89

Working Paper

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An International Study of Childhood Poverty

The Effects of Pre-school Attendance on the Cognitive Development of Urban Children aged 5 and 8 Years

Evidence from Ethiopia

Tassew Woldehanna and Liyousew Gebremedhin

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Contents

Abstract

This paper, using data from the Young Lives longitudinal survey in Ethiopia, examines the effects of pre-school attendance on the cognitive development of urban children at the ages of 5 and 8 (measured by the Peabody Picture Vocabulary Test (PPVT) and the Cognitive Development Assessment – Quantitative test (CDA-Q)). We used propensity score matching techniques in order to estimate the impact of pre-school. We also substantiated the analysis using various empirical approaches including ordinary least squares and instrumental variable estimation methods. Our results show that pre-school attendance has a statistically significant positive impact on the cognitive development of children at the ages of both 5 and 8 years, with the bigger impact at the latter age. Moreover, pre-school attendance has also a positive and statistically significant effect on primary school enrolment and progression through grades. Despite the fact that early childhood education has immense importance for children's cognitive development, public investment in pre-school education is currently limited in Ethiopia, with the private sector taking the key role, which may exacerbate the inequality that exists between rich and poor (and between urban and rural areas). Therefore, given the relatively low rate of pre-school attendance and the low quality of basic education, the Government needs to reconsider its education priorities so as to invest more in early childhood education.

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About Young Lives

Young Lives is an international study of childhood poverty, following the lives of 12,000 children in 4 countries (Ethiopia, India, Peru and Vietnam) over 15 years. **www.younglives.org.uk**

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1. Introduction

Recent research in the fields of health, neuroscience, psychology and cognition has found that cognitive and non-cognitive stimulation in early life are critical for long-term skill development, as key brain pathways for subsequent learning and lifelong capabilities begin to form during the early stages of life (Hidalgo and Urzua 2010; Shonkoff and Phillips 2000; Bransford 1979; Shore 1997; Sternberg 1985). Hence, early childhood is a crucial time for governments to invest in interventions that benefit a child in several dimensions, including the physical, the intellectual and the social (Hidalgo and Urzua 2010). Returns to investments made in early childhood will be higher than those to investments made later in life simply because beneficiaries have a longer time to reap the rewards (Becker 1964).

Early childhood education is also seen by many as an integral part of basic education and represents the first step in achieving the goals of Education For All in particular (UNESCO 1996) and encouraging human skill formation in general (see, among others, Cunha et al. 2006; Heckman 1999; Currie 2001; Goodman and Sianesi 2005). The human capital literature in the field of economics has also placed emphasis on investing in children at an early age and demonstrated its importance empirically (Becker 1993; Heckman et al. 2003; and Cunha and Heckman 2007). One reason for this is that a well-conceived, high-quality early childhood education helps to meet the diverse needs of young children during the crucial early years of life and enhance their readiness for schooling, and has a positive and influence on later school achievements; and a second reason is that investments in human capital have dynamic complementarities (Carneiro and Heckman 2003; Carneiro et al. 2006). There is a strong multiplier effect associated with public investment in early childhood, whereby investment in the early years, particularly for disadvantaged children, can make investment in the later years more productive since remediating early disadvantages later may be prohibitively costly (Hidalgo and Urzua 2010; Heckman 2006).

The effect of early childhood education is not limited to the cognitive development of young children, but also to a number of non-cognitive skills such as motivation, self-discipline and socialisation (Heckman 2007; Cunha et al. 2006; Carneiro, et al. 2003; Helmers and Patnam 2009). Nevertheless, as cognitive ability is less malleable later in life than non-cognitive ability, intervening to improve cognitive functioning should begin early in life (Heckman and Masterov 2007: 16). Additionally, cognitive skills are also much easier to measure at early ages compared to non-cognitive skills (Connelly 2008).

Woodhead (2009) states that early education may be the single most effective intervention for helping poor children, families, communities and nations break the intergenerational cycle of poverty. Currie (2001) also believes this and suggests that it may be more effective for a government to equalise initial endowments through early childhood development programmes than to compensate for differences in outcomes later in life. Nevertheless, despite the appeal of public investment in early childhood development, relatively few rigorous and systematic evaluations of early childhood education programmes have shown the effects of these interventions in developing countries, particularly on cognitive and non-cognitive skill indicators (Hidalgo and Urzua 2010).

Early childhood education in Ethiopia is provided predominantly by the private sector, non-governmental organisations (NGOs), and religious institutions. Except for some technical support and quality monitoring, the Government has a very limited role in pre-school education (MOFED 2010). Pre-school education in Ethiopia is not compulsory and no budget is allotted to it by the Government. Rather, the sector is dominated by fee-charging nursery schools and kindergartens that mainly meet the needs of middle-class parents living in urban and semi-urban areas of the country. Due to this set-up, pre-school enrolment is limited to urban areas and children from richer families.

Woldehanna (2011) analysed the impact of pre-school attendance on the cognitive development of 5-year-old children. One question arising from that study is whether the effect of pre-school education on cognitive development would persist at later ages. The aim of this paper is, therefore, to analyse the persistence of the effect of early childhood education on the cognitive development of children, and to identify policy implications. Specifically, the objectives of the paper are:

1. to analyse the effect of pre-school attendance on the verbal cognitive development of children at around the ages of 5 and 8 years (as measured by Peabody Picture Vocabulary Test scores), and on their quantitative cognitive development (as measured by Cognitive Development Assessment – Quantitative test scores);
2. to analyse the effect of pre-school attendance on the age of entry into primary school and on progression through the early grades of primary school; and
3. to identify the implications for government policy on pre-school education.

We employed various econometric techniques including ordinary least squares (OLS), instrumental variables (IV) and propensity score matching estimation methods in order to estimate impacts. We used the longitudinal dataset of Young Lives,[1] analysing data from the Younger Cohort in Ethiopia, composed of 2,000 children followed for three survey rounds, when the children were aged 1, 5 and 8 years in 2002, 2006 and 2009, respectively.

The findings of this study contribute to the existing literature in a number of ways. First, we find that early childhood education has an impact on the cognitive development of children that persists up to the age of 8 years. Hence, this could add weight to the argument for the expansion of government (public) pre-schools, as we believe this is the foundation for sustainable quality education in the country. Second, beyond the supply-side response, it may eventually create a demand-side response: most people currently consider pre-school a luxury that can be substituted easily by primary school but this study offers some evidence for raising communities' awareness of the advantages of sending their children to pre-school so that better educational performance can be achieved in the future. Moreover, this study also adds more evidence from one developing country, Ethiopia, to the existing educational empirical literature.

The rest of the paper is structured as follows. Section 2 presents a related literature review together with the assessment of the Ethiopian early childhood education trends. Section 3 lays down the framework for the econometric analysis and describes the data. Section 4 presents the descriptive statistics and section 5 contains the empirical results. Concluding remarks with policy-relevant implications are provided in section 6.

1 Young Lives is a 15-year-study of childhood poverty in four developing countries: Ethiopia, India (in the state of Andhra Pradesh), Peru and Vietnam. It follows two cohorts of children in each of these countries. More information about the sample is given in sub-section 3.2.

2. Literature review and Ethiopian context

2.1 Review of studies on pre-school education and cognitive development

A large body of literature makes the case for investment in early childhood development. The early years of life are critical for the acquisition of concepts, skills and attitudes that lay the foundation for life-long learning (Cunha et al. 2006; Carneiro and Heckman 2003). Early childhood is the time when children's brain development advances at a pace greater than any other stage in life as many of the brain's structures and biochemical routes are developed in the first two years of life (Bruner 1999; Halfon et al. 2001). Heckman (2007) states that skill formation is easier at early period because the skill grows along with the development of brain neurons. The literature on human capital, hence, puts a great deal of emphasis on the significance of early childhood education (Heckman and Klenow 1997; Cunha et al. 2006).

A number of authors have developed a model of skill formation that allows them to assess education and training policies over the life cycle of a person (see, among others, Heckman 2000; Carneiro and Heckman 2003; Cunha et al. 2006). The key insight of this model is that the formation of skills is a life cycle process that demonstrates both self-productivity and complementarity, where education gained at one stage is an input into the learning process at the next stage, implying that skills are self-reinforcing. Similarly, the productivity with which investments at one stage of education are transformed into valuable skills is positively affected by the level of skills that a person has already obtained in the previous stages, implying that skills produced at one stage raise the productivity of investment at subsequent stages. Jointly, these features of self-productivity and complementarities produce a skill multiplier whereby an investment in education at one stage not only directly raises the skills attained at that stage, but also indirectly raises the productivity with which educational investments at the next stage will be transformed into further skills (Carneiro and Heckman 2003; Cunha et al. 2006; Woessmann 2006).

The human capital argument also stresses that there are multiple important skills, both cognitive and non-cognitive, and that for some of these skills (most notably on the cognitive side), there are sensitive or even critical periods in a person's life cycle where investments are particularly effective or even crucial, and that inadequate early investment is difficult and costly to remedy later on (Cunha et al. 2006; Woessmann 2006). This signifies that investment in education is more effective when made at an early stage of development than in later years, as young children's cognitive ability and behaviour are more malleable than those of adults (Connelly 2008; Heckman and Masterov 2007).

In the education literature it has been widely argued that there is always a trade-off between efficiency and equity objectives, where one can only be achieved at the expense of the other (see, for example, Cunha et al. 2006; Becker and Tomes 1986; Becker and Tomes 1979). However, the EACEA (2009) notes that, viewed from a wider perspective, equity and efficiency are in fact mutually reinforcing if investment is made in early childhood education. It is both more efficient and more equitable to invest in education very early: correcting failure later on is not merely inequitable, but highly inefficient in comparison. This is so not only because early childhood education facilitates later learning, but also because it can produce large socio-economic returns, especially as regards disadvantaged children (Heckman 1999; EACEA 2009). Currie (2001) hypothesises that families may under-invest in early childhood because of market failures such as liquidity constraints and information failures. Hence, public investment in high-quality early childhood education can produce important long-term improvements in the intellectual and social development of disadvantaged children.

In addition to the human capital argument, there is a strong justification from the human rights side, which argues that the responsibility to protect a child's human rights is the most important reason to invest in programmes to enhance early childhood development (Myers 1995; Woodhead 2009). While there is substantial empirical evidence that pre-primary school programmes targeted at disadvantaged children have significant benefits for the children (Lee et al. 1990; Barnett 1995; Currie and Thomas 2000; Schweinhart et al. 2005), little is known about the benefits for the population as a whole (Cascio 2009; Magnuson et al. 2004).

A huge body of empirical works demonstrate the effects of early childhood education on a child's cognitive, language and social development, mainly in Western Europe and North America, particularly in the United States. Still, little has been learned about the relationship between early childhood education and child outcomes in settings outside developed countries, although comparable research is being done in a growing number of developing countries (UNESCO 2010).

Behrman et al. (2004) assessed the impact of the Bolivian Integrated Child Development Program on multiple child outcome measures. Using generalised propensity score matching methods to allow programme impacts to be estimated as non-parametric functions of age and duration, the study found that the programme had positive impacts on participants' gross and fine motor skills, psychosocial skills, and language acquisition. Impacts were found to be cumulative, with greater impacts associated with longer programme exposure, particularly longer than a year.

Berlinski et al. (2009) studied the effects of a national, publicly funded early childhood education programme on primary school achievement in Argentina. Using an identification strategy, they took advantage of the variation in treatment intensity across regions and cohorts to estimate the effect of expanding pre-primary school facilities on subsequent achievement in primary school. Their results showed that attending pre-primary school had a positive causal effect on subsequent third grade standardised Spanish and mathematics test scores. They estimated that one year of pre-primary school increased average third-grade test scores by 8 per cent and a quarter of a standard deviation. They also found that pre-primary school attendance positively affected students' self-control as measured by attention, class participation and self-discipline.

A similar study by Berlinski et al. (2008) in Uruguay using a household survey that collected retrospective data on pre-school attendance showed significant and positive effects of pre-school attendance on completed years of primary and secondary education via a reduction in grade-retention rates since early school years and a reduction in drop-out rates among teenagers who had attended pre-school.

Bernal and Keane (2010) collected quasi-experimental data on Colombian children aged 0 to 6 years, to evaluate the effects of a community-based welfare programme on the nutritional status, health, cognitive and psychosocial development of children. Relying on choice-based sampling, the evaluation employed non-parametric propensity score matching methods to estimate the impact of the programme, while taking into account the length of duration. The results indicate that there were short-term positive and significant effects on the cognitive and psychosocial development of children who had participated in the programme for at least 16 months. Their results also indicated that the programme had a positive and significant effect on nutritional status, measured by a reduction in the probability of chronic malnutrition. In addition, the study implemented an instrumental variables technique to estimate the medium-term effects of the programme on cognitive development and found positive effects of participating in the welfare programme on academic achievement in the fifth grade, particularly in the area of language, conditional on participating in the programme for a longer period of time.

Magnuson et al. (2004), using nationally representative longitudinal data from US children, analysed whether pre-kindergarten education (nursery education given to children below the age of 3) increased school readiness at kindergarten entry and whether any of the effects lasted. In the analysis, controlled by various socio-economic variables and state dummies, pre-kindergarten attendance was instrumented by state expenditure on early childhood education and care. The findings indicated that pre-kindergarten attendance increased maths and reading skills at kindergarten entry, but was also associated with an increase in behavioural problems. Furthermore, while the cognitive gains largely faded out by the spring of first grade, the negative effects on classroom behaviour did not. In fact, the largest and most lasting academic gains were found for disadvantaged children. Similarly, Loeb et al. (2005) examined the influence of pre-school centres on children's cognitive and social development using longitudinal data. To identify the effects, the authors employed OLS, instrumental variables and matching estimates. The main findings indicated that pre-school centres raised reading and maths scores, but had a negative effect on socio-behavioural measures.

Campbell et al. (2002) also examined the effect of a scientific experimental centre on children's cognitive and non-cognitive behaviour using data from a longitudinal study of the benefits of early childhood educational intervention. The results from OLS and matching estimations showed that the treated children on average had relatively higher cognitive ability, captured by test scores, than untreated children. The treated children got better results for reading and mathematical skills tests and attended school for more years compared to untreated children and were more likely to join college. The result further showed that the difference in cognitive ability between the treated and untreated was wider for girls than boys. Looking at non-cognitive skills, the result shows that teenage pregnancy was greatly reduced among the treated children, though it was not possible to avoid it totally.

Using the Chicago Longitudinal Study, Reynolds and Temple (1998) studied the impact of public pre-school and kindergarten programme on child development outcomes. The study contained 1,150 young children living in poverty. who attended the Chicago Child-Parent Centres. These centres provided comprehensive educational support and family support to economically disadvantaged children between the ages of 3 and 9 and their parentsSpecial , ensuring a stable transition from pre-school to early primary school. The children were enrolled for varying lengths of time, which allowed the researchers to examine the long-term effects of differing levels of participation beginning at different ages. Results of the study demonstrated that children who were involved in the programme had higher reading and maths scores during adolescence than those who had not participated. Children who had been involved in the programme experienced lower grade-retention rates and lower special education placement by the age of 20. Children who had attended full-day kindergartens had significantly lower rates of special education and grade retention. Cost–benefit analysis of the programme indicated that every dollar invested in the pre-school programme returned US$7.14 in education, social welfare, and socio-economic benefits by reducing public expenditure on remedial education, criminal justice treatment and crime victims.

Taking into account any early schooling and pre-school participation among a cohort of British children born in 1958, Goodman and Sianesi (2005) assessed whether any effects on cognition and socialisation were long-lasting, as well as their net impact on subsequent educational attainment and labour market performance. Employing a fully interacted linear model and matching method, as well as controlling for a particularly rich set of child, parental, family and neighbourhood characteristics, the study found that early education had a positive and long-lasting effect. Specifically, pre-compulsory education (pre-school education or school entry prior to the age of 5) was found to yield large improvements in cognitive tests at the age of 7 and remained significant throughout the school years, up to the age of 16. The effects on socialisation appear to be more mixed, according to parental reports of adverse behaviour of children at the age of 7. In adulthood, pre-compulsory schooling was found to increase the probability of people obtaining qualifications and being employed at the age of 33.

Cleveland and Krashinsky (1998) also separately assessed the effects of pre-school education on the cognitive and behavioural development of children aged 5 and 10 using several different types of ordinary pre-school programmes (from full-day, full-week day nurseries to part-day, part-week playgroups with parental participation). Based on 'analyses of variance' controlling for a number of important socio-economic and family factors, they found that pre-school education generally boosted cognitive attainment at the ages of 5 and 10. In terms of problem behaviour, pre-school education was found to have no effect at the age of 5 but to increase some types of behavioural problems at the age of 10, in particular conduct disorder, although the latter associations were relatively weak. The study also found weak evidence for the benefits of nursery education being slightly greater for socially disadvantaged children, although this difference was small compared to the general benefit of pre-school education for all children.

Sylva et al. (2002) conducted a large-scale study following 2-year-olds and older children attending pre-school. At school entry they had better cognitive outcomes (pre-reading, early number and language skills) and superior social and behavioural skills than their peers without pre-school experiences; longer pre-school attendance led to higher cognitive gains when entering school; and the cognitive gains of attending pre-school were larger for disadvantaged children. Carneiro et al. (2006) investigated the determinants and consequences of cognitive skills and social adjustment of children in Britain. The result showed that children from the professional and managerial social classes had higher cognitive and non-cognitive skills at age of 7. Moreover, parents' education, the interest of parents in their children's education and how much the parents read to them also made a positive contribution to the development of children's cognitive skills.

Lefebvre and Merrigan (2002), however, found negligible effects in their investigation of the relationship between childcare arrangements and developmental outcomes of young children using data from the Canadian National Longitudinal Survey of Children and Youth. The results suggest that infant/toddler non-parental care arrangements had insignificant or negligible impacts on developmental outcomes. For pre-schoolers, modes of care and early education did not, on average, influence cognitive development. The results of fixed-effect estimates for a sample of siblings aged 0–47 months confirmed the preceding conclusion. The analysis was repeated to identify the determinants of the probability the child's test score would be in the bottom part of the distribution of test scores and the conclusions were similar.

The related research for Africa is very scant. Very few studies have been conducted to assess the effects of pre-school attendance on the cognitive development of children. For instance, Glick and Sahn (2009) estimated the determinants of cognitive ability among 14- to 17-year-olds in Senegal. Unlike standard school-based samples, tests were administered to children no longer – or never – enrolled, as well as to current students. Results of the study indicated that the number of years of schooling strongly affected cognitive skills, but such effects are conditional on parental education and household wealth, as well as the quality of local state schools. Family background primarily affected skills indirectly through its impact on the number of years of schooling. Therefore closing the years of schooling gaps between poor and wealthier children might help to minimise the gap in cognitive skills between these groups.

A study by Malmberg et al. (2010) investigated the effects of a child-centred intervention programme on the cognitive development of East African children attending pre-school (in Kenya, Zanzibar and Uganda). Altogether 321 children (153 non-interventions and 168 interventions) participated in a cross-sequential study over three time-points during children’s pre-school years (mean ages 4.3, 6.0 and 7.1 years). A multilevel model in which time was coded flexibly (i.e., child’s age operationalised as months from start of the intervention), showed a beneficial curvilinear effect of the intervention programme on children’s cognitive gains. A moderation analysis suggested that the effect of observed pre-school quality was stronger in the intervention programme.

The various studies mentioned above are almost unanimous about the cognitive benefits of early childhood education, but there is quite a big variation among studies regarding the degree of benefit, and the research into effects on behaviour and non-cognitive skills has had more mixed results. Moreover, many of the studies depend on experimental methods rather than observational data or natural experiment which cast doubts on the applicability of the results to Africa and specifically for Ethiopia.

To our knowledge, very few studies have been conducted related to early childhood education in Ethiopia. Using Young Lives longitudinal data, Woldehanna et al. (2008) estimate correlates of pre-school enrolment for 5-year-old children from a probit model. The findings of this study indicate that having more-educated parents, being from a Muslim household and having long-term health problems in the family have positive and statistically significant associations with the probability of a child being enrolled in pre-school, in the latter case perhaps because the parents feel the extra support will be helpful to their child or the family.. However, the more older siblings a 5-year-old has, the less likely he or she is to be enrolled in pre-school. Another study by Woldehanna (2011) used the same dataset to investigate the effects of early childhood education on the cognitive development of pre-school age children (5 years old), with particular emphasis on the urban parts the country. The study employed ordinary least squares, instrumental variable estimation and propensity score matching techniques. Across all these models, the results persistently showed that early childhood education was positively associated with a substantial improvement in children’s cognitive development. In this paper we want to see if there is still a significant positive association between pre-school education and cognitive development at a later age, including performance in primary education.

2.2 Early childhood education in Ethiopia

Formally, compulsory education in Ethiopia starts at the age of 7 in primary school. Nevertheless, children can join pre-primary schools between the ages 3 to 6, depending on the availability of the programme in their areas. Early childhood education is in the form of kindergarten schools and predominantly provided by the private sector, NGOs, communities and faith-based organisations. Government intervention is very limited. In its 2007/8 report (MOE 2009), the Ministry of Education states that the Government does not run a pre-school education programme for two main reasons. While one reason, as stated in the document, is to enhance the involvement of the private sector in the education sector, the second justification is to maximise the Government's effort at the other levels of the sector. As a result of this limited government intervention, the enrolment rate for pre-school education has remained very low, especially in rural areas. In addition, primary education is currently accepted as a substitute for pre-school education in most parts of the county. That is, the majority of students are enrolled in primary education without having any exposure to a pre-school programme.

Data compiled by the Ministry of Education for its 2008/9 report (MOE 2010) indicate that out of the estimated 7.31 million children of the appropriate age group (ages 4–6), only about 382,741 (5.2 per cent) are reported to have accessed pre-primary education. However, a closer examination of the Ministry of Education data reveals that even though enrolment is low, it has been growing since 2006/7 at approximately 13.8 per cent per year for the past five years. In 2010/11 the gross enrolment rate in kindergarten (defined as the percentage of the total number of children in kindergarten, irrespective of age, out of the total pre-school age population) was 5.2 per cent, higher than the previous year by about 0.4 percentage points. Similarly, albeit still inadequate, the number of kindergartens has increased from year to year, growing from 964 kindergartens in 2000/1 to 3,418 in 2010/11, with an average annual growth rate of 10.3 per cent between 2006/7 and 2010/11. Table 1 gives an overview of enrolment rates in pre-school education in Ethiopia from 2000 to 2011, disaggregated by gender.

Table 1. *Gross enrolment rate in pre-school education in Ethiopia, 2000–11, by gender (%)*

Year	Boys	Girls	Total
2000/1	2.0	2.0	2.0
2001/2	2.1	2	2.1
2002/3	2.0	2.0	2.0
2003/4	2.2	2.1	2.2
2004/5	2.4	2.3	2.3
2005/6	2.8	2.6	2.7
2006/7	3.2	3.1	3.1
2007/8	3.9	3.9	3.9
2008/9	4.2	4.2	4.2
2009/10	4.8	4.7	4.8
2010/11	5.3	5.2	5.2

Source: Authors' compilation based on MOE (2009) and MOE (2010).

Despite the trend of the pre-school enrolment rate to increase at the national level, differences between regions and between urban and rural areas are stark. For example, in

2008/9, in Addis Ababa the pre-school gross enrolment rate was 74 per cent. Dire Dawa (20 per cent) and Harari (11 per cent) have the next highest enrolment rates. However, for all the remaining regions, the gross enrolment rates were less than the national average gross enrolment rate over the years 2000/1 to 2010/11. The Ministry of Education (MOE 2010) reports that in urban areas there is a large increase in parents' desire to have their children attend kindergartens. However, there seems to be such change in attitudes in rural areas. A similar enrolment pattern to the national figures is observed in Young Lives data, which indicate that pre-school enrolment in 2006 was about 57 per cent for 5-year-old children in urban areas, but less than 3 per cent for children in rural areas. Hence, our analysis is limited to urban areas because we do not have a sufficiently large sample to conduct econometric analysis for rural areas.

3. Methodology

3.1 Estimation methods

Our primary aim was to investigate the net effect of pre-school or early childhood education on subsequent cognitive development. It is important to note that the terms early childhood education and pre-school education are used interchangeably in this study. Therefore, early childhood – or pre-school – education in this study refers to educational efforts directed at children aged between 3 and 6 that aim at fostering the cognitive, social, motivational and emotional development of young children in order to provide them with a good start in formal primary education. A good start in primary school, in turn, increases the likelihood of favourable educational and social outcomes later in life.

We look at the cognitive functioning of the child when aged 5 and 8 and consider two different measures of cognitive ability: the Peabody Picture Vocabulary Test (PPVT), which tests receptive vocabulary, and the Cognitive Development Assessment – Quantitative (CDA-Q) test which measures children's understanding of quantity-related concepts. Having two different tests enables us to evaluate which aspects of cognitive development are most receptive to pre-school influences. Todd and Wolpin (2004) conceive of knowledge acquisition as a production process, in which current and past inputs are combined with an individual's genetic endowment of mental capacity to produce a cognitive outcome. They identify two kinds of inputs that mainly make up the production function: inputs that are endogenous and reflect choices made by parents, and inputs that are exogenous and not subject to parental choice. Hence we consider a set of child and household characteristics that may influence those test scores. Because our subjects are young children, we need to take into account both parental choices and other influences.

Hence, although our main aim is to evaluate the effects of early childhood education on cognitive development outcomes, we must acknowledge the fact that those outcomes are likely to be influenced by various factors beyond early childhood education. For this reason, we introduce a set of control variables to reduce the omitted variable bias and improve the robustness of the results. The key insight is that a child's learning productivity is partially determined by parental investments in early childhood education, health and nutrition. Denoting CA_{ija} as a test score measure of cognitive achievement for child *i* residing in household *j* at age *a*, the achievement production function can be specified as:

$$CA_{ija} = CA\left(Y_{ij}^{c}(a), Y_{ij}^{e}(a), \mu_{ij0}, \varepsilon_{ija}\right) \quad (1)$$

where Y^c_{ija} denotes the vector of parent-chosen inputs at a given age, Y^e_{ija} represents exogenous inputs; while $Y^c_{ij}(a)$ and $Y^e_{ij}(a)$ denote the vectors of their respective input histories as of age *a*; μ_{ij0} is the child's endowed mental capacity, and ε_{ija} represents measurement error. According to Todd and Wolpin (2004), the empirical implementation of equation (1) is difficult for three reasons: (i) inheritable endowments are unobservable; (ii) datasets on inputs are incomplete (i.e. have incomplete input histories and/or missing inputs); and (iii) inputs may be chosen endogenously with respect to unobserved endowments and/or prior achievement.

Taking these caveats into consideration, and attempting to overcome the limitations of equation (1), we further specify the equation by including pre-school attendance and a vector of control variables; namely, nutritional status of children at the age of 1; health indicators of children at the age of 1, wealth index of the household when the child was aged 1; household demographic compositions; dependency ratio; parents' education (fathers' and primary caregivers' highest grade completed) and whether the child is enrolled in primary school. Accordingly, the basis of our estimation strategy can be summarised by the following education production function:

$$CA_{ija} = \beta_j + \alpha PS_{ija} + \gamma Z_{ija} + U_{ij} \qquad (2)$$

where CA_{ija} is child *i*'s cognitive development, measured by the test score of interest, living in community *j*; PS_{ij} is a dummy variable for whether child *i* is enrolled in pre-school at the age of 3 or above, Z_{ij} is a vector of other (confounding) factors affecting child *i*'s cognitive development since birth, which basically include nutritional status (N_{ij}), household composition, wealth and child characteristics. β_j is a child or household fixed effect; and U_i is a disturbance term.

However, estimating equation (2) using OLS is still likely to lead to biased estimates of the parameters of interest as many of the inputs we consider are possibly correlated with household unobservable characteristics and other factors of early childhood experiences. Also, no matter how comprehensive our list of inputs, it is possible that there are omitted variables in equation (2). All of these considerations give rise to serious concerns about the exogeneity of the input measures (that is, there are good reasons to suspect that the pre-school attendance and some of PS_i are correlated with Z_{ij}). Therefore, pre-school attendance is highly likely to be correlated with the error term and hence endogenous – $E(X_{ij},U_{ij})\neq 0$. This makes OLS estimator o biased and calls for the IV estimation method. The same is also true for nutritional status as it is an endogenous variable in the specified model. Hence, In order to deal with this problem we need to impose further assumptions on equation (2). In particular, we will assume that

$$U_{ij} = V_{ij} + \varepsilon_{ij} \qquad (3)$$

where V_{it} is the term that captures unobserved factors, and ε_{ij} is the white noise.

Equations (2) and (3) require valid and relevant instruments for the suspected endogenous variables. There are two conditions that need to be satisfied for the instruments to be appropriate. First, the instruments must be strongly correlated with the endogenous variables (pre-school attendance and z-score of height-for-age at age 1), which is testable via F-test on the first-stage regression. Second, instruments must be uncorrelated with the error terms, conditional on other explanatory variables, which could be verified by the specification test or test of over-identification, provided we have more than two instruments for one endogenous variable. Hence, based on these criteria, we have chosen community dummies for pre-school attendance and shocks occurring shortly before and after the birth of the child, that affected household welfare negatively for nutritional status.

One computational method which can be used to calculate IV estimates is two-stage least squares (2SLS). In the first stage, each endogenous covariate in equation (2) is regressed on all of the exogenous variables in the model. This 2SLS method involves estimating a (set of) first-stage equation(s):

$$d_{ij} = \beta_1 CD_{ij} + \beta_2 Shocks_{ij} + \beta_3 Z_{ij} + \alpha_{ij} + \varepsilon_{ij} \qquad (4)$$

where *d* is dummy variable for a child's participation in pre-school, while *CD* cluster dummies and *Shocks* are pre- and post-natal shocks that affected the household welfare negatively; Similarly, for the other endogenous variable (nutritional status at the age of 1) the equation becomes:

$$N_{ij} = \gamma_1 Shock_{ij} + \gamma_2 CD_{ij} + \gamma_3 X_{ij} + \alpha_{ij} + \varepsilon_{ij} \qquad (5)$$

where N_{ij} is z-score of height-for-age at the age of 1. After running these equations in the first-stage estimation, the predicted values from these regressions are obtained. In the second stage, the regression of interest is estimated as usual, except that in this stage, values for pre-school participation and nutritional status predicted using the parameter estimates of equation (4) and equation (5) (i.e., $\widehat{PS}$ and $\hat{N}$), are used as an explanatory variable in the second-stage estimation instead of observed pre-school attendance (PS_{ij}) and nutritional status (N_{ij}). Following these estimations, 2SLS estimates will then be estimated using the robust generalised method of moments estimation technique, with robust standard errors adjusted for the clustering of data at the community level and with additional correction for the two-stage estimation process.

Moreover, we have used an alternative IV estimation method known as the Wooldridge approach, in which propensity score or predicted probability of pre-school attendance is used as an instrument for pre-school attendance (Wooldridge (2002: 623). In this case we first run a probit model of pre-school attendance where cluster/site dummies and pre- and post-natal shocks as well as other factors that affect the cognitive outcome are included. Then we predicted the probability of pre-school attendance propensity score of pre-school attendance. In the second-stage regression, we used the predicted probability of pre-school attendance as an instrument for pre-school while we excluded cluster/site dummies and pre- and post-natal shocks in order to identify the parameters. According to Wooldridge (2002: 623), this estimator has provided efficient estimates.

Our investigation of the causal effect of early education on the cognitive development of those children receiving early education would ideally require us to compare the average test score of these children to the average test score that these same children would have achieved had they not attended pre-school ('average treatment effect on the treated' – ATT). However, since a given child either attends pre-school or does not, the average test score that pre-school children would have achieved had they not attended pre-school remains an unobserved counterfactual (Goodman and Sianesi 2005). Trying to estimate the counterfactual no-pre-school outcomes for pre-school children with the observed mean outcome of home children will yield unbiased estimates of the impact of pre-school only if children attend pre-school based on characteristics which are unrelated to outcomes (Goodman and Sianesi 2005).

In both the OLS and IV estimation methods, the explanatory variables used to explain cognitive outcomes of children at the ages of 5 and 8 are pre-school enrolment, height-for-age z-score at the ages of 1 and 5, age of the child in months during Round 1 survey, gender of the child (male dummy), wealth index in Round 1, household composition, highest grade completed by primary caregiver and father of the child, number of months for which the child was breastfed, relative size at birth measured by five-point Likert scale (−2 to 2), dummy for if child had health problems at the age of 1 year, and whether the child was enrolled in primary school at the age of 8. Among these explanatory variables, as discussed above, pre-school enrolment and height-for-age z-score at the age of 1 are the endogenous variables. In the standard IV estimation, urban site dummies and pre- and post-natal shocks that affected household welfare negatively are used as instrumental variables for pre-school enrolment and height-for-age z-score. In the Wooldridge IV estimation, the predicted probability of pre-school enrolment obtained from the propensity score estimation for the matching regression is used as an instrument for pre-school enrolment.

3.2 Propensity score matching

The accuracy of estimating the impact of pre-school attendance on the cognitive development of children using an econometric model depends largely on the availability of instruments that satisfy relevance and validity conditions. Since there is no appropriate test to ensure the validity of instruments used for pre-school attendance, we used propensity score matching techniques to assess the impact of pre-school on cognitive development. We only used the OLS and IV estimation methods to substantiate the propensity score results.

Selection of an appropriate comparison group through propensity score matching offers the best way of estimating the impact of pre-school on cognitive development. This method of assessing impact requires some assumptions about the ‘correct’ functional form. The matching assumptions ensure that the only remaining relevant difference between the two groups is programme participation (pre-school attendance, in this case) provided that the differences can be captured by the observables and there is no individual effect. However, since we have a lot of observables including what happened to mothers and the households before the birth of child and the child and household characteristics before the child enrolled in pre-school, we can capture many of the differences among the children and hence we can match the treated (pre-school attendees) with the untreated (children not attending pre-school) in a better way than many studies relying on cross-sectional datasets. The propensity score analysis proceeds in two steps. First, we estimate a propensity score for each individual as the conditional probability (from a logit model) of attending pre-school, given the full set of covariates. The propensity score is next used to create a matched control group of children who did not attend pre-school. We use kernel marching method and limit the sample to children for whom there is sufficient overlap in propensity scores between the pre-school attendees and comparison group (the area of common support). The robustness of the results was checked by using other matching techniques such as nearest neighbourhood matching, radius matching and one-to-one matching. If the matching process proceeds correctly, the treatment and control children will have similar measured characteristics and the effects of pre-school education can be estimated by comparing the matched groups' means; that is, by using the average treatment effect on the treated (ATT), which is calculated as

$$ATT \equiv E(CA_{i1} - CA_{i0} \mid d_i = 1) \qquad (6)$$

where d_i is pre-school enrolment dummy which is 1 if enrolled in pre-school education and 0 otherwise, CA_{i1} and CA_{i0} are cognitive outcomes, with CA_{i1} the score of outcome that would be observed if the child attended pre-school and CA_{i0} the outcome score observed on the same child at the same age if the child did not attend pre-school education.

$$d_i = \alpha_1 X + \varepsilon_i \qquad (7)$$

where *d* is dummy variable for a child's participation in pre-school, while *X* are variables that affect both the attendance at pre-school and cognitive development outcomes.

Implementing matching requires choosing a set of variables covariates, *x*, that credibly satisfy the condition that the outcome variable (cognitive development in our case) must be independent of treatment (pre-school enrolment) conditional on the propensity score. Heckman et al. (1997) also show that omitting important variables can seriously increase bias in resulting estimates. Moreover, there is no guideline on how to choose conditioning variables, *x*, (Smith and Todd 2005), hence selection of *x* variables intuitively is very important, and hence these covariates must include variables that affect both the outcome and the participation in programmes. Both Smith and Todd (2005) and Sianesi (2004) have advised that it is necessary to have a thorough knowledge of the programme, (in our case, pre-school education) in order to select variables to be included in the logit model of propensity score.

Based on economic theory, as well as our knowledge of the factors affecting Ethiopian parents' decisions about whether to send their children to pre-school, in the estimation of propensity score of pre-school attendance, the explanatory variables we used are those that affect both pre-school attendance and cognitive outcomes.

3.3 Data source

To investigate the effects of early childhood education on young children's cognitive development and school achievement, we use data from the Young Lives longitudinal survey in Ethiopia, which is part of an international study tracking the lives of children in four developing countries: Ethiopia, Peru, Vietnam, and India (in the state of Andhra Pradesh). The panel survey follows two cohorts of children in each country. We are using data relating to the Younger Cohort, which consists of approximately 2,000 children who were first surveyed in last quarter of 2002 when they were around the age of 1. The children, their caregivers and members of their communities were then re-interviewed in the last quarters of 2006 and 2009. The data is drawn from a sample of households residing in five major regions of the country, where about 96 per cent of the population live. The three survey rounds of surveys also oversample poor and urban families in order to study the causes, consequence and effects of poverty and inform policymakers about this. The data collected in all three rounds includes information on children's and their families' access to key services, work and time-use patterns and social relationships, as well as core economic indicators such as assets. In addition, there are also data on children's nutritional status, cognitive and schooling outcomes. A great deal of information is also available in the data about the family circumstances (including pre-natal care and birth weight, family income, household composition, family structure, and family background) of these children over the three rounds.

What we are aiming to do is understand the degree of association between pre-school attendance (between the ages of 3 and 6/7) and cognitive development test scores measured in Round 2 (when the children were 5) and in Round 3 (when they were 8). During the Round 2 survey, each parent was asked if the child was attending pre-school when she or he was 3 years old. Then in Rounds 2 and 3, cognitive development outcomes were measured when children were aged about 5 (in Round 2) and 8 (in Round 3) using the PPVT and the CDA-Q test. While the former is a test of vocabulary recognition that has been widely used as a general measure of cognitive achievement, the latter is a test commonly used in assessing the cognitive development of young children. More information on these tests is given in the next section.

4. Descriptive statistics

In our investigation, we have classified the variables obtained from the Young Lives data into three broad categories, namely: treatment variables, outcome variables and covariates (control variables). This section will provide (with the aid of Tables 2 to 6 and Figure 1) brief descriptive statistics for these variables.

Table 2 presents the descriptive statistics for the variables used in our estimation and discussed in the previous section.

Table 2. *Descriptive statistics of variables used in estimation (urban sample)*

Variables	Mean	S.D.
Standard PPVT score in Round 2	76.25	21.14
Standard PPVT score in Round 3	99.31	36.52
Raw score of CDA-Q test in Round 2	9.44	2.73
Raw score of CDA-Q test in Round 3	10.09	5.74
Height-for-age z-score (Round 1)	−0.94	1.77
Height-for-age z-score (Round 2)	−1.19	1.12
Height-for-age z-score (Round 3)	−0.97	1.02
Child is male	0.52	0.50
Relative size of child when born (from −2 to 2)	0.06	1.07
Child had health problems at the age of 1 year	0.43	0.50
Length of time child was breastfed (months)	28.94	13.52
Household is female-headed	0.27	0.45
Highest grade completed by primary caregiver	4.98	4.30
Highest grade completed by household head	8.88	8.17
Age of household head	41.03	11.43
Wealth index	0.47	0.16
Number of children below 17 years of age	2.97	1.34
Household size	5.83	2.07
Logarithm of PPVT score in Round 2	3.17	4.796
% of CDA-Q questions correctly answered in Round 2	62.93	93.333
Logarithm of % of CDA-Q questions correctly answered Round 2	4.09	4.536
Logarithm of PPVT test score in Round 3	4.52	5.075
% of CDA-Q questions correctly answered in Round 3	34.80	96.55
Logarithm of % of CDA-Q questions correctly answered in Round 3	3.37	4.570
Grade completed at the age of 8 or in Round 3	0.92	3.000
Dummy variable for a child who began formal schooling at age 8	0.87	1.000
Pre-school attendance	0.569	1.00

N=745 (only the urban sample, Younger Cohort children)

Pre-school education (the treatment variable for this study) is defined as education taking place in establishments regularly attended by a child outside his or her own home that provide educational activities for children before they start formal primary school. These include formal centre-based care in the form of nurseries (privately operated, community-owned and public). Twenty-five per cent of the total sample and 57 per cent of the urban sub-sample in the Young Lives Younger Cohort attended pre-school (Table 3). Around three-quarters of the pre-schools (70 per cent for the total sample and 76 per cent for the urban sample) in which the children were enrolled were run by private providers (Table 3). For this reason, 91 per cent of the caregivers had to pay for the child to attend the facilities (Table 4). Children were reported to spend 34 hours a week at the centres. The average age of the child when first enrolled in pre-school was just over four years (49 months), and the child stayed at pre-school for another three and a half years on average before progressing to formal primary education. The standard of care at the pre-school centres was found to be at least 'reasonably OK' by over 97 per cent of the children's parents (Table 4).

Table 3. *Comparison of cognitive outcomes and primary school enrolment by pre-school attendance*

Variable	Urban children		Average test score	
	N.	%	PPVT	CDA-Q
No pre-school (in R2)	321	43.09	67.92	4.61
Of which enrolled in formal school (in R3)	250	77.9	71.94	5.60
Pre-school (in R2)	424	56.91	110.99	11.65
Private	321	75.71	115.73	12.59
Public	32	7.55	106.61	10.06
Community	47	11.08	96.34	8.74
Government-funded	24	5.66	102.42	10.85
Other	–	–	67.92	4.61
Of which enrolled in formal school (in R3)	400	94.34	111.93	11.90

Source: Authors' calculations from Young Lives data (Rounds 2 & 3)

Table 4. *Characteristics of pre-school in urban areas*

Variable	Mean	Std. Dev.
Caregiver had to pay for child to attend (%)	0.91	0.29
Length of time child attended pre-school (years)	3.69	0.82
Age of child when first attended pre-school (months)	48.85	8.88
Hours per week child attended pre-school	34.01	7.20
Standard of care and teaching at pre-school		
Excellent	0.25	0.43
Good	0.51	0.50
Reasonably OK	0.21	0.41
Bad	0.02	0.15
Extremely bad	0.01	0.09

Source: Authors' calculations from Young Lives data (Rounds 2 & 3); N=462

The outcome variables used in this study are a child's score on two standard achievement tests: namely, the PPVT and the CDA-Q test. The PPVT is a widely used test of receptive vocabulary. Its main objective is to measure vocabulary acquisition in persons from 2.5 years old to adulthood. The test is individually administered, untimed, norm-referenced and orally administered (Cueto et al. 2009). It offers both raw scores as well as standard scores. In the PPVT, the recipient hears a word ('boat', 'lamp', 'cow', 'goat', etc.) in their mother tongue and is then asked to identify which of four pictures corresponds with the spoken word.

The quantitative achievement score in the CDA-Q test is the other dependent variable considered in this study. The CDA-Q test was developed by the International Evaluation Association (IEA). There are several CDA sub-tests, including Spatial Relations, Quantity and Time. However, only the Quantity sub-test was administered to the sample in this study. The CDA-Q test used in Round 3 measured various numerical abilities appropriate for children aged 8, and had two parts. The first part was administered orally and had 9 items, scored '1' for correct and '0' for blank or incorrect. The second part was a written test and had 20 items. It is observed from the data that scores on both tests of cognitive ability rose over time.

The average standard score in the PPVT in Round 3 was 79 out of 160 (with a higher average score of 99 for children from urban areas); in Round 2 it was 68 (76 for the urban sample). The average score in the CDA-Q test was 6 (out of a possible 29). Standard scores of the PPVT reveal that the children who took the tests showed improvements from the previous round of the survey (Round 2). The scores were still higher for the urban sample (9 in Round 2 and 10 in Round 3).

The explanatory variables used in the study as controls (covariates) encompass household socio-economic and demographic variables, and measures of child health and nutritional status, and enrolment in primary school. They are summarised in Table 2 above. The wealth index is constructed by summing measures of housing quality, consumer durables and accessible services. The components are calculated as scaled values (0 to 1). The measure of housing quality 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.

Height-for-age records of the sampled children from all three rounds of survey are reported to reflect cumulative linear growth. Height-for-age deficits indicate past or chronic inadequacies in nutrition and/or chronic or frequent illness, but cannot measure short-term changes in malnutrition. Low height-for-age relative to a child of the same gender and age in the reference population is referred to as 'shortness'. Extreme cases of low height-for-age, where shortness is interpreted as pathological, are referred to as 'stunting'. The construction of height-for-age z-score is based on comparisons with a 'healthy' reference population. The WHO has developed a table (WHO 2006, 2007) to measure nutritional status based on data from the USA, Ghana and a range of other countries from all continents. The validity of this reference standard stems from the empirical observation that well-nourished and healthy children will have a very similar distribution of height and weight to the reference population, regardless of their ethnic background or where they live. On average, the urban sampled children have a height-for-age z-score of −0.97 (Table 2). Forty-three per cent of the urban children also experienced some kind of health problem by the age of 1.

With regard to the remaining explanatory variables, the data show that the average length of time that a child was breastfed is 29 months (32 for the whole of the Younger Cohort); the sampled children have an average birth size of 0.06 (on the five-point Likert scale for the relative size of child when born – ranging from −2 to 2); 52 per cent of the children are male; and during Round 3, the average age of children in the urban sample was 97 months (see Table A6 in the Appendix).

In order to get a general idea of the differences in cognitive (and school) performance outcomes between children who received early education and those that did not, we made some simple descriptive analysis for the selected outcome measures, PPVT and CDA-Q test scores. Attending pre-school is found to be in a positive rhythm with enrolment in formal primary education. As Table 3 shows, 94 per cent of the children who were attending pre-school in Round 2 were enrolled in formal first-cycle primary schools in Round 3. Of the 6 per cent (30 in number) of the children who were not then enrolled in formal school, 25 were still in pre-school; 4 of them attended pre-school for less than 6 months, and the one remaining child attended pre-school for less than a year.

Table 5 compares the relative performance in school, as reported by parents, of children who received pre-school education and those who did not, and reveals a trend that corroborates the claim that early education enhances subsequent cognitive and school outcomes. As Table 6 shows, 18 per cent of the urban children who attended pre-school performed excellently in primary school, as compared to only 10 per cent of children who did not attend pre-school. Similarly only 4 per cent of pre-school attendees performed poorly as opposed to 7 per cent of non-attendees. In general, the performance of children in primary education and attendance at pre-school have a statistically significant correlation (Table 6),[2] indicating that better primary school performance is associated with pre-school attendance. This result is supported further by the kernel density estimation by pre-school attendance presented in Figure 1.

Table 5. *Urban children's cognitive development and grade progression at the age of 5 years and 8 years by pre-school attendance*

	Non-pre-school	Pre-school	Total
Raw PPVT score in Round 2	21.84	30.47	26.79
Logarithm of PPVT score in Round 2	2.99	3.31	3.17
% of CDA-Q questions correctly answered in Round 2	55.26	68.68	62.93
Logarithm of % of CDA-Q questions correctly answered in Round 2	3.96	4.19	4.09
Raw score of PPVT in Round 3	81.22	126.29	106.87
Logarithm of PPVT score in Round 3	4.30	4.69	4.52
% of CDA-Q questions correctly answered in Round 3	25.29	42.01	34.80
Logarithm of % of CDA-Q questions correctly answered in Round 3	3.02	3.62	3.37
Grade completed at the age of 8 or in Round 3	0.78	1.04	0.92
Dummy variable for a child who began formal schooling at age 8	0.78	0.94	0.87

N=745

2 The Pearson's Chi-square value is 24.58 and P-value (the lowest level of significance at which the null hypothesis of no correlation) is less than 1 per cent, indicating a highly statistically significant correlation between pre-school attendance and performance in school.

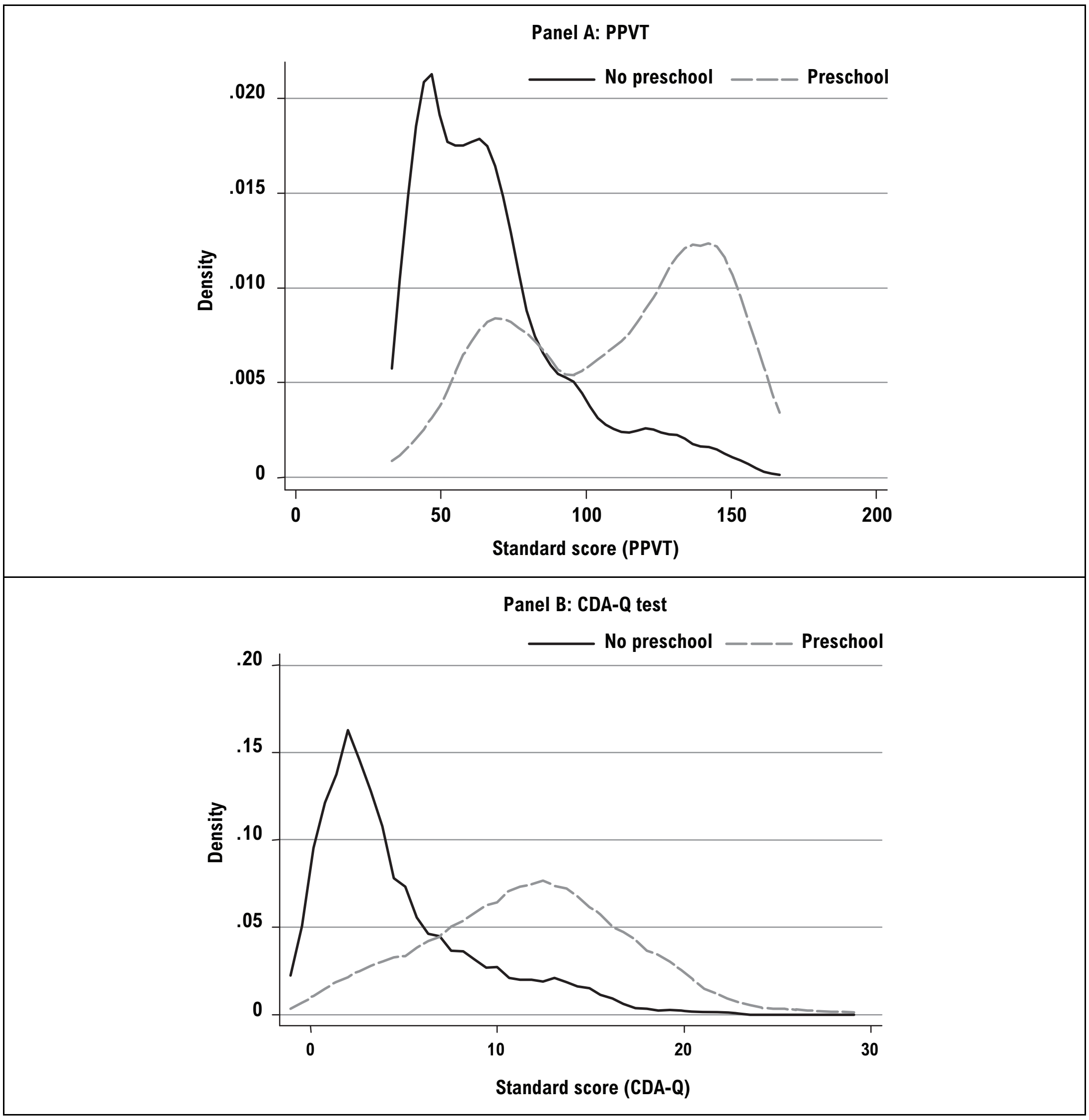
Table 6. *Primary school performance of urban children by pre-school attendance (%)*

Performance in school	Non-attendees	Attendees	Total
Excellent	9.52	17.63	12.06
Good	49.95	50.81	50.22
Reasonably good	33.33	27.61	31.54
Poor	6.98	3.71	5.96
Very bad	0.21	0.23	0.22

N= 745; Pearson chi2 = 24.58 P-value = 0.000

Figure 1 shows the distribution of percentile ranks in PPVT and CDA-Q test scores for the children when aged 8, comparing those with a pre-school background and those without any pre-school education. The graphs reveal how differently the pre-school and non-pre-school children performed. In particular, children with early education are concentrated among the top ranks, which shows that these children performed much more strongly on these tests.

Figure 1. *Kernel density estimates for PPVT and CDA-Q scores of 8-year-old children, by pre-school attendance*



5. Estimation results

As indicated in the methodology section (Section 3) above, we estimated propensity score models in order to estimate othe effect of early childhood education (pre-school education) on cognitive development outcomes measured by vocabulary (PPVT) test and CDA-Q test scores. In order to substantiate the results of the propensity score matching model, we also estimated OLS and IV in order to provide the associates of cognitive development outcomes measured by PPVT and CDA-Q test scores. Table 8 provides the estimated results of propensity score matching models (see Table A2 to see the first-stage estimation, probit model, used to derive propensity score). Table 9 presents a summary of the results of OLS and IV models (see details of estimation in Tables A3a to A4b). The IV models estimated include the Wooldridge approach (see details in Tables A3a and A3b) and two versions of standard IV models: in the first IV model only pre-school attendance is endogenous (see details in Table A4a, columns 3 and 6), while in the second IV model both pre-school attendance and early childhood nutrition are endogenous (see details in Table A4b, columns 4 and 7). The details of the estimates for all models and the descriptive statistics of variables used in the regressions are provided in Tables A3a to A6 in the Appendix.

Because of the absence of pre-schools in many rural areas of Ethiopia, the number of rural children attending pre-school is very low and hence we are obliged to estimate pre-school attendance model only for urban areas. When the dependent variable is the cognitive development outcome in Round 3, we have added one more explanatory variable, namely whether the child was enrolled in formal school, because being in formal school may affect children's test score.

5.1 Propensity score matching estimates

The goal of the propensity score matching approach is to reproduce the treatment group among the non-treated group, this way re-establishing the experimental conditions in a non-experimental setting (Blundell and Costa Dias 2008). In the case of this study, while children who have attended pre-school belong to the treatment group, pre-school-age children who did not attend pre-schools are considered as the non-treated group. Accordingly, to examine the differential effects of pre-school attendance on the urban children's cognitive test scores, we initially estimate propensity scores by running probit regressions of pre-school attendance on a set of observed covariates (see Table A2 in the Appendix).

Although the model of propensity score need not to be accurate (Cameron and Trivedi 2005), the models fit quite well for some of the propensity score models (the Pseudo R^2 is 56.5 per cent – Table A2). To ensure that the control and treatment groups look identical in terms of their covariate (*x* vector), we run a balancing test after estimating the logit model propensity score. The test we run ensures that the balancing condition is satisfied.

Using stata *'psmatch2'* command (Leuven and Sianesi 2003), we conducted kernel smoothing to match treatment and comparison observations and estimate the treatment effect on the treated group. We then extracted only the ATT from the kernel matching results. To see the robustness of the results, we have also computed ATT using nearest neighbourhood, radius and local linear regression matching. In the kernel matching methods, all members of the treated group are matched with a weighted average of all controls with weights that are inversely proportional to the distance between propensity scores of treated and controls (Brand and Halaby 2006). In the analysis, the common support option has been selected; and the region of common support is given by [0.031, 0.998]. In the region of common support we have 220 matched non-pre-school and 414 pre-school children (Table 7). There seems sufficient overlap between the two. Though it is possible to estimate both the average treatment effect across the entire population (ATE) and the average treatment effect on the treated (ATT), we are confined to the latter as our purpose is to see the impact of pre-school education on the cognitive development of children who have received pre-school education. The ATT here is the average difference in cognitive scores between pre-school attendees and non-pre-school attendees among urban pre-school-age children in the longitudinal dataset.

Table 7. *Frequency of matched non-pre-school and pre-school children*

Estimated propensity score	Non-pre-school children	Pre-school children	Total
0.03109	127	9	136
0.2	28	20	48
0.4	25	23	48
0.6	17	54	71
0.8	12	59	71
0.9	7	66	73
0.95	4	183	187
Total	**220**	**414**	**634**

Accordingly, we obtained ATT estimates for both PPVT and CDA-Q test scores from the kernel and other matching regressions for all urban children in the sample. In fact, we also obtained cognitive scores separately for boys and girls. ATT estimates for cognitive scores are summarised in Table 8. Kernel matching estimates suggest that there is cognitive achievement advantage from receiving early childhood education in the sense that pre-school attendance is highly associated with better cognitive outcomes for children. We tested the robustness of the results (Table A1) and also obtained similar patterns (the same sign or positive effects) when we used nearest neighbour and radius matching techniques, although the results were less statistically significant for the nearest neighbour and local linear regression matching estimates (see Table A1 in the Appendix). From the kernel matching estimates, we found that 5-year-old children who attended pre-school scored 31.2 per cent higher in the PPVT and 23.1 per cent higher in the CDA-Q test than those who did not attend pre-school. When the children reached the age of 8, compared to the non-attendees, pre-school attendees scored 36.1 per cent higher in the PPVT and 59.2 per cent in CDA-Q test, indicating that gain from pre-school increased as the children grew older. The result we obtained from the propensity score matching was much closer to IV estimates (presented in the next sub-section), indicating the robustness of our results. Moreover, we found that pre-school education had a strong impact on enrolment in primary school and grade completion at the age of 8. The primary school enrolment rate of the children who had attended pre-school was 11.8 per cent higher than that of the non-pre-school attendees, and these children were, on average, more than a fifth of a grade further on than the other children.[3]

3 Though the age range of children is between 7 and 8 years, the grades completed range from 0 to 3.

Table 8. *Impact of pre-school education on children's cognitive development at the ages of 5 years (Round 2) and 8 years (Round 3) by gender of the children from ATT kernel matching*

	Girls and boys		Girls		Boys	
	ATTk	T-stat	ATTk	T-stat	ATTk	T-stat
Round 2 (at age 4.5 to 5.5)						
Ln (PPVT score)	0.312***	9.27	0.410***	6.24	0.307***	4.10
Ln (CDA-Q test score)	0.231***	8.66	0.253***	4.54	0.233***	4.12
Round 3 (at age 7.5 to 8.5)						
Ln (PPVT score)	0.361***	13.310	0.356***	9.13	0.370***	9.91
Ln (CDA-Q test score)	0.592***	10.780	0.601***	8.08	0.614***	7.65
Grade completed at the age of 8 or in Round 3	0.218***	4.640	0.216***	3.00	0.252***	4.21
Dummy variable for a child beginning formal school in Round 3	0.118***	4.640	0.098**	2.86	0.162***	4.25

Notes: ATTk= Average treatment effect on the treated from kernel matching; result of psmatch2;
k=5 in the default k-nearest neighbour matching
*** p<0.01, ** p<0.05, * p<0.1

The direction of the impact of pre-school attendance on cognitive outcomes was the same when we computed the estimates for girls and boys separately, although we found that pre-school had a slightly greater effect on the cognitive development of girls than boys when the children were aged 5, but that the effect was slightly greater on boys than on girls when the children were aged 8. Eight-year-old boys who had attended pre-school also had higher grade progression rates and primary school enrolment rates than 8-year-old girls.

5.2 OLS and IV estimations

To substantiate the results of the propensity score matching techniques of assessing the impact of pre-school on cognitive development, we also use parametric econometric models including OLS, standard IV estimates and Wooldridge IV estimates.

We are aware that finding relevant and valid instrumental variables is not that easy though the instruments we have chosen have passed the relevance and validity test. However, to check the robustness and examine the strength of the results,we used econometric models such as OLS, IV and Wooldridge IV estimation methods.

As with the results of matching models, the OLS, standard IV estimates and Wooldridge IV estimates show that pre-school attendance is positively and strongly associated with better cognitive test scores, though OLS provides lower estimates than IV estimates. The IV estimates always have the same sign or direction of effect but are much larger than the corresponding OLS estimates. OLS estimator is not efficient if we have endogenous variables in our model. While the Wooldridge IV estimator is efficient, there is no way of testing for mis-specification or over-identification because we have only one instrument in our set-up. The over-identification test suggests that the IV estimates in a model where pre-school is the only endogenous variable present a specification problem, hence we do not use them to interpret the result. We have reasonably better estimates in the standard IV estimates where both pre-school attendance and the nutritional status of children are endogenous because they satisfy the relevance (based on first-stage regression) and validity (based on over-identification test) conditions.

The OLS result concurs with our claim that early childhood education (measured by attendance at pre-school) positively affects subsequent cognitive development (as reflected in test scores). As Table 9 shows, 5-year-old children who attended pre-school scored 17.2 per cent more in the PPVT and 16.2 per cent more in CDA-Q test than those who did not attend pre-school. At the age of 8, these children scored 25.7 per cent higher in the PPVT and 32.8 per cent more in the CDA-Q test than those who had not attended pre-school.

Table 9. *Summary of IV results on the relationship between pre-school attendance and children's cognitive development at the age of 5 years (Round 2) and 8 years (Round 3)*

	Ln (PPVT test score)	Ln (CDA-Q test score)
Round 2		
OLS	0.172***	0.166***
IV – (Wooldridge approach) only pre-school endogenous	0.216***	0.234***
IV – only pre-school attendance endogenous	0.318***	0.315***
IV – both pre-school attendance and height-for-age z-score endogenous	0.279***	0.276***
Round 3		
OLS	0.257***	0.328***
IV – (Wooldridge approach) only pre-school endogenous	0.437***	0.511***
IV – only pre-school attendance endogenous	0.463***	0.485***
IV – both pre-school attendance and height-for-age z-score endogenous	0.392***	0.303***

Notes: *** p<0.01, ** p<0.05, * p<0.1; ATT= Average treatment effect on the treated; result of psmatch2 ; k=2 in the k-nearest neighbourhood matching; ln (PPVT score) =Logarithm of PPVT score in Round 2; ln (CDA-Q test score)=Logarithm of % of CDA-Q test questions correctly answered in Round 2; Wooldridge approach – takes propensity score (predicted probability of enrolment in pre-school education) as instrument for pre-school enrolment.

The IV estimates also show a significant positive association between pre-school and cognitive development outcomes at the ages of both 5 and 8 years. The estimated associations are higher than those of OLS estimates. More specifically in the Wooldridge IV estimates, *ceteris paribus,* 5-year-old-children who attended pre-school scored 21.6 per cent higher in the PPVT and 23.4 per cent higher in CDA-Q test. At the age of 8, the associations are much higher for both cognitive outcomes: 43.7 per cent higher in the PPVT and 51.1 per cent higher in the CDA-Q test (Table 9).

The magnitude of the association is only slightly higher in the estimates of standard IV version, where both pre-school enrolment and nutritional status are endogenous. The other IV estimate, where only pre-school is endogenous, is not much different from either of the other IV estimates, indicating the robustness of the results.

It is important to mention the associations between the cognitive outcomes of children and other confounding factors provided in Tables A3b and A4b in the Appendix. In all the estimation methods discussed so far, we found household wealth and parents' education (including the education level of both the father and the primary caregiver) had a strong association with cognitive development outcomes measured by PPVT and CDA-Q test scores. With respect to the nutritional status of children at the age of 1, we found that nutritional status was positively associated with PPVT and CDA-Q test scores. This indicates that early nutritional status is an important correlate of subsequent cognitive development. Tables A4a and A4b try to show the gender differential in cognitive development by including a dummy for boys, although statistically insignificant. In all estimation methods, we found that there was a higher association between pre-school attendance and cognitive development for girls than for boys. However, the association is only statistically significant for cognitive outcomes in Round 2 in the IV estimates where both pre-school and height-for-age z-scores are endogenous, indicating that the unexplained gender differential cognitive outcome is not robust. Moreover, it is apparent to see that there is no statistically significant association between demographic variables or household composition and cognitive development outcomes. This may indicate that the composition and number of members in a household did not matter for these Ethiopian urban children's cognitive outcomes.

6. Conclusions

The Government of Ethiopia has until recently limited its involvement in the pre-school sector in order to prioritise its efforts at other levels of the education system. As a result, the private sector has been the dominant provider of pre-school education services. However, the high fees associated with the private sector exclude children from economically disadvantaged households and rural areas. For instance, the data from Young Lives indicate that only 25 per cent of the Younger Cohort attended pre-school. Nationally, data from the Ministry of Education (MOE 2009, 2010) indicate that only 4.2 per cent of the 7 million pre-school-age children attend pre-school. Therefore, it seems current government policy on early childhood education is creating a gulf in pre-school attendance between children from rural and urban areas and between rich and poor families.

Motivated by this fact, we analysed the correlation between pre-school attendance and test scores, and the impact of pre-school education on subsequent cognitive development, using longitudinal data from the Young Lives survey in Ethiopia. We implemented alternative econometric specifications including different instrumental variable estimation methods and propensity score matching techniques. Across all these models, the results consistently showed that early childhood education was positively associated with children's cognitive development both at the age of 5 and at the age of 8. Furthermore, not only is it associated with cognitive development, but pre-school attendance is also positively associated with early entry into primary school and with grade completion at the age of 8.

Our impact assessment results derived from the propensity score matching techniques indicate that pre-school attendance at the age of 3 has a strong positive effect on the cognitive development of children at the ages of both 5 and 8 years, as measured by vocabulary and CDA-Q test scores. Specifically, we found that, as a result of pre-school attendance, 5-year-old urban children who received pre-school education scored 31.2 per cent higher in the PPVT and 23.1 per cent in CDA-Q test than children who did not. When these children reached the age of 8, pre-school attendees scored 36.1 per cent higher in the PPVT and 59.2 per cent higher in the CDA-Q test, indicating that the gain from pre-school attendance increased as children grew older. Moreover, as a result of pre-school education, children who had been to pre-school had progressed further through primary school, by 0.218 of a grade on average, than those who had not. Enrolment rates in primary school were also higher by 11.8 per cent for children who had attended pre-school than for those who had not,

The OLS and IV estimation results reinforced these findings. From the OLS model, we found out that pre-school attendance had 25.7 per cent and 32.8 per cent differential effects on standard PPVT and CDA-Q scores, respectively, for 8-year-old urban children. PPVT scores, in the IV model, are found to increase by a magnitude of as high as 44 per cent because of pre-school attendance for the urban sample. CDA-Q scores, on the other hand, showed a 51 per cent differential effect on the urban observations. At the age of 5, the differential effect of pre-school attendance was smaller, indicating an increased association between pre-school attendance and cognitive development as children got older and hence higher returns from early investment at a later age.

Our results reveal that early education programmes had a positive effect on the cognitive development and academic progress of a relatively large sample of children. Such positive effects could benefit the nation as a whole in the future. The new early childhood care and education policy framework (drafted in 2010) does now envisage increased government engagement with the sector and is an opportunity for Government to reconsider its priorities and give more attention and resources to the equitable development and expansion of pre-school education. If the Government were to give pre-school education the same priority as primary, secondary and tertiary education, and establish government pre-schools for poor children in both rural and urban areas, it would help to equalise initial endowments among children and make Ethiopian society both fairer and more productive.

References and further reading

Barnett, W.S. (1995) 'Long-Term Effects of Early Childhood Programs on Cognitive and School Outcomes', *The Future of Children* 5.3: 25–50

Becker, G.S. (1993) *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education* (3rd ed.), Chicago, IL: University of Chicago Press

Becker, G.S. (1964) *Human Capital*, New York , NY: Columbia University Press

Becker, G.S. and N. Tomes (1986) 'Human Capital and the Rise and Fall of Families', *Journal of Labor Economics* 4.3, Part 2: S1–S39

Becker, G.S. and N. Tomes (1979) 'An Equilibrium Theory of the Distribution of Income and Intergenerational Mobility', *Journal of Political Economy* 87.6: 1,153–1189

Behrman, J., Y. Cheng and P. Todd (2004) 'Evaluating Pre-school Programs when Length of Exposure to the Program Varies: A Nonparametric Approach', *Review of Economics and Statistics* 86.1: 108–32

Berlinski, S., S. Galiani and P. Gertler (2009) 'The Effect of Pre-primary Education on Primary School Performance', *Journal of Public Economics* 93: 219–34

Berlinski, S., S. Galiani and M. Manacorda (2008) 'Giving Children a Better Start: Pre-school Attendance and School-Age Profiles', *Journal of Public Economics* 92, 1,416–40

Bernal, R. and M. Keane (2010) 'Quasi-structural Estimation of a Model of Childcare Choices and Child Cognitive Ability Production', *Journal of Econometrics* 156.1: 164–89

Blundell, R. and Costa Dias, Monica (2008) *Alternative Approaches to Evaluation in Empirical Microeconomics*, IZA DP No. 3,800, Bonn: Institute for the Study of Labor

Brand, Jennie E. and Charles N. Halaby (2006) 'Regression and Matching Estimates of the Effects of Elite College Attendance on Educational and Career Achievement', *Social Science Research* 35.3: 749–70

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

Bruner, J.T. (1999) *The Myth of the First Three Years: A New Understanding of Early Brain Development and Lifelong Learning*, New York, NY: Free Press

Cameron, A. Colin and Pravin K. Trivedi (2005) *Microeconometrics: Methods and Applications*, New York, NY: Cambridge University Press

Campbell, F.A., C.T. Ramey, E. Pungello, J. Sparling and S. Miller-Johnson (2002) 'Early Childhood Education: Young Adult Outcomes from the Abecedarian Project', *Applied Developmental Science 6.1, 42–57*

Carneiro, P. and J. Heckman (2003) *Human Capital Policy*, Cambridge, MA: MIT Press

Carneiro, Pedro, Claire Crawford and Alissa Goodman (2006) *Which Skills Matter?*, CEE Discussion Papers 0059, London: Centre for the Economics of Education, London School of Economics

Carneiro, P., F. Cunha and J.J. Heckman (2003) 'Interpreting the Evidence of Family Influence on Child Development', paper presented at conference on 'The Economics of Early Childhood Development: Lessons for Economic Policy', Federal Reserve Bank, Minneapolis, USA, 17 October 2003

Cascio , Elizabeth U. (2009) *Do Investments in Universal Early Education Pay Off? Long-term Effects of Introducing Kindergartens into Public Schools*, Working Paper 14,951, Cambridge, MA: National Bureau Of Economic Research

Cleveland, G. and Krashinsky, M. (1998) 'The Benefits and Costs of Good Child Care – The Economic Rationale for Public Investment in Young Children', A Policy Study, Toronto: Department of Economics, University of Toronto Scarborough

Connelly, C. (2008) 'Early Childhood Education in Buffalo', fact sheet, Buffalo, NY: Partnership for the Public Good

Cueto S., J. Léon, G. Guerrero and I. Muñoz (2009) *Psychometric Characteristics of Cognitive Development and Achievement Instruments in Round 2 of Young Lives*, Technical Note 15, Oxford: Young Lives

Cunha, F. and J.J. Heckman (2007) 'The Technology of Skill Formation', *American Economic Review* 97.2: 31–47

Cunha, Flavio, James J. Heckman, Lance Lochner and Dimitriy V. Masterov (2006) 'Interpreting the Evidence on Life Cycle Skill Formation' in Eric Hanushek and Finis Welch (eds) *Handbook of the Economics of Education*, Volume 1, Amsterdam: North Holland

Currie, J. (2001) 'Early Childhood Education Programs', *Journal of Economic Perspectives* 15.2: 213–38

Currie, J. and D. Thomas (2000) 'School Quality and the Longer-term Effects of Head Start', *Journal of Human Resources* 35: 755–74

EACEA (2009) 'Early Childhood Education and Care in Europe: Tackling Social and Cultural Inequalities', Brussels: Education, Audiovisual and Culture Executive Agency (P9 Eurydice)

Glick, Peter and David E. Sahn (2009) 'Cognitive Skills Among Children in Senegal: Disentangling the Roles of Schooling and Family Background', *Economics of Education Review* 28.2: 178–88

Goodman, Alissa and Barbara Sianesi (2005) 'Early Education and Children's Outcomes: How Long Do the Impacts Last?', *Institute for Fiscal Studies* 26.4: 513–48

Halfon N, E. Shulman and M. Hochstein (2001) 'Brain Development in Early Childhood: Building Community Systems for Young Children,' Los Angeles, CA: UCLA Center for Healthier Children, Families and Communities

Heckman, J. (2007) 'The Economics, Technology, and Neuroscience of Human Capability Formation', *Proceedings of the National Academy of Sciences* 104.33: 13,250–55

Heckman, J.J. (2006) 'Skill Formation and the Economics of Investing in Disadvantaged Children', *Science* 312.5782: 1,900–2

Heckman, J. (2000) 'Policies to Foster Human Capital', *Research in Economics* 54.1: 3–56

Heckman, J.J. (1999) 'Doing it Right: Job Training and Education', *Public Interest* 135: 86–107

Heckman, James J. and D.V. Masterov (2007) 'The Productivity Argument for Investing in Young Children', paper presented at the Allied Social Sciences Association Annual Meeting, Chicago, USA, 5–7 January 2007

Heckman, James J. and P.J. Klenow (1997) 'Human Capital Policy', University of Chicago, mimeo

Heckman, J.J., A.B. Krueger and B.M. Friedman (2003) *Inequality in America: What Role for Human Capital Policies?*, Cambridge, MA: MIT Press

Heckman, J.J., H. Ichimura and P.E. Todd (1997) 'Matching As An Econometric Evaluation Estimator: Evidence from Evaluating a Job Training Programme', *Review of Economic Studies* 64.4: 605–54

Helmers, C. and Manasa Patnam (2009) *The Formation and Evaluation of Childhood Skill Acquisition: Evidence from India*, Working Paper 38, Oxford: Young Lives

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

Lee, Valerie E., J. Brooks-Gunn, Elizabeth Schnur and Fong-Ruey Liaw (1990) 'Are Head Start Effects Sustained? A Longitudinal Follow-up Comparison of Disadvantaged Children Attending Head Start, No Pre-school, and Other Pre-school Programs', *Child Development* 61.2: 495–507

Lefebvre, Pierre (2006) *Impact of Early Childhood Care and Education on Children's Pre-school Cognitive Development: Canadian Results from a Large Quasi-experiment*, Working Paper 06-36, Montreal: Consortium Érudit, University of Montreal

Lefebvre, Pierre and Philip Merrigan (2002) 'The Effect of Childcare and Early Education Arrangements on Developmental Outcomes of Young Children', *Canadian Public Policy* 28.2: 159–86

Leuven, E. and 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, http://ideas.repec.org/c/boc/bocode/s432001.html (accessed on 23 August 2012)

Loeb, Susanna, Margaret Bridges, Bruce Fuller, Russell Rumberger and Daphna Bassok (2005) 'How Much is Too Much? The Influence of Pre-school Centers on Children's Social and Cognitive Development', *Economics of Education Review* 26.1: 52–66

Magnuson, K.A., M. Meyers, C.J. Ruhm and J. Waldfogel (2005) 'Inequality in Children's School Readiness and Public Funding', *Focus* 24.1: 12–18

Magnuson, K.A., M. Meyers, C.J. Ruhm and J. Waldfogel (2004) 'Inequality in Pre-school Education and School Readiness', *American Educational Research Journal* 41.1: 115–57

Malmberg, Lars-Erik, Peter Mwaura and Kathy Sylva (2010) 'Effects of a Pre-school Intervention on Cognitive Development among East-African Pre-school Children: A Flexibly Time-coded Growth Model', *Early Childhood Research Quarterly* 26.1: 124–33

MOE (2010) *Education Statistics Annual Abstract 2008/09,* Addis Ababa: Ministry of Education

MOE (2009) *Education Statistics Annual Abstract 2007/08*, Addis Ababa: Ministry of Education

MOFED (2010) Growth and Transformation Plan (GTP): 2010/11–2014/15. Volume I: Main Text, Addis Ababa: Ministry of Finance and Economic Development

Myers, R. (1995) *The Twelve Who Survive: Strengthening Programmes of Early Childhood Development in the Third World*, Ypsilanti, MI: High/Scope Press

Orkin, Kate, Workneh Abebe Yadete and Martin Woodhead (2012) *Delivering Quality Early Learning in Low-resource Settings: Progress and Challenges in Ethiopia, Bernard van Leer Foundation Working Papers in Early Childhood Development 59*, The Hague: Bernard van Leer Foundation

Reynolds, A. and J.A. Temple (1998) 'Extended Early Childhood Intervention and School Achievement: Age 13 Findings from the Chicago Longitudinal Study', *Child Development 69*: 231–46

Schweinhart, L.J., J. Montie, Z. Xiang, W.S. Barnett, C.R. Belfield and M. Nores (2005) *Lifetime Effects: The High/Scope Perry Pre-school Study Through Age 40*, Ypsilanti, MI: High/Scope Press

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

Shore, R. (1997) *Re-thinking the Brain: New Insights into Early Development*, New York, NY: Families and Work Institute

Sianesi, B. (2004) 'An Evaluation of the Swedish System of Active Labour Market Programmes in the 1990s', *Review of Economics and Statistics* 86.1: 133–55

Smith, J.A. and P.E. Todd, (2005) 'Does Matching Overcome LaLonde's Critiques of Non-experimental Estimators?', *Journal of Econometrics* 125.1–2: 305–53

Sternberg, R. (1985) *Beyond IQ: A Triarchic Theory of Human Intelligence*, Cambridge: Cambridge University Press

Sylva, Kathy, Edward Melhuish, Iram Siraj-Blatchford, Brenda Taggart and Karen Elliot, (2002) *Measuring the Impact of Pre-school on Children's Cognitive Progress Over the Pre-school Period*, Technical Paper 8a, London: Institute of Education

Todd, P.E. and K.I. Wolpin (2004) 'On the Specification and Estimation of the Production Function for Cognitive Achievement', *Economic Journal* 113 .485: F3–33

UNESCO (2010) *Moscow Framework for Action and Cooperation: Harnessing the Wealth of Nations*, report of The World Conference on Early Childhood Care and Education (ECCE), Moscow, 27–29 September 2010

UNESCO (1996) *Links Between Early Childhood Development and Education and Primary Education*, UNESCO Education Sector Monograph no. 6/1996, Paris: UNESCO

Woessmann, L. (2006) *Efficiency And Equity Of European Education And Training Policies*, CESifo Working Paper No. 1779, Munich: Center for Economic Studies

Woldehanna, Tassew (2011) 'The Effects of Early Childhood Education Attendance on Cognitive Development: Evidence from Urban Ethiopia', *Ethiopian Journal of Economics* 20.1: 113–64

Woldehanna, Tassew, Alemu Mekonnen and Tekie Alemu (2008) *Young Lives: Ethiopia Round 2 Survey Report*, Oxford: Young Lives

Woodhead, Martin (2009) *Pathways Through Early Childhood Education in Ethiopia, India and Peru: Rights, Diversity and Equity*, Working Paper No. 54, Oxford: Young Lives

Wooldridge J.M. (2002) *Econometric Analysis of Cross Section and Panel Data*, Cambridge, MA: MIT Press

WHO (2007) *WHO Child Growth Standards*, Geneva: World Health Organization

WHO (2006) *WHO Child Growth Standards*, Geneva: World Health Organization

Appendix

Table A1. *Impact of pre-school education on children's cognitive development at the ages of 5 and 8*

	Kernel matching		Radius matching		k-Nearest neighbour matching (k=2)		k-Nearest neighbour matching (k=1)		Local linear regression matching	
Child outcome	**ATT**	**T-stat**	**ATT**	**T-stat**	**ATT**	**T-stat**	**ATT**	**T-stat**	**ATT**	**T-stat**
Round 2 (at age of 4.5 to 5.5)										
Logarithm of PPVT score in Round 2	0.312***	9.270	0.307***	9.470	0.130	1.540	0.152**	2.630	0.250***	3.720
Logarithm of % of maths questions correctly answered in Round 2	0.231***	8.660	0.230***	8.910	0.272***	3.790	0.269***	5.630	0.158**	2.720
Round 3 (at age of 7.5 to 8.5)										
Logarithm of PPVT score in Round 3	0.361***	13.310	0.365***	14.440	0.095	1.040	0.160	1.120	0.090	1.580
Logarithm of % of maths questions correctly answered in Round 3	0.592***	10.780	0.590***	11.290	0.175	1.330	0.199	1.400	0.233*	1.910
Grade completed at the age of 8 or in Round 3	0.218***	4.640	0.219***	4.780	0.177	1.050	0.138	1.080	0.111	1.180
Dummy variable for a child begun formal school in Round 3	0.118***	4.640	0.117***	4.860	0.133	0.950	0.124	1.370	0.105	1.810

Notes: ATT= Average treatment effect of the treated; result of psmatch2 ; k=2 in the k-Nearest neighbourhood matching; note: *** $p<0.01$, ** $p<0.05$, * $p<0.1$
N=634 (220 matched control group-non-pre-school- and 414 treatment group – pre-school children).

Table A2. *First-stage probit estimation of pre-school attendance*

	Coefficient (t-ratio)
Dummy variable for site 2 in Addis Ababa	0.174 (0.476)
Dummy variable for site 3 in Addis Ababa	−0.249 (−0.685)
Dummy variable for urban site in Amhara region	−1.832*** (−5.899)
Dummy variable for urban site in Oromia region	−2.159*** (−6.871)
Dummy variable for urban site 1 in SNNP region	−3.273*** (−8.670)
Dummy variable for urban site 2 in SNNP region	−0.640* (−1.946)
Dummy variable for urban site in Tigray region	−2.757*** (−7.661)
Dummy variable for other urban sites (where children moved out of their site)	−1.738*** (−4.863)
Calculated age in months for deriving z-scores in Round 1	0.037* (1.890)
Wealth index for 1-year-olds (Round 1)	1.743*** (2.828)
Dummy for male	0.030 (0.217)
Number of family members below 7 and above 65 years old	−0.155 (−1.623)
Number of children between 7 and 17 years old	−0.051 (−0.988)
Number of male family members > 17 and less than 65 years	−0.048 (−0.510)
Number of female family members > 17 and less than 65 years	0.113 (1.190)
Highest grade completed by primary caregiver	0.059*** (2.912)
Highest grade completed by father	0.065*** (3.717)
Dummy for a child whos had long-term health problem	−0.342 (−1.207)
Dummy for illness	−0.025 (−0.168)
Dummy for theft	0.215 (0.931)
Dummy for increased input prices	0.193 (1.030)
Dummy for divorce or separation in family	−0.732** (−2.408)
Dummy for place of employment shutdown or job loss	0.004 (0.019)
Dummy for decrease in food availability	0.208 (1.205)
Dummy for loss of job/source of income/family enterprise	−0.157 (−0.814)
Dummy for divorce or separation in family	0.040 (0.127)
Dummy for severe illness or injury	−0.052 (−0.248)
Constant	0.078 (0.157)
Number of observations	744
Log-likelihood	−221.04
Pseudo R2	0.565

Notes: *** p<0.01, ** p<0.05, * p<0.1; The region of common support is [.03108989, .99817445]

Table A3a. *Estimation of Round 2 cognitive development on pre-school attendance (propensity score as instrument)*[a]

Explanatory variables	Log (PPVT test score) coefficient (t-ratio)	Log (Q-CDA test score) coefficient (t-ratio)
Dummy variable for child being enrolled in pre-school	0.216*** (3.822)	0.234*** (5.466)
Height-for-age z-score of at the age of 1 year	0.013 (1.372)	0.023*** (3.282)
Calculated age in months for deriving z-scores in Round 1	0.029*** (6.134)	0.016*** (4.625)
Wealth index for 1-year-olds (Round 1)	0.212 (1.573)	0.025 (0.215)
Dummy for male	0.040 (1.273)	0.011 (0.444)
Number of children below 7 and above 65 years old	-0.034* (-1.696)	-0.014 (-0.740)
Number of children between 7 and 17 years old	0.015 (1.336)	-0.001 (-0.065)
Number of male family members > 17 and less than 65 years	-0.010 (-0.471)	-0.004 (-0.259)
Number of female family members > 17 and less than 65 years	-0.009 (-0.399)	-0.009 (-0.535)
Highest grade completed by primary caregiver	0.018*** (3.761)	0.009** (2.555)
Highest grade completed by father	0.002 (0.349)	-0.002 (-0.508)
Number of months the child was breastfed	-0.000 (-0.181)	0.000 (0.488)
Five-point Likert scale for the relative size of birth weight (−2 to 2)	-0.007 (-0.494)	-0.006 (-0.559)
Dummy for child had health problems at the age of 1 year	-0.052* (-1.665)	-0.008 (-0.339)
Constant	2.603*** (28.609)	1.864*** (22.543)
Number of observations	719	720
Adjusted R^2	0.199	0.139
Centered R^2 (r2c)	0.215	0.156
Uncentered R^2 (r2c)	0.983	0.979
Under identification test (Kleibergen-Paap rk LM statistic) (idstat)	452.038	453.068
P-value for under identification test (idp)	0.000	0.000

Notes: [a]Wooldridge (2002: 623)
*** p<0.01, ** p<0.05, * p<0.1

Table A3b. *Estimation of Round 3 cognitive development on pre-school attendance (propensity score as instrument)[a]*

Explanatory variables	Log (PPVT score)	Log (Q-CDA test score)
	coefficient (t-ratio)	coefficient (t-ratio)
Dummy variable for child being enrolled in pre-school	0.437*** (8.855)	0.511*** (5.673)
Height-for-age z-score of at the age of 5 years	0.026** (2.002)	0.051* (1.904)
Height-for-age z-score of at the age of 1 year	-0.009 (-1.011)	0.008 (0.492)
Dummy variable for a child begun formal school	0.033 (0.853)	0.426*** (5.206)
Calculated age in months for deriving z-scores	0.016*** (4.163)	0.020*** (2.957)
Wealth index for 1-year-olds (Round 1)	0.308** (2.442)	0.921*** (3.698)
Wealth index for 5-year-olds (Round 2)	0.067 (0.546)	0.028 (0.116)
Dummy for male	0.007 (0.289)	0.012 (0.262)
Number of children below 7 and above 65 years old	-0.017 (-0.922)	-0.081** (-2.222)
Number of children between 7 and 17 years old	0.003 (0.322)	-0.023 (-1.250)
Number of male family members > 17 and less than 65 years	0.011 (0.689)	-0.004 (-0.146)
Number of female family members > 17 and less than 65 years	-0.020 (-1.452)	-0.051* (-1.755)
Highest grade completed by primary caregiver?	0.002 (0.619)	-0.000 (-0.004)
Highest grade completed by father?	-0.005 (-1.422)	0.006 (0.884)
Number of months the child breastfed	-0.000 (-0.059)	0.003* (1.749)
Five point Likert scale for the relative size of birth weight (−2 to 2)	-0.011 (-0.982)	-0.002 (-0.082)
Dummy for child had health problems at the age of 1 year	-0.038 (-1.455)	0.014 (0.286)
Constant	2.696*** (7.417)	-0.669 (-0.984)
Number of observations	724	705
Adjusted R^2	0.270	0.281
Centered R^2 (r2c)	0.287	0.298
Uncentered R^2 (r2c)	0.995	0.925
Under identification test (Kleibergen-Paap rk LM statistic) (idstat)	439.831	436.246
P-value for under identification test (idp)	0.000	0.000

Notes: [a]Wooldridge (2002: 623)
*** p<0.01, ** p<0.05, * p<0.1

Table A4a *Regression of log of Round 2 PPVT score and CDA-Q test score*

	Ln of PPVT score			Ln of CDA-Q test score (% correctly answered)		
	OLS coef/t	IV version1 coef/t	IV version 2 coef/t	OLS coef/t	IV version1 coef/t	IV version 2 coef/t
Dummy variable for child being enrolled in pre-school	0.172***	0.318***	0.315***	0.166***	0.279***	0.276***
	(4.490)	(4.863)	(3.847)	(5.682)	(5.373)	(3.610)
Height-for-age z-score at the age of 1 year	0.014	0.007	0.187***	0.024***	0.017**	0.232***
	(1.465)	(0.778)	(2.943)	(3.272)	(2.533)	(4.267)
Calculated age in months for deriving z-scores in Round 1	0.029***	0.027***	0.052***	0.017***	0.015***	0.045***
	(6.269)	(5.797)	(4.972)	(4.722)	(4.326)	(4.991)
Wealth index for 1-year-olds (Round 1)	0.246*	0.149	−0.050	0.079	−0.047	−0.214
	(1.832)	(1.131)	(−0.275)	(0.775)	(−0.406)	(−1.237)
Dummy for boys	0.041	0.025	0.107**	0.013	0.007	0.090**
	(1.290)	(0.803)	(2.255)	(0.547)	(0.291)	(2.103)
Number of family members below 7 and above 65 years old	−0.037	−0.036*	−0.023	−0.018	−0.022	0.002
	(−1.608)	(−1.790)	(−0.847)	(−0.999)	(−1.171)	(0.078)
Number of children between 7 and 17 years old	0.015	0.015	−0.003	−0.002	−0.004	−0.026*
	(1.211)	(1.304)	(−0.207)	(−0.166)	(−0.473)	(−1.821)
Number of male family members > 17 and less than 65 years	−0.010	−0.005	−0.048*	−0.004	−0.000	−0.047**
	(−0.495)	(−0.232)	(−1.793)	(−0.229)	(−0.009)	(−2.248)
Number of female family members > 17 and less than 65 years	−0.006	−0.008	−0.009	−0.003	−0.011	−0.010
	(−0.288)	(−0.332)	(−0.359)	(−0.215)	(−0.728)	(−0.447)
Highest grade completed by primary caregiver	0.019***	0.017***	0.013**	0.010***	0.009***	0.004
	(4.068)	(3.497)	(2.119)	(2.795)	(2.662)	(0.869)
Highest grade completed by father	0.002	−0.001	−0.002	−0.000	−0.001	−0.003
	(0.533)	(−0.137)	(−0.394)	(−0.123)	(−0.419)	(−0.728)
Number of months the child was breastfed	−0.000	0.000	0.000	0.000	0.001	0.001
	(−0.322)	(0.371)	(0.078)	(0.228)	(0.592)	(0.607)
Five-point Likert scale for the relative size birth weight (−2 to 2)	−0.008	−0.006	−0.038**	−0.008	−0.010	−0.033*
	(−0.537)	(−0.426)	(−1.962)	(−0.686)	(−0.907)	(−1.859)
Dummy for child who had health problems at the age of 1 year	−0.050	−0.043	−0.025	−0.006	−0.017	0.037
	(−1.535)	(−1.377)	(−0.631)	(−0.234)	(−0.715)	(1.040)
Constant	2.607***	2.594***	2.560***	1.869***	1.909***	1.797***
	(26.289)	(28.399)	(22.229)	(24.653)	(23.604)	(15.796)
Number of observations	719	719	719	720	720	720
Adjusted R^2	0.200	0.182	−0.196	0.146	0.122	−0.862
Centered R^2 (r2c)		0.198	−0.173		0.139	−0.826
Uncentered R^2 (r2c)		0.983	0.975		0.979	0.955
Under-identification test (Kleibergen-Paap rk LM statistic) (idstat)		264.065***	23.262***		266.558***	24.092***
P-value for under-identification test (idp)		0.000	0.026		0.000	0.020
Hansen J statistics (over-identification test of all instruments) (j)		24.438	11.244		41.265	12.179
P-value for ove- identification test (jp)		0.018	0.423		0.000	0.350

Notes: *** p<0.01, ** p<0.05, * p<0.1; The instruments are regional dummies and pre- and post natal shocks. IV version1: only pre-school enrolment is endogenous ; IV version 2: both pre-school and height-for-age z-score of are endogenous variables.

Table A4b *Regression of log of Round 3 PPVT score and CDA-Q test score*

	Ln of PPVT score			Ln of CDA_Q test score (% correctly answered)		
	OLS coef/t	IV version 1 coef/t	IV version 2 coef/t	OLS coef/t	IV version 1 coef/t	IV version 2 coef/t
Dummy variable for child being enrolled in pre-school	0.257***	0.463***	0.392***	0.328***	0.485***	0.303***
	(8.352)	(9.469)	(5.998)	(5.656)	(5.554)	(2.967)
Height-for-age z-score of at the age of 5 years	0.031**	0.029**	0.134**	0.056**	0.052**	−0.101
	(2.464)	(2.298)	(2.321)	(2.339)	(1.991)	(−0.970)
Height-for-age z-score of at the age of 1 year	−0.008	−0.013	−0.144***	0.009	0.007	0.074
	(−1.033)	(−1.454)	(−3.030)	(0.584)	(0.402)	(0.958)
Dummy variable for a child who has begun formal school	0.069*	0.008	0.042	0.460***	0.444***	0.481***
	(1.770)	(0.199)	(0.876)	(5.901)	(5.487)	(5.209)
Calculated age in months for deriving z-scores	0.016***	0.016***	0.001	0.021***	0.019***	0.023**
	(4.679)	(4.331)	(0.139)	(3.117)	(2.894)	(2.158)
Wealth index for 1-year-olds (Round 1)	0.388***	0.387***	0.337**	1.003***	0.769***	1.041***
	(3.232)	(3.142)	(2.244)	(4.428)	(3.169)	(3.871)
Wealth index for 5-year-olds (Round 2)	0.152	0.060	0.229	0.117	0.256	0.304
	(1.290)	(0.491)	(1.633)	(0.523)	(1.138)	(1.254)
Dummy for boys	0.015	0.006	−0.022	0.020	0.008	−0.016
	(0.581)	(0.220)	(−0.621)	(0.408)	(0.181)	(−0.279)
Number of family members below 7 and above 65 years old	−0.027	−0.011	−0.027	−0.092***	−0.107***	−0.103***
	(−1.493)	(−0.641)	(−1.309)	(−2.697)	(−3.016)	(−2.790)
Number of children between 7 and 17 years old	0.001	0.002	0.006	−0.026	−0.029	−0.027
	(0.068)	(0.254)	(0.535)	(−1.403)	(−1.595)	(−1.370)
Number of male family members > 17 and less than 65 years	0.010	0.008	0.027	−0.005	0.012	−0.015
	(0.640)	(0.511)	(1.475)	(−0.151)	(0.430)	(−0.497)
Number of female family members > 17 and less than 65 years	−0.007	−0.026*	−0.029*	−0.038	−0.037	−0.013
	(−0.420)	(−1.818)	(−1.666)	(−1.263)	(−1.294)	(−0.383)
Highest grade completed by primary caregiver	0.005	0.001	0.004	0.003	−0.003	0.001
	(1.374)	(0.144)	(0.824)	(0.392)	(−0.388)	(0.107)
Highest grade completed by father	−0.003	−0.005	−0.007*	0.008	0.008	0.011*
	(−0.757)	(−1.482)	(−1.649)	(1.267)	(1.315)	(1.688)
Number of months the child was breastfed	−0.001	−0.000	0.000	0.002	0.002	0.001
	(−0.731)	(−0.331)	(0.353)	(1.118)	(1.578)	(0.316)
Five-point Likert scale for the relative size birth weight (−2 to 2)	−0.016	−0.006	−0.006	−0.006	−0.009	−0.009
	(−1.328)	(−0.495)	(−0.392)	(−0.275)	(−0.384)	(−0.348)
Dummy for child who had health problems at the age of 1 year	−0.031	−0.037	−0.066**	0.020	0.051	0.063
	(−1.206)	(−1.418)	(−2.185)	(0.409)	(1.103)	(1.294)
Constant	2.607***	2.674***	4.095***	−0.736	−0.585	−1.130
	(7.511)	(7.494)	(6.689)	(−1.113)	(−0.904)	(−1.157)
Number of observations	724	724	724	705	705	705
Adjusted R^2	0.304	0.258	−0.008	0.291	0.281	0.240
Centered R^2 (r2c)		0.275	0.016		0.298	0.258
Uncentered R^2 (r2c)		0.994	0.992		0.925	0.920
Under-identification test (Kleibergen-Paap rk LM statistic) (idstat)		415.407***	27.495***		411.690***	30.410***
Hansen J statistics (over-identification test of all instruments) (j)		25.529	11.235		54.214	32.981
P-value for over-identification test (jp)		0.008	0.340		0.000	0.000

Note: *** p<0.01, ** p<0.05, * p<0.1; The instruments are regional dummies and pre- and post-natal shocks. IV version 1: only pre-school enrolment is endogenous ; IV version 2: both pre-school and height-for-age z-score of are endogenous variables; t-ratios are in parentheses.

Table A5. *Descriptive statistics by pre-school attendance (only those on the common support)*

	Matched non–pre-school	Pre-school	Total
Height-for-age z-score of at the age of 1 year	−0.918	−0.770	−0.822
Height-for-age z-score of at the age of 8 years	−1.270	−0.981	−1.081
Dummy variable for a child who had begun formal school	0.850	0.942	0.910
Calculated age in months for deriving z-scores in Round 1	12.169	12.570	12.431
Calculated age in months for deriving z-scores in Round 2	62.296	62.553	62.464
Calculated age in months for deriving z-scores in Round 3	97.337	97.897	97.703
Wealth index for 1-year-olds (Round 1)	0.288	0.388	0.353
Wealth index for 5-year-olds (Round 2)	0.328	0.429	0.394
Dummy for male	0.514	0.531	0.525
Number of family members below 7 and above 65 years old	1.577	1.440	1.487
Number of children between 7 and 17 years old	0.191	0.157	0.169
Number of male family members > 17 and under 65 years	0.055	0.029	0.038
Number of female family members > 17 and under 65 years	0.195	0.159	0.172
Highest grade completed by primary caregiver	0.332	0.338	0.336
Highest grade completed by father	0.177	0.200	0.192
Number of months the child was breastfed	0.068	0.053	0.058
Five-point Likert scale for the relative size of child when born (-2 to 2)	0.155	0.135	0.142
Dummy for child had health problems at the age of 1 year	1.414	1.254	1.309
Dummy for illness	1.109	1.254	1.203
Dummy for theft	1.236	1.543	1.437
Dummy for increased input prices	3.564	6.449	5.448
Dummy for divorce or separation in family	5.241	8.200	7.174
Dummy for place of employment shutdown or job loss	32.050	26.133	28.186
Dummy for decrease in food availability	0.077	−0.010	0.021
Dummy for loss of job /source of income/family enterprise	0.441	0.401	0.415
Dummy for divorce or separation	0.359	0.324	0.336
Dummy for severe illness or injury	0.118	0.077	0.091
Number of observations	220	414	634

Table A6. *Descriptive statistics of variables used in the regressions*

Variable		Mean	Std. Dev.	Min	Max
r1_zhfa	Height-for-age z-score at the age of 1 year	−0.943	1.774	−6.040	8.170
r2_zhfa	Height-for-age z-score at the age of 8 years	−1.193	1.119	−6.570	4.590
hsstrtr3	Dummy variable for a child begun formal school	0.872	0.334	0.000	1.000
r1_agemons	Calculated age in months for deriving z-scores in Round 1	12.329	3.582	6.100	18.233
r2_agemons	Calculated age in months for deriving z-scores	62.451	3.779	55.294	74.743
r3_agemons	Calculated age in months for deriving z-scores	97.643	3.697	90.251	110.127
wi11	Wealth index for 1-year-olds (Round 1)	0.330	0.152	0.006	0.757
wi25	Wealth index for 5-year-olds (Round 2)	0.373	0.153	0.008	0.881
dmale	Dummy for male	0.522	0.500	0.000	1.000
depen	Number of family members below 7 and above 65 years old	1.524	0.701	1.000	5.000
ch7to17	Number of children between 7 and 17 years old	1.304	1.341	0.000	8.000
nbn17_65mr1	Number of male family members > 17 and less than 65 years	1.165	0.821	0.000	5.000
nbn17_65fr1	Number of female family members > 17 and less than 65 years	1.410	0.824	0.000	6.000
careed	Highest grade completed by primary caregiver	4.984	4.302	0.000	14.000
daded	Highest grade completed by father	6.590	4.749	0.000	14.000
lngbfed	Number of months the child was breastfed	28.930	13.523	0.000	36.000
bsize1	Five-point Likert scale for the relative size of child when born (−2 to 2)	0.056	1.069	−2.000	2.000
childprobd	Dummy for child had health problems at the age of 1 year	0.430	0.495	0.000	1.000
dillnesr2	Dummy for illness	0.349	0.477	0.000	1.000
dtheftr2	Dummy for theft	0.097	0.296	0.000	1.000
dinputprr2	Dummy for increased input prices	0.191	0.393	0.000	1.000
ddivorcer2	Dummy for divorce or separation of family	0.058	0.234	0.000	1.000
demplr2	Dummy for place employment shutdown or job loss	0.172	0.378	0.000	1.000
hhfood	Dummy for decrease in food availability	0.340	0.474	0.000	1.000
hhjob	Dummy for job loss/source of income/family enterprise	0.183	0.387	0.000	1.000
hhdiv	Dummy for divorce or separation	0.059	0.236	0.000	1.000
hhill	Dummy for severe illness or injury	0.138	0.346	0.000	1.000

N= 745, cluster dummies excluded

The Effects of Pre-school Attendance on the Cognitive Development of Urban Children aged 5 and 8 Years: Evidence from Ethiopia

This paper, using data from the Young Lives longitudinal survey in Ethiopia, examines the effects of pre-school attendance on the cognitive development of urban children at the ages of 5 and 8 (measured by the Peabody Picture Vocabulary Test (PPVT) and the Cognitive Development Assessment – Quantitative test (CDA-Q)). We used propensity score matching techniques in order to estimate the impact of pre-school. We also substantiated the analysis using various empirical approaches including ordinary least squares and instrumental variable estimation methods. Our results show that pre-school attendance has a statistically significant positive impact on the cognitive development of children at the ages of both 5 and 8 years, with the bigger impact at the latter age. Moreover, pre-school attendance has also a positive and statistically significant effect on primary school enrolment and progression through grades. Despite the fact that early childhood education has immense importance for children's cognitive development, public investment in pre-school education is currently limited in Ethiopia, with the private sector taking the key role, which may exacerbate the inequality that exists between rich and poor (and between urban and rural areas). Therefore, given the relatively low rate of pre-school attendance and the low quality of basic education, the Government needs to reconsider its education priorities so as to invest more in early childhood education.

Young Lives
An International Study of Childhood Poverty

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About Young Lives

Young Lives is an international study of childhood poverty, involving 12,000 children in 4 countries over 15 years. It is led by a team in the Department of International Development at the University of Oxford in association with research and policy partners in the 4 study countries: Ethiopia, India, Peru and Vietnam.

Through researching different aspects of children's lives, we seek to improve policies and programmes for children.

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Young Lives is coordinated by a small team based at the University of Oxford, led by Professor Jo Boyden.

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- *General Statistics Office, Vietnam*
- *Child and Youth Studies Group (CREET), The Open University, UK*
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