjusted for preschool attendance, γ is the coefficient relating preschool attendance to the cognitive scores adjusted for the predictors, d is the coefficient relating the predictors to preschool attendance; α_1, $\alpha_2$and α_3 are intercepts, and ε_1,ε_2, and ε_3 are error terms.

The analyses were done using STATA version 12.

Results

Descriptive findings

Before proceeding to the analysis of preschool attendance and its associated benefits to children's cognitive performance, it is imperative to describe some characteristics of the urban sample children and their families. As shown in Table 2, the percent of boys is slightly higher than girls (52% versus 48%). On average, the children were breastfed for 28.94 months. While 43% of them had some kind of short-term health problem by the first year, long-term health problems were not pervasive (7.7%). The mean grades completed by father and primary caregiver were respectively 6 and 5 while average household size was 6, with 3 of them below 17 years of age. The median of baseline wealth index (0.375) of the households was low and almost equals the mean (0.373), which may imply that many of the children are from lower-

income families. But in the third round (2009) this average family wealth index rose to 0.47, which might be the result of the recent robust economic growth seen in the country.

With respect to preschool access, preschoolers were reported to spend 34 hours a week at the centres. The average age of a child when first enrolled in preschool was just over four years (49 months) and was expected to stay at preschool for another three and a half years before progressing to primary education at age 7. Also, 91% of the caregivers were required to pay for their children to attend preschool, showing that the subsector is dominated by fee-charging preschools.

"----------
Table 2 about here
----------"

Although more than one-half of the urban children had the chance to attend preschool education, there was a considerable disparity between children of poor and rich families. To capture this disparity Figure 1 divides the sample children into four quartiles based on the baseline wealth, where the first quartile of families is considered as the 'poorest' (less than 0.25) and those in the fourth quartile as 'least-poor' (greater than 0.75). It appears that children's access to preschool is heavily influenced by the economic status of their families. For example, more than three-fourths of the children from the 'poorest' families never attended any preschool between the ages of three and five while 84% of the children from households at the top quartile had this opportunity. This signifies that many of the children who attended preschool are from affluent families. The inaccessibility of private preschools for children of the poor can also be seen by relating average wealth index to preschool types. The data show that these children who attended private preschool were from households with an average

baseline wealth index of 0.448, but these who were in community and partly public preschools were from households with average indexes of 0.386 and 0.360, respectively.

"----------
Figure 1 about here
----------"

What predictors relate to children attending or not attending preschool?

To identify the factors relating to children's preschool access empirically by controlling for relevant variables, we ran logit regression. In doing this, we checked if there was a multicollinearity problem by computing the condition index of the cross product (X'X) of the vector of predictors, X. According to Greene (2003, p.58), condition index in excess of the value 20 is an indicative of a multicollinearity problem. We found a condition index of 10.9, indicating that muticollinearity is not a serious problem in the analysis.

Table 3 presents the results of the logit regression. As the coefficients from the logit model cannot be interpreted straightforwardly we will focus on the marginal effects when interpreting this analysis. Consistent with the findings in Figure 1 the results show that the baseline family wealth index has a significant effect on the probability of preschool enrolment, where children from high-income families tend to have much higher probabilities of enrolment than children from lower-income families. The marginal value effect indicates that as wealth index rises by one percentage point above its baseline mean index, the probability of being enrolled in preschool for a child increases by 74.7%, confirming that household wealth is a strong determinant of preschool attendance in Ethiopia.

Another significant factor strongly affecting the probability of preschool enrolment is location of a child. When dealing with location, Addis Ababa is used a point of reference and in order to capture the level of preschool provision, the survey in SNNP has two sites (Hawassa city and the remaining urban areas). The marginal effects on location show that a child located in sites other than Addis Ababa has a significantly lower probability of enrolment. For instance, a child residing in the urban site of Amhara has 59.4% less probability than a child living in Addis Ababa. Enrollment is even lower for children living in the Tigray and SNNP regions (outside Hawassa city) who respectively have 71.5% and 74.6% lower probabilities. Parental education is also observed to have a positive influence on enrollment while early family separation and migration of a child from one area to another are related to a lower probability of enrollment. However, variables related to family size and composition, child's long-term health problem, short-term economic shocks and child gender were found to be insignificant determinants of preschool enrollment. While the non-significant result for gender may imply that there is no gender bias in preschool enrolment at early ages in Ethiopia, the non-significant finding for child health could be due to the fact that few of the urban sample children had long-term health problems (7.7%).

"----------
Table 3 about here
----------"

Does preschool experience in Ethiopia relate to children's cognitive development?

One of the most important issues in this study is to examine the potential impact of preschool experience on cognitive performance of 5 and 8 year-olds. To do this we initially tested for an overall t-value using the Hotelling T^2 test to check the issue of capitalizing on the mean difference of the outcomes. The T^2 value was highly significant (T^2= 12689.13 and P<0.01) indicating that we were not capitalizing on chance when computing multiple t tests.

As shown in Table 4 preschoolers had significantly higher cognitive scores than non-preschoolers. For example, the differences in standard PPVT scores between the two groups at the ages of 5 and 8 are respectively 14.37 and 35.12. The same is true with the percent of correctly answered CDA-Q5 and Maths tests, where preschoolers scored respectively 13.41 and 16.71 percentage points higher than non-preschoolers. Furthermore, children with preschool experience were more likely to enroll in formal schooling at age 7 than those without this experience. Early grade progression was also significantly higher for preschoolers than for non-preschoolers.

"----------
Table 4 about here
----------"

To examine the potential impact of preschool experience on cognitive development more robustly kernel matching score, in which preschoolers were considered as a treated group and non-preschoolers as a control group was estimated. This was done by initially estimating propensity score using a logit model of preschool attendance on a set of observed covariates that affect both preschool and cognitive development such as early childhood stunting and dummy variables that capture family separation, job loss, food unavailability, death/reduction in household members, severe illness, death of livestock and natural disaster. To ensure that

the preschool and non-preschool children look identical in terms of their covariates, we further ran a balancing test, which helps to check whether the propensity score model is adequately specified. Results indicated that the balancing condition is satisfied (readers wishing details on this analysis should contact the author of this paper at the e-mail address specified). The conditional probabilities estimated from the propensity score model were then used to compute the average treatment effect on the treated (ATT) in the kernel matching analysis (Leuven & Sianesi, 2003).

Table 5 presents the average treatment effect on the treated children (ATT). The ATT estimates suggest that there is a significant cognitive achievement advantage from receiving early childhood education. Statistically, 5-year-old children who attended preschool scored 31.2% higher in the PPVT test and 23.1% higher in the CDA-Q5 than those who did not. When the children reached the age of 8, preschoolers also scored respectively 36.1% and 59.2% higher in the PPVT and Maths tests, indicating that gains from preschool experiences increase as the children get older.

Moreover, preschool experience was found to have a strong impact on enrolment in primary school and grade progression, where there was 11.8 percentage points of difference in primary school enrolment between the two groups at age 7. Also, at age 8, preschoolers were, on average, more than a fifth of grade further on than the non-preschoolers. There are noticeable differences by gender as well. While preschool boys performed higher in the quantitative tests at the ages of 5 and 8, the opposite was the case with the receptive vocabulary tests. Boys also showed higher primary school enrolment and grade progression rates than girls of the same ages.

"----------
Table 5 about here
----------"

Does preschool attendance mediate the influence of family backgrounds on child cognitive performance?

The huge positive impact of family wealth, education and regional location on the probability of preschool enrolment seen in the logit regression leads to the question of whether those factors are also predictors of child cognitive performance by creating an opportunity to preschool access. To analyze such causal chains mediation analyses were computed following the procedures outlined by MacKinnon, Fairchild, & Fritz, (2007). The effects on child cognitive performance that come from household wealth, education and regional location through the influence of preschool attendance are termed as indirect (mediated) effects (Little, Preacher, Selig, & Card, 2007), while the direct contribution of those predictors (through everything from improved health and nutrition to stimulation and opportunity and parental behaviors) are called direct effects. On the whole, the indirect and direct effects add up to the total effects of the mediation process.

Table 6 reports the bootstrap results of the mediation analyses. Based on the significance criteria defined by Little et al (2007) the bias-corrected confidence intervals indicate that all the indirect effects of the three predictors and their total indirect (mediated) effect are statistically significant (as all bias-corrected confidence intervals do not contain zero). Such results imply that preschool attendance mediates the influence of family wealth, education and regional location on child cognitive performance in Ethiopia. To be more specific, in the PPVT test, the proportion of total effect that is mediated is 24.7%, which is one-third of the direct effects. It however is important to note that the proportion of indirect effects from family

wealth (20.9%) and regional location (13.4%) were found to be much larger than that of parental education (0.6%). The analyses on the Maths test also show similar results, where the indirect effects from family wealth (29.6%) and regional location (19.1%) were much greater than the effect coming from parental education (0.8%).This part of the mediation analysis also reveals that the percentage of total effect mediated on the Maths test is about 23.3%, which also makes up nearly one-third of the direct effects.

"----------
Table 6 about here
----------"

Discussion and Conclusions

This study used a very rich dataset, gathered over 3 time periods (infancy, early childhood, and elementary age) with very low attrition rates, to examine the main factors relating to children's preschool access and its associated contribution to cognitive performance and school readiness. The data obtained from the surveys reveal that only 25% of the preschool age children have the opportunity to attend this vital stage of education in Ethiopia, with significant disparities between urban and rural areas. The data also show that the subsector is dominated by fee-charging preschools, where nine out of ten primary caregivers are required to pay preschool fees.

In spite of such a scenario, the Government of Ethiopia does not run public preschool programmes, aiming to maximise its effort at the other levels of the education sector and to enhance the involvement of the private sector. This shows that the current policy in this subsector is creating a huge divide between children of the rich and poor and rural and urban areas.

Motivated by this fact, we analyzed the main factors that lead to children's differential access to preschool and its link with cognitive scores of 5 and 8 year olds, employing logit model, kernel matching techniques and mediation analyses. Results from the logit model indicate that household wealth, education and regional location are found to be very strong determinants of preschool enrolment. The effect of household wealth on the probability of a child to get enrolled is particularly high, suggesting that preschool attendance in Ethiopia is basically perceived as a luxury service provision rather than a necessity. Additional analysis by baseline wealth index quartiles indicates that more than three-fourths of the children from the poorest households never attended any preschool, while more than four-fifths from the least-poor had this opportunity, confirming that only privileged children are likely to attend preschool in Ethiopia. The same is true with regional location, where a child living in Addis Ababa has much higher probability of enrolment than a child living in urban parts of the other regions. Evidence that the probabilities of enrollment are much lower in Tigray and SNNP (excluding Hawassa city) regions indicates that existing preschool centers are mainly concentrated in big cities/towns, where only middle-income sections of the society can afford preschool for their children.

Estimates from the kernel matching analysis also consistently show that preschool attendance has a strong positive effect on children's cognitive development. The result show that 5-year-old children who attended preschool scored significantly higher in the standard PPVT and CDA-Q5 tests than those who did not. When the children turned 8, compared to the non-preschoolers, preschoolers also scored significantly higher in the standard PPVT and Maths tests, indicating that gains from preschool experience increase as children grow older, which

is in line with the concept of "skill begets skill" (Heckman, 2006). Enrolment in primary school was also much higher for preschoolers, with better progression, than for non-preschoolers.

What is more, bootstrap results from the mediation analyses reveal that family economic disparities and regional location of a child predict inequalities of preschool participation in Ethiopia and that these inequalities in early education in turn predict child cognitive performance, as well as later outcomes such as middle-childhood educational inequalities.

What can be inferred from the results of this study is that preschool education, though not a panacea, substantially improves the cognitive development and school readiness of children and contributes a paramount role for early skill formation, through which growing educational inequalities might be reduced. However it is paradoxical to expect full potential development of children and future educational equalities if the provision of early childhood schemes favours children of the rich and excludes the poor and marginalized ones. Therefore, these findings are a wake-up call for the Ethiopian government to reduce the existing high divide in children's development through public investment by giving preschool the same priority as the primary, secondary and tertiary education sectors. By doing this, it might be possible to equalise initial endowments among children and reduce future educational inequalities.

Table 1. Sample size by Round (R) and preschool experience

Residence area	R1 (2002)	R2 (2006)	R3 (2009)	Preschool Attendance
Urban area	700	762(+)	745	56.91%
Rural Area	1299	1150	1139	3.33%
Total	1999	1912	1884	24.53 %

Note: *(+) the increase in the urban sample in R2 is because of mobility of the sampled Children from rural to urban areas*

Table 2. Descriptive statistics (urban sample N=745)

Variables	Mean	Std.Dev.
Child is male (%)	52.22	0.5
Highest grade completed by father	6.58	4.74
Highest grade completed by primary caregiver	4.97	4.30
Family wealth index in Round 1 (2002)	0.37	0.14
Family wealth index in Round 3 (2009)	0.47	0.15
Number of family members <7&>65 years	1.52	0.70
Number of children between 7 &17 years	1.30	1.34
Number of male family members >17& <65 years	1.16	0.82
Number of female family members >17&<65 years	1.40	0.82
Household size	5.83	2.06
Length of time child was breastfed (months)	28.94	13.51
Child had long term health problem (%)	7.70	0.26
Child had any health problem before age 1(%)	43.18	0.49
Shock in input prices (%)	19.10	0.39
Divorce or separation of family (%)	5.80	0.23
Child attended preschool (%)	56.91	0.49
Caregiver had to pay for child to attend (%)	91.27	0.28
Length of time child attended pre-primary school (years)	3.72	0.74
Age when first attended pre-primary school (months)	48.25	8.78
Hours per week child attended pre-primary school	35.11	6.10
Child being enrolled in private preschool (%)	75.71	0.42
Child being enrolled in partly public preschool (%)	13.21	0.33
Child being enrolled in community preschool (%)	11.08	0.31

Table 3. Logit model estimation of preschool attendance (Enrolment=1, otherwise 0)

	Coef.	Marginal effect	Std. Err.	P>z
Dummy variable for urban site of Amhara region	-2.986	-0.594	0.049	0.000
Dummy variable for urban site of Oromia region	-3.586	-0.65	0.041	0.000
Dummy variable for urban site 1 in SNNP region	-5.37	-0.746	0.03	0.000
Dummy variable for urban site 2 in SNNP region	-0.872	-0.213	0.109	0.05
Dummy variable for urban site Tigray region	-4.704	-0.715	0.033	0.000
Dummy variable for a child mobility out of site	-2.709	-0.541	0.059	0.000
Wealth index for 1-year-olds (Round 1)	3.177	0.747	0.269	0.006
Highest grade completed by father	0.158	0.037	0.007	0.000
Dummy for male	0.073	0.017	0.057	0.763
Number of family members < 7&>65 years	-0.295	-0.069	0.04	0.081
Number of children between 7&17 years	-0.103	-0.024	0.021	0.253
Number of male family members >17&< 65 years	-0.102	-0.024	0.039	0.542
Number of female family members >17&< 65 years	0.252	0.059	0.04	0.138
Dummy for a child had long term health problem	-0.513	-0.125	0.126	0.321
Dummy for increased input prices	0.213	0.049	0.074	0.506
Dummy for divorce or separation of family	-1.181	-0.287	0.12	0.016
Constant	0.861			
Number of observations	745			
Log-Likelihood	-235.22			
Pseudo R^2	0.538			

Note: (1) Addis Ababa is used as a point of reference for regional variation

(2) Condition index of the explanatory variable is computed to be 10.9

Table 4. Urban children's cognitive development, enrolment and grade progression at the ages of 5, 7 and 8

	Non-pre-schoolers	Pre-schoolers	Mean difference	
			difference	P value
Standardized PPVT score at age 5	68.02	82.39	-14.37	0.000
Standardized PPVT score at age 8	79.31	114.44	-35.128	0.000
CDA-Q5 questions correctly answered at age 5 (%)	55.26	68.67	-13.41	0.000
Maths questions correctly answered at age 8 (%)	25.28	42.00	-16.71	0.000
Children enrolled in primary school at age 7 (%)	77.88	94.33	-16.45	0.000
Grade completed at age 8	0.775	1.036	-0.260	0.000

N=745

Table 5. Impact of preschool on child cognitive development, enrollment and grade progression at the ages of 5, 7 and 8, kernel matching analysis

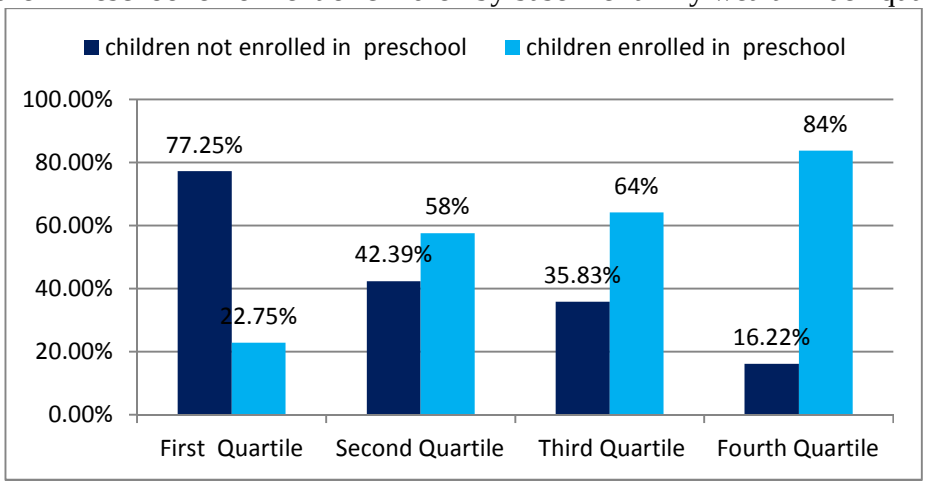
Outcome variables	Girls and boys		Girls		Boys	
	ATTk	T-stat	ATTk	T-stat	ATTk	T-stat
Ln (PPVT score) at age 5	0.312***	9.27	0.410***	6.24	0.307***	4.10
Ln (CDA-Q5 score) at age 8	0.231***	8.66	0.253***	4.54	0.233***	4.12
Ln (PPVT score) at age 5	0.361***	13.310	0.356***	9.13	0.370***	9.91
Ln (Maths score) at age 8	0.592***	10.780	0.601***	8.08	0.614***	7.65
Children enrolled in primary school at age 7 (%)	0.118***	4.640	0.098**	2.86	0.162***	4.25
Grade completed at age 8	0.218***	4.640	0.216***	3.00	0.252***	4.21

Notes: ATTk= Average treatment effect on the treated from kernel matching; *** p<0.01, ** p<0.05, * p<0.1

Table 6. Bootstrap Results of Mediation Analyses (preschool attendance as a mediator)

Dependent variable	Observed	Bootstrap	Bias-corrected confidence	
Ln (PPVT score) at age 8	Coef.	Std.err.	interval (95%)	
Indirect effect of family wealth	0.209	0.040	0.137	0.301
Indirect effect of parental education	0.006	0.001	0.003	0.008
Indirect effect of regional location	0.134	0.018	0.101	0.173
Total indirect effect	0.349	0.052	0.253	0.461
Proportion of total effect mediated	0.247			
Ratio of indirect to direct effect	0.326			
Dependent variable				
Ln (Maths score) at age 8				
Indirect effect of family wealth	0.296	0.063	0.184	0.431
Indirect effect of parental education	0.008	0.002	0.004	0.012
Indirect effect of regional location	0.191	0.035	0.128	0.265
Total indirect effect	0.495	0.091	0.341	0.703
Proportion of total effect mediated	0.233			
Ratio of indirect to direct effect	0.301			

Figure 1 Preschool enrolment of children by baseline family wealth index quartile



References

Blundell, R., & Costa Dias. (2008). Alternative Approaches to Evaluation in Empirical Microeconomics. *Institute for the Study of Labor, IZA DP No. 3800.*

Bransford, J.D. (1979). Human Cognition: Learning, Understanding, and Remembering, Belmont, CA: Wadsworth

Campbell, A., Ramey, T., Pungello, E., Sparling, J., & Miller-Johnson, S. (2002). Early Childhood Education: Young Adult Outcomes from the Abecedarian Project. *Applied Developmental Science, 6 (1),* 42–57

CSA. 2013. Population Projections for Ethiopia: 2007-2037, Central Statistical Agency, Addis Ababa, Ethiopia

Cueto, S., Leon, J., Guerrero, G., & Muñoz, I. (2009). Psychometric characteristics of cognitive development and achievement instruments in round two of Young Lives. Young Lives. *Technical Note* No. 15, January 2009.

Cunha, F., & Heckman, J.J. (2007).The Technology of Skill Formation. American Economic Review, 97(2), 31–47.

Currie, J.(2001).Early Childhood Education Programs. *Journal of Economic Perspectives, 15(2), 213–38*

Dunn, L. M., & Dunn, L. M.(1997). *PPVT-III: Peabody picture vocabulary test*. American Guidance Service Circle Pines, MN.

Grantham-McGregor, S., Cheung, Y. B., Cueto, S., Glewwe, P., Richter, L., Strupp, B., et al. (2007). Developmental potential in the first 5 years for children in developing countries. Lancet, 369(9555), 60-70.

Glick, P. (2007). Cognitive Skills among Children in Senegal: Disentangling the Roles of Schooling and Family Background, *SAGA Working Paper, JEL: I21, J24*

Goodman, A., & Sianesi, B.(2005). Early Education and Children's Outcomes: How Long Do the Impacts Last? *Institute for Fiscal Studies, 26(4),* 513–48

Greene, W. (2003). Econometric Analysis. 3rd ed. New York: MacMillan

Heckman, J.J. (2006). Skill Formation and the Economics of Investing in Disadvantaged Children. *Applied Developmental Science, 312.5782:* 1900–2

Hidalgo, G.N., & Urzua, S. (2010). The Effect of Participation in Public Childcare Centers: Evidence from Chile.

Leuven, E., & B. Sianesi. (2003). PSMATCH2: Stata Module to Perform Full Mahalanobis and Propensity Score Matching, Common Support Graphing, and Covariate Imbalance Testing, Chestnut Hill, MA: Boston College

Little, T. D., Preacher, K. J., Selig, J. P., & Card, N. A. (2007). New developments in latent variable panel analysis of longitudinal data. *International Journal of Behavior Development, 31, 357-365.*

Macours, Karen., Schady, N.R., & Vakis, R. N. (2008). Cash Transfers, Behavioral Changes, and Cognitive Development in Early Childhood: Evidence from a Randomized Experiment. *Policy Research WP 4759*

MacKinnon, D.P., Fairchild, A.J., & Fritz, M.S. (2007). Mediation analysis. *Annual Review of Psychology, 58, 593-614*

Magnuson, K., & Duncan, G.J. (2014). Can Early Childhood Interventions Decrease Inequality of Economic Opportunity? Prepared for the FED of Boston Conference, Inequality of Economic Opportunity, Boston, Massachusetts.

Malmberg, L.E., Mwaura, P.,& Sylva, K. (2010). Effects of a Preschool Intervention on Cognitive Development among East-African Preschool Children. Early Childhood Research Quarterly, 26(1), 124–33

Ministry of Education. (2010, 2013). *Education Statistics Annual Abstract Report*, Addis Ababa: Ministry of Education of Ethiopia

Shonkoff, J.P.,& Phillips, D.A. (2000). From Neurons to Neighbourhoods: the Science of Early Childhood Development. Washington, DC*: National Academy Press*

Susanna, L. (2005). How much is too much? The influence of preschool centers on children's social and cognitive development. *Economics of Education Review* 26(1):52–66.

UNESCO. (2006b). Strong foundations: Early childhood Care and education. EFA Global Monitoring. Paris: *UNESCO.*

Young Lives. (2008).Young Lives: Ethiopia Round 2 Survey Report. *Young Lives Country* Report, Oxford: Young Lives.

Zuilkowski, S. S., Fink, G., Moucheraud, C., & Matafwali, B. (2012). Early childhood education, child development and school readiness: Evidence from Zambia. South African Journal of Childhood Education, 2(2), 117-136.