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Increasing educational attainment in Egypt: The impact of early childhood care and education ☆

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ABSTRACT

This paper investigates the impact of early childhood care and education on subsequent educational attainment in Egypt. Comparisons between siblings are used to control for selection and duration analysis methods are used to account for the presence of current students in the data. These methods are compared to OLS to demonstrate the importance of accounting for both observed and unobserved heterogeneity and for students who have not yet completed their schooling. Early childhood care and education significantly reduces the probability of dropping out, specifically during basic education. The change in educational attainment from early childhood care and education is approximately one additional year of schooling. Key pathways for this effect include improved school performance, such as increases in test scores and decreases in repetition, during basic education. Results indicate expanding early childhood care and education would be an important and effective policy for improving educational outcomes.

1. Introduction

The Egyptian government is making a major investment in early childhood education through an expansion in access to kindergarten. Providing kindergarten to only 30% of Egyptian children by 2015 is estimated to cost the country $103 million (UNDP & Institute of National Planning, 2008). There is a body of supportive international evidence indicating that kindergarten, as a form of early childhood education, is a worthwhile investment. Early childhood care and education can have a positive impact on human development in both the short and long run. While early educational interventions *can* have important effects, there is also a great deal of heterogeneity in program impacts (Nores & Barnett, 2010). The quality of early childhood interventions and the country-specific context in which they are applied can cause enormous variation in program effects.

In the context of Egypt and the Middle East and North Africa (MENA) region, there is a shortage of evidence on the impact of early childhood care and education (ECCE) (Janssens, Van Der Gaag, & Tananka, 2001; Todd, 2010). Current estimates of the impact of ECCE in Egypt are merely simulations (Janssens et al., 2001; van Ravens & Aggio, 2008) on the basis of evidence from places such as Chicago, India, and Bolivia. ECCE is under-researched throughout the MENA region; a recent meta-analysis examining the high-quality evidence on early childhood development used 56 different studies from 23 countries throughout the world, none of which came from the MENA region (Nores & Barnett, 2010). Engle et al.'s (2011) review of the evidence on preschools likewise includes no countries from the MENA region. As well as being under-researched, early childhood is under-resourced in the region. Despite the fact that the region is middle-income, pre-primary enrollments in the MENA

☆ Some preliminary findings of this paper were included in a short policy brief, "Is Early Childhood Care and Education a Good Investment for Egypt? Estimates of Educational Impacts, Costs, and Benefits" (English and Arabic). 2012. *Survey of Young People in Egypt Policy Brief No. 3*. New York, NY: The Population Council.

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region more closely resemble those of Sub-Saharan Africa than other middle-income countries (UNESCO, 2010). This paper contributes important evidence on the under-researched issue of ECCE in MENA by estimating the impact of ECCE on educational outcomes in Egypt.

Early childhood is an important focus of human development interventions and policies because it is when persistent development gaps and deficits occur, and also when interventions to rectify disadvantage yield benefits that justify their costs (Heckman, 2006). The plasticity of children's brains (Shonkoff & Phillips, 2000) and the challenges of reversing early deficits make early childhood a vital window for interventions (Naudeau, Kataoka, Valerio, Neuman, & Elder, 2011). Childcare, education, nutrition, healthcare, and cash transfer programs are the primary types of early childhood interventions and show a broad variety of health, cognitive, behavioral, and educational impacts (Aboud, 2006; Baqui et al., 2009; Berlinski, Galiani, & Gertler, 2009; Bernal & Fernández, 2013; Bhutta et al., 2008; Black et al., 2008; Eickmann et al., 2003; Engle et al., 2011; Naudeau et al., 2011; Nores & Barnett, 2010; Temple & Reynolds, 2007; Walker et al., 2011). Which intervention or combination of interventions is the best investment remains a subject of discussion and analysis (Engle et al., 2011; Nores & Barnett, 2010).

A great deal of the debate focuses on studies from the United States, where evidence shows the potentially large impacts of ECCE. Camilli, Vargas, Ryan, and Barnett (2010) synthesize 123 studies and demonstrate that preschool programs have significant effects on children's cognition, social skills, and school progress. The Abecedarian Project, the Chicago Child Parent Center Program, and the Perry Preschool Program in particular provide impressive results and the best-studied evidence (Heckman, Moon, Pinto, Savelyev, & Yavitz, 2010; Temple & Reynolds, 2007; Vegas & Santibanez, 2010). These programs show positive economic returns to quality preschool, with benefit/cost ratios in the 4–10 range, higher than most other alternative education interventions (Temple & Reynolds, 2007).

Evidence from the United States showing the impact of preschool has been reinforced by international evidence. ECCE programs in East Africa (Mwaura, Sylva, & Malmberg, 2008) and Colombia (Bernal & Fernández, 2013) and preschool programs in Uruguay (Berlinski et al., 2009; Berlinski, Galiani, & Manacorda, 2008), Bolivia (Behrman, Cheng, & Todd, 2004) and Bangladesh (Aboud, 2006) show the potential of ECCE to improve cognitive, non-cognitive, and educational outcomes. Because of its powerful impact, early childhood education is considered a cornerstone of meeting the goal of Education for All and the Millennium Development Goals, as well as an important element of development and poverty reduction strategies (UNESCO, 2006).

However, not all ECCE programs are equal. Negative, insignificant, and small impacts, as well as positive, significant, and large impacts are visible in the literature (Engle et al., 2011; Nores & Barnett, 2010; Walker et al., 2011). Much of the evidence showing a large impact for ECCE comes from high quality programs (Temple & Reynolds, 2007; Vegas & Santibanez, 2010). In Bangladesh, a revised higher quality preschool program was found to be a significant improvement over existing preschool on a number of cognitive and social outcomes (Moore, Akhter, & Aboud, 2008). Evidence also suggests that disadvantaged children may particularly benefit from ECCE programs (Heckman, 2006), but this evidence is not conclusive (Nores & Barnett, 2010).

The focus of this study on long-run educational attainment and the pathways through which ECCE affects attainment is a particularly valuable addition to the literature on ECCE. Studies on the short term effects of early childhood interventions are much more common (Nores & Barnett, 2010), but short term effects may dissipate, particularly in terms of academic or cognitive gains or for particular sub-groups (Currie & Thomas, 1995; Magnuson, Ruhm, & Waldfogel, 2007). Truly long term studies from the developing world are rare. Two of the longer-term studies include Berlinski et al. (2009), which quantifies the cognitive effects of preschool at third grade in Uruguay, and Berlinski et al. (2008), which examines preschool's effect on 7–15 year-olds' educational attainment in Uruguay. This effect, as they point out, is not necessarily predictive of final attainment. Hazarika and Viren (2013) similarly examine the effect of participation in early childhood development programs on 7–18 year-olds' school enrollment in rural North India, and find significant and substantial increases in enrollment, but do not calculate the programs' impact on educational attainment.

Selection into ECCE is a challenge in estimating the causal effect of ECCE, since ECCE is likely to be correlated with a host of observable and unobservable characteristics. This study identifies the effects of ECCE through within-family estimates. This approach to controlling for selection has been used in a number of other studies of ECCE (Berlinski et al., 2008; Currie & Thomas, 1995) and is recognized as an effective approach to generating causal estimates for education data (Card, 1999). The data set used to estimate the impact of ECCE is Egypt's first representative survey of young people to include a question about ECCE attendance. The data cover a sample of youth who would have been of preschool age in 1984–2004. Appropriate econometric techniques, such as estimating the impact of ECCE within-family, can generate ECCE effects from this cross-sectional data.

The results show that early childhood care and education has an impact on educational attainment that is both statistically significant and sizeable. ECCE increases educational attainment by approximately one year, with this effect primarily due to decreased primary and preparatory drop out. A key pathway for ECCE's impact on educational attainment is improved school performance, such as higher test scores, decreased grade repetition, and improvements in school tracking, during the early years. Investments in ECCE can be a powerful approach to improving educational outcomes, and the international research suggests that increases in ECCE are likely to have other beneficial effects on human development as well.

The paper proceeds as follows. Section 2 discusses the data. Section 3 provides background on Egypt and its educational system. Section 4 describes the empirical strategy. Section 5 presents the findings on educational attainment. Section 6 examines the pathways that may drive ECCE's impact on attainment. Section 7 discusses a number of checks for selection into ECCE. Section 8 concludes with the implications of the findings, their limitations, and suggests directions for future research.

2. Data

A recent survey, the 2009 Survey of Young People in Egypt (SYPE), provides an opportunity to marshal evidence on ECCE's impact in Egypt. The survey covers a nationally representative sample[1] of 15,029 youth with household and individual data on each youth. Within households, one youth 10–14, one male and one female 15–21, and one male and one female 22–29 were randomly sampled. The survey includes over a hundred questions on education, as well as numerous child and family characteristics such as child demographics, parental education, and household wealth. A retrospective question on nursery or kindergarten attendance was included in the education section. The question was "Before you attended school, have you ever been to a nursery or kindergarten?" and potential responses were "yes," "no," or "don't know"[2] (Population Council, 2011). Although there may be some recall error in this retrospective question, a study in Uruguay that compared the pattern of preschool attendance in retrospective data and contemporaneous statistics on preschool attendance found quite similar reports of attendance (Berlinski et al., 2008). Additionally, any mis-reporting, as a form of measurement error, will attenuate the effect of ECCE, making the estimates in this paper a lower bound.[3] While information on type of ECCE and duration of attendance would also be of great interest, such data were not collected.

3. Egypt–background and education system

Egypt is a middle-income country with a population of 85 million (CAPMAS, 2013) including a large youth population (UNDP & Institute of National Planning, 2010). This youth population presents both a sizeable challenge, in terms of delivering education and expanding employment, and an enormous opportunity to advance the development of Egypt and the wellbeing of its citizens. Substantial strides have been made in educating Egypt's youth. The right to a free public education is enshrined in Egypt's constitution (Egypt State Information Service, 2014) and Egypt is approaching universal primary enrollment (UNDP & Institute of National Planning, 2008). Primary (five years, grades 1–5)[4] and preparatory (three years, grades 6–8) schooling are compulsory basic education, with entry at age six. General (university track) or vocational (almost always a terminal degree) secondary, both of which are three years (grades 9–11), may follow preparatory. Those who continue for higher education may attend two-year post-secondary institutes or four-year university programs (grades 12–15). A few students may go on for additional years of graduate education. The education system is largely public (88%), with some private (5%) and religious schools (7%) as well (Population Council, 2011). Public schools are technically free of charge, but households' education spending tends to be substantial, especially for fees, supplies, and private tutoring (World Bank, 2002a).

The ECCE system in Egypt can be divided into two types: kindergartens and nurseries (UNDP & Institute of National Planning, 2008). Kindergartens are one or two years of pre-primary classes for children aged 4–6, with formal curricula and teachers; they fall under the oversight of the Ministry of Education. Half are government run, and the remainder privately run by NGOs, religious schools, workplaces, or private individuals. Nurseries are designed to provide childcare for children under the age of four and lack a strong educational component. However, due to a shortage of kindergarten space, up to 40% of nursery children are estimated to be aged 4–6. The nursery system includes public provision, under the Ministry of Social Solidarity, but this accounts for less than a third of services. Over two-thirds of nursery services are NGO provided, and some by the private sector. Parents generally have to pay for ECCE, and enrollment fees can be a barrier for both kindergarten and nurseries.[5] Quality of both teachers and facilities is highly variable, but often low (UNDP & Institute of National Planning, 2008).[6]

Two Egyptian education trends are particularly relevant to an examination of ECCE's impact. These are the increase in both ECCE enrollments and enrollments throughout the education system. Fig. 1 shows the trend in ECCE attendance by birth cohort and gender. Although less than 30% of the oldest youth in the SYPE attended ECCE, more than 50% of the youngest youth have done so, and there has generally been a trend of increasing ECCE attendance with more recent birth cohorts.[7] There has also been, especially in earlier birth cohorts, a gender gap in ECCE attendance. Males are

[1] The sample is nationally representative after the application of sample weights. Sample weights took into account all the dimensions of household and individual sampling strategies. See Population Council (2011) for further information on sampling and weights.

[2] $N = 176$ for don't know, coded as no.

[3] Denote y^* as the true value of ECCE and y as the reported value. Because ECCE is always bounded between zero and one, if $y^* = 1$, then $y - y^* \leq 0$ and likewise if $y^* = 0$, then $y - y^* \geq 0$. There is necessarily a negative correlation between any measurement error and the true value. Assuming mis-reporting is independent of other covariates, the estimated coefficient on ECCE will be biased towards zero (Bound, Brown, & Mathiowetz, 2001).

[4] In 1988 primary school was reduced from six years to five. In the 2004/2005 school year, the sixth year of primary was restored to the schooling system (Shahine, 2003). In this analysis, primary school always counts as five years of schooling.

[5] Around 2000, when the younger end of the sample would have been of ECCE age, annual kindergarten fees at an average government school would have been between 15% and 22% of the per capita poverty line ($2/day), a line below which nearly 40% of Egyptians fell. Private kindergartens would be essentially inaccessible to poorer families, as their fees ranged from approximately 75% to 373% of the same per capita poverty line. Fees for government nurseries were 9–45% of that per capita poverty line (calculated from El-Laithy, Lokshin, & Banerji, 2003; World Bank, 2002b). There is not good national data on private nurseries. The available examples illustrate fees can also be a barrier for this care type. For instance, in 2008, the fees in private nurseries in poor districts of greater Cairo amounted to 15% of the 2008/2009 lower per capita poverty line for a family of five, while the fees in an NGO nursery in Giza amounted to 25% of the same poverty line (calculated from UNDP & Institute of National Planning, 2008; World Bank, 2011).

[6] ECCE faces a shortage of both human and material resources (UNDP & Institute of National Planning, 2008). Facilities often fall short on hygiene and lack adequate space to play. A field study of nursery schools in Giza and Cairo found widely varying pedagogy, curriculum, staffing, space and facilities. The use of unqualified staff is common. Only 15% of staff in the field study had a higher education degree in early childhood education and more than half had only a high school diploma (UNDP & Institute of National Planning, 2008).

[7] Although separating the roles of increased supply and demand in ECCE expansion is difficult, the prevalence of kindergarten-aged children in nurseries (UNDP & Institute of National Planning, 2008) suggests that, despite a policy of increasing the number of kindergarten classrooms, demand for ECCE is high, especially relative to the supply of kindergartens.

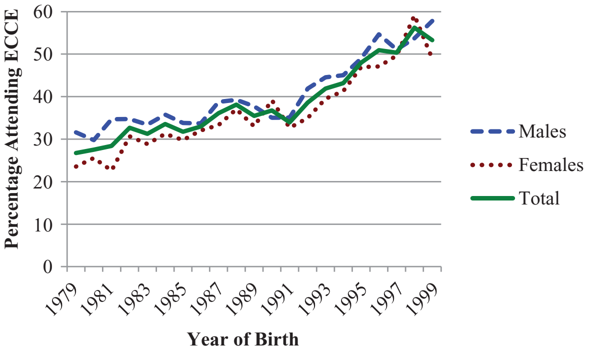

Fig. 1. ECCE attendance by gender and birth cohort (percentages). Source: Author's calculation based on SYPE 2009 data.

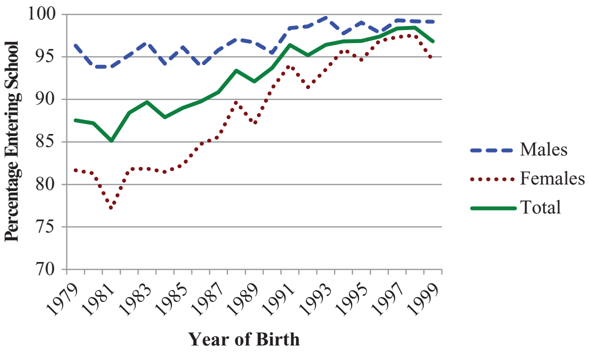

Fig. 2. School entry by gender and birth cohort (percentages). Source: Author's calculation based on SYPE 2009 data.

slightly more likely to attend ECCE than females. Fig. 2 shows a related and simultaneous trend, the general expansion of school attendance. While less than 90% of youth in the oldest birth cohorts even entered school, more than 95% of younger birth cohorts did so; likewise the years of schooling attained by youth have increased over time. School entry also shows a gender gap, and one that is larger than the ECCE gap. Females born in 1979–1985 entered school at rates around 81%, while males were much closer to 95%. This gender gap has diminished substantially over time.

Although access to education has expanded, quality issues in the education system persist, which could alter the impact of ECCE. The relatively simultaneous expansion of both ECCE and overall education can also complicate an identification of ECCE impact. Additionally, the impact of early educational interventions can fade over time when not supported by additional quality education (Currie & Thomas, 1995). Although ECCE may help mitigate problems in the Egyptian education system, for instance reducing drop out, Egypt may also be poorly positioned to maximize any ECCE gains due to the low quality of the education system. Systematic problems abound, including high rates of drop out, absenteeism, and grade repetition, as well as pedagogical problems such as rote memorization (Krafft, 2012).

4. Empirical strategy

There are no experimental or longitudinal studies on the impact of ECCE in Egypt. Although it is cross-sectional and non-experimental, the SYPE data and its features can be used, with appropriate econometric techniques, to generate causal estimates of the impact ECCE has on children in Egypt. This paper uses and compares two different estimation approaches: ordinary least squares (OLS) regressions and comparing siblings (within-family estimates using family fixed effects). This mix of methods provides a range of estimates under different assumptions about selection into ECCE. Duration analysis methods are also used to account for the fact that current students in the data have not achieved their final educational attainments.

ECCE is not distributed independently of other characteristics that confer educational advantages. Thus, it is important to control for characteristics that will impact educational outcomes and that are also related to ECCE. A number of controls are incorporated into the regressions, including gender, father's education, mother's education, wealth quintile based on an asset index, birth cohort, governorate of birth, and urban/rural residence.[8] These are characteristics that other studies have shown to be strongly predicative of educational attainment (Assaad, 2013).

Within-family or family fixed effects, essentially sibling comparisons, are another method that can help address selection into ECCE. Within-family estimates are recognized as an effective approach to generating causal estimates for questions relating to education. Although measurement error tends to be amplified in within-family estimates compared to other methods such as OLS or instrumental variables (IV), ability bias is higher in IV estimates than OLS or family fixed effects models (Card, 1999). Since measurement error in within-family models will bias estimates of ECCE's impact downward, while ability bias with IV will bias estimates upward, within-family estimates are the more conservative approach.

Since many of the unobservables that affect both selection into ECCE and educational outcomes are at the household level, by comparing siblings within a household where one received ECCE and one did not, the impact of ECCE can be estimated with greatly diminished, if not eliminated, selection bias. This technique has been used to estimate the impact of Head Start in the U.S. (Currie & Thomas, 1995) as well as preschool expansion in Uruguay (Berlinski et al., 2008). These sibling comparison or family fixed effects models generally estimate equations of the form:

$$Y_{ij} = \beta_0 + \beta_k X_{ijk} + \alpha_j + \varepsilon_{ij} \quad (1)$$

where the outcome, Y, for individual i in family j is a function of k individual characteristics, X_{ijk}, such as ECCE that vary by an individual within a family, as well as a family fixed effect, α_j, that reflects variability across families, and ε_{ij}, representing the random variability of individuals within families. The within-family estimates are restricted to actual siblings in their parents' household in order to avoid comparing two youth in the same household with different parents, or a married couple.

Changes between children's ECCE and school years can still bias results, and the direction of this effect is ambiguous depending on the nature of these changes. Preferential

[8] The set of covariates used in this study was necessarily restricted by the variables that were available in the SYPE.

treatment of some children is also an issue. Parents may select their more (or less) able children into ECCE. The possibility that parents select children with higher innate ability into ECCE is particularly problematic in identifying whether it is actually ECCE that has a positive effect. However, when Berlinski et al. (2008) used within-family methods to estimate the effect of preschool on subsequent educational attainment in Uruguay they also used instrumental variable estimates that controlled for the non-random selection of siblings. They obtained similar results with both sibling comparisons and instrumental variables. Although different patterns of selection might occur in Egypt than in Uruguay, Berlinski et al.'s (2008) findings suggest non-random selection of siblings is unlikely to substantially bias results. Other studies on the effects of education have shown that ability bias is smaller in within-family estimates than OLS estimates (Card, 1999). Additionally, findings can also be tested for some cases of parental preference, such as preference for oldest or male children. The SYPE data also include self-reported test scores, which can be used as a measure of ability to examine whether parents are selecting more (or less) able siblings.

Counter-balancing the problem of potential preferential treatment biasing within-family ECCE effect estimates upward is the possibility of two types of sibling spillovers. What one child learns may spill over to other siblings and bias estimates of ECCE effects downward within families. This spillover is likely to occur when older siblings receive ECCE and their knowledge spills over to younger siblings. There is suggestive evidence of a positive but small sibling spillover effect in Head Start in the United States (Garces, Thomas, & Currie, 2002). Additionally, a younger sibling attending ECCE may in fact have positive spillovers to educational outcomes for an older (usually female) sibling regardless of their ECCE status. A study from Kenya indicates strong substitution between ECCE and older-sibling (female) child care and concomitant school exit (Lokshin, Glinskaya, & Garcia, 2000). With both older to younger sibling and younger to older (female) sibling spillovers possible, within-family effects may underestimate actual ECCE program effects. Comparing across methods, while OLS is likely to over-estimate ECCE's impact due to selection into ECCE, family fixed effects methods will remove any sources of bias, even unobserved characteristics, that are constant within families. However, family fixed effects models may still have some bias due to the net effects of selection among siblings counterbalanced by possible spillovers and attenuation due to measurement error.

As well as confronting an econometric challenge with selection into ECCE, there is a challenge with the data in terms of right censoring on educational outcomes due to the fact that many respondents are current students. Counting current years of education as final when a student has not yet left school will bias results. Additionally, years of schooling is more properly understood as a time-to-event (school exit) outcome, one where ECCE may have different effects on the likelihood of leaving school in different grades. Because the survey covers 10–29 year-olds, it is essentially a collection of entry cohorts, which are ideal for time-to-event or duration analysis. A hazard function, $h(t)$ can be used to model the probability of school exit, T, between time t and $t+\Delta t$ conditional on survival until time t or later (Moeschberger & Klein, 2003):

$$h(t) = \lim_{\Delta t \to 0} \frac{\Pr(t \le T < t + \Delta t | T \ge t)}{\Delta t} \qquad (2)$$

The hazard function can then be estimated to model the risk of leaving school and how different characteristics, X, such as ECCE, alter this risk. This hazard function can be transformed into changes in the mean years of schooling by comparing the difference in simulated survival functions (the proportion of students remaining in school by year) with and without ECCE.

For the outcome of years of schooling a Cox proportional hazards model with time interactions is used, which does not require a parametric form of the baseline hazard function to be specified (Moeschberger & Klein, 2003).[9] This model specification allows the chances of dropping out and the impact of ECCE to vary at each year of schooling. Because exiting schooling is much more likely to occur at the end of different stages, the absence of a parametric form is a desirable feature; models which specify an underlying parametric distribution of the hazard function would be inaccurate. A variety of different studies have used the Cox model to examine educational attainment while including those still in school, for instance an investigation of the impact of remittances on years of schooling in El Salvador (Edwards & Ureta, 2003), a study of the impact of wealth on the demand for and duration of schooling in Vietnam (Glewwe & Jacoby, 2004), and a study of the impact of poverty, intra-household decision making, and school quality on years of schooling (Brown & Park, 2002).

The Cox proportional hazards model estimates (Moeschberger & Klein, 2003):

$$h(t|X) = h_0(t) \exp\left(\sum_{k=1}^{p} \beta_k X_k\right) \qquad (3)$$

where $h_0(t)$ is the baseline hazard rate of school exit, X_k are the covariates and β_k are the parameters to be estimated. Partial maximum likelihood estimation leads to estimates of the coefficients without requiring an estimate of the baseline hazard.

The Cox proportional hazards model assumes proportionality, that is, that the effect of covariates is not a function of time. If this assumption is violated, estimates may be inaccurate. Including time-dependent covariates in the model solves this problem (Moeschberger & Klein, 2003). Time interactions between each year and ECCE allow the effect of ECCE to vary over time, as some of the effects of ECCE may dissipate, as has been suggested by other research (for instance Currie & Thomas, 1995; Magnuson et al., 2007). Time dependent covariates to allow for time interactions can be added into a hazard model by specifying X_{kt} that are interactions of time t and a covariate (Moeschberger & Klein, 2003), such as ECCE. The β_{kt} estimated for such interactions are the effect of a covariate at time t, for instance if $t = 3$, the effect of ECCE on the hazard of school exit at year 3.

The proportional hazards model assumes that the hazard function and time are continuous and no tied events should

[9] The baseline hazard is akin to a constant in an OLS regression, and represents the hazard of dropping out at each year for the reference case.

occur (Therneau & Grambsch, 2000). However, as is often the case, the SYPE data record schooling time discretely, in years. Ties (simultaneous failures, i.e. dropping out at the same point in time) present a computational challenge to estimating the hazard model without bias. The proportional hazards model with the exact partial method for handling ties is therefore ideal, as it treats time as discrete (Therneau & Grambsch, 2000).

The Cox proportional hazards model can include family fixed effects by generating separate strata for families. This allows the baseline hazards to be different for each family (Ridder & Tunali, 1999), akin to a family-specific error term. The Cox proportional hazards model at time t for a subject in family j is then (Moeschberger & Klein, 2003):

$$h_j\left(t|X\right) = h_{0j}\left(t\right) \exp\left(\sum_{k=1}^{p} \beta_k X_k\right) \tag{4}$$

While the baseline hazards, $h_{0j}(t)$, may vary by family, the estimated coefficients on covariates are constrained to be equal. Thus, causal estimates of ECCE's impact on attainment can be generated using family fixed effects in duration models, which account for current students.

5. Findings

5.1. The distribution of ECCE attendance

Youths' background is closely related to their ECCE attendance (Table 1). A total of 39.3% of youth in the SYPE reported attending ECCE. Males are slightly more likely to have attended ECCE (41.1%) than females (37.4%). Younger youth are much more likely to have attended ECCE than older youth (51.1% of 10–14 year olds versus 29.8% of 25–29 year olds). This time trend follows the increased availability of ECCE, especially kindergarten classrooms being built (Janssens et al., 2001). Family background has a close relationship with ECCE. Youth in the highest wealth quintile are almost five times more likely to have attended ECCE than youth in the lowest quintile. Although there is an overall increase with wealth, the jump in ECCE attendance is particularly sharp in the fourth and highest quintiles. This wealth gradient is consistent with issues of financial access determining ECCE utilization (UNDP & Institute of National Planning, 2008). Parents' education is also closely tied with ECCE. Children with more-educated parents, especially highly (post-secondary institute, university, or above) educated parents are more likely to attend ECCE.

Place of residence has strong associations with youths' attendance of ECCE. More than two-thirds (69.5%) of youth in urban governorates attended ECCE and more than half of youth in urban Lower Egypt (56.1%). These are also the more privileged areas of Egypt in terms of education and wealth. Rural Upper Egypt, generally identified as the poorest region in Egypt, also has the lowest ECCE attendance rate at 16.6%. While much of the literature (Engle et al., 2011; Magnuson et al., 2007; Naudeau et al., 2011; Vegas & Santibanez, 2010) identifies ECCE as particularly important for the most disadvantaged children, the current distribution of ECCE in Egypt favors children with other advantages.

5.2. Educational attainment

ECCE can deliver educational, economic, and social benefits through a number of different cognitive and behavioral avenues. Given the nature of the data available, not all of these benefits can be measured. However, many of the benefits link to educational outcomes, on which data are available; one of the strengths of the SYPE is a very detailed education section. The resulting estimates of impacts on educational attainment can be considered a conservative estimate of total ECCE impacts. This section first describes the distribution of education in the sample, and then presents a sequence of OLS, within-family, and hazard model estimates of the impact of ECCE on educational attainment.

5.2.1. Distribution of education

The educational attainment of youth in the SYPE sample is challenging to describe because of the large number of youth who are current students. Table 2 therefore breaks down the educational status of youth by distinguishing between current students and those who are no longer in school in terms of the highest level they have attended. The table also shows how this pattern evolves by age group. Almost half (48%) of the sample consists of current students, although this ranges from 94% of those aged 10–14 to 1% of those aged 25–29. The share of current primary students in the sample is 15% and the share of current preparatory students 16%. Around 6% of youth are current vocational secondary students, and 4% general secondary students. Less than 1% of youth are currently in post-secondary institutes, but 7% are in university or above.

While 7% of youth never attended school, a similar share have attended primary and stopped, as well as 8% who have attended preparatory and stopped. The most common educational status is having attended vocational secondary and then left school (21%). Just 1% of youth attended general secondary and stopped; this is unsurprising since general secondary is not designed to be a terminal degree but instead the track into higher education. While 2% of youth in the sample have attended post-secondary institutes and then stopped, more commonly youth have attended university and above (7%) and then stopped. Looking at the breakdown of educational status by age group, it is clear that educational attainment has been improving over time as fewer youth never attend school or stop after just a primary education. Among youth old enough to have finished their schooling, the most common degree is a vocational secondary education (almost 40% of youth attain this degree). University degrees are also common (around 20% of older youth). Although the educational status of younger cohorts is uncertain, ECCE may play a role in current and future improvements in educational attainment.

5.2.2. OLS estimates

Although ECCE is definitely not distributed independently of other covariates that will impact educational attainment, the bivariate relationship between ECCE and years of schooling can help benchmark other estimates. In a regression of years of schooling on ECCE with no background characteristics for all youth aged 10–29 (not shown), ECCE attendance predicted 1.28 more years of schooling. However, many

Table 1
ECCE attendance and distribution of samples (percentages).

	Attending ECCE	% of ECCE attendees	% of within-family sample	% of youth population
Gender				
Males	41.1	53.4	58.0	51.1
Females	37.4	46.6	42.0	48.9
Age group				
10–14	51.1	37.2	25.8	28.6
15–17	39.5	16.2	23.6	16.1
18–24	34.8	31.9	40.2	36.0
25–29	29.8	14.7	10.3	19.3
Wealth				
Lowest	16.2	8.2	16.1	19.9
Second	23.0	12.1	18.5	20.6
Middle	32.8	18.3	24.2	21.9
Fourth	51.9	26.3	26.7	19.9
Highest	77.8	35.1	14.5	17.7
Father's education				
Illiterate	22.6	11.8	25.1	20.6
Primary	37.6	16.6	23.5	17.4
Preparatory	45.8	6.9	7.9	6.0
Vocational secondary	57.5	20.6	18.1	14.1
General secondary	55.7	1.3	1.5	1.0
Post-secondary institute	70.2	2.5	1.9	1.9
University and above	76.2	16.4	9.1	8.4
Missing	29.2	22.8	13.0	30.7
Mother's education				
Illiterate	25.0	23.6	43.6	37.1
Primary	42.8	17.2	24.0	15.8
Preparatory	53.1	7.3	7.0	5.4
Vocational secondary	66.1	21.9	15.7	13.0
General secondary	74.6	1.5	1.1	0.8
Post-secondary institute	84.8	2.6	0.8	1.2
University and above	86.0	11.6	4.0	5.3
Missing	26.4	14.4	3.8	21.5
Region				
Urban governorates	69.5	37.9	22.8	21.4
Urban Lower Egypt	56.1	15.8	12.5	11.1
Rural Lower Egypt	34.0	27.3	34.1	31.5
Urban Upper Egypt	32.5	6.3	8.5	7.7
Rural Upper Egypt	16.6	11.2	20.0	26.6
Frontier governorates	31.6	1.4	2.2	1.8
Residence				
Urban	61.3	49.3	34.3	31.6
Rural	25.9	38.9	54.7	58.9
Informal urban housing (slum)	48.5	11.8	11.0	9.6
Total	39.3	100.0	100.0	100.0
N (observations)	15,027	5,981	2,579	15,029

Source: Author's calculations based on SYPE 2009 data.

youth, especially in the 10–17-age range, are still in school, and therefore this variable is censored and biases the estimate. Restricting the ECCE/years of schooling relationship to youth 18–29 (some 18–29 year-olds may be current students at the university level, still biasing the relationship downward), ECCE was associated with 3.34 additional years of schooling (not shown).

ECCE is associated with other characteristics that confer educational advantage. Adding a number of controls, Table 3 displays results from OLS regressions of ECCE on years of schooling. Specification 1 controls for family and individual background characteristics and restricts the sample to 18–29 year olds. A 1.79-year increase in years of schooling was associated with ECCE after adding these controls. Another important issue that may be biasing results is ever-entry into school. Among those respondents who have never been to school at all ($N = 1{,}167$), very few ($N = 21$) report attending ECCE. Although parents' decision to send their children to ECCE occurs chronologically before formal school entry, conceptually the decision is a function of the unobserved intention to educate children. Some international literature ascribes to ECCE the effect of increased entry into primary school (Arnold, Bartlett, Gowani, & Merali, 2007; UNESCO, 2006), but does not convincingly disprove joint selection into both ECCE and schooling. Additionally, in the context of Egypt, never-entry is becoming a less frequent problem. Those that

Table 2
Educational status and enrollment by age group.

	Age group				
	10–14	15–19	20–24	25–29	Total
Educational status					
Non-students (highest level attended)					
Never attended	2.4	4.5	9.5	12.8	6.7
Primary	3.1	6.9	8.4	13.3	7.4
Preparatory	0.8	10.9	9.4	10.3	7.5
Vocational secondary	0.0	14.6	38.5	37.6	20.7
General secondary	0.0	0.7	2.1	1.3	0.9
Post-secondary institute	0.0	0.3	3.3	3.7	1.6
University and above	0.0	0.1	13.6	19.8	7.2
Sub-total of non-students	6.2	37.9	84.9	98.9	52.1
Current students (current level)					
Primary	52.7	0.2	0.0	0.0	15.1
Preparatory	40.8	14.2	0.0	0.0	15.6
Vocational secondary	0.2	19.4	0.9	0.0	5.6
General secondary	0.1	14.3	0.2	0.0	4.1
Post-secondary institute	0.0	1.4	0.6	0.1	0.6
University and above	0.0	12.6	13.4	1.0	7.0
Sub-total of current students	93.8	62.1	15.2	1.1	47.9
Total	100.0	100.0	100.0	100.0	100.0
N (observations)	4,053	4,096	3,726	3,154	15,029

Source: Author's calculations based on SYPE 2009 data.

are still failing to enter school have the most disadvantaged backgrounds, and the least access to ECCE. Their stated reasons for not entering school, such as cost, health, or parental opposition (Krafft, 2012) are not alterable with ECCE. Including never-attending youth as members of the comparison group falsely ascribes to ECCE some of the impact of parents' decision to send their children to school at all.

Specification 2 attempts to correct this issue by limiting the regression to 18–29 year olds who ever attended school. The coefficient on ECCE drops from the 1.79 of Specification 1 to 1.09 additional years of schooling as a result of ECCE. The relationship between ever entry and ECCE, driven by the unobserved intention to educate children, was leading to an approximately 0.7 year over-estimation of the impact of ECCE. Results are far more credible excluding those who never attend school; only the ever-entered sample is used hereafter.

ECCE could have heterogeneous impacts, such as a particular benefit for disadvantaged youth or a differential effect by gender. When an interaction between ECCE and gender was tested in addition to Specification 2, it was not significant (Table A1). Nor were wealth interactions significant (Table A1). Unlike U.S. studies that suggest disadvantaged students receive the largest benefits of ECCE (Heckman et al., 2010; Temple & Reynolds, 2007) ECCE does not appear to have a uniquely positive effect for Egypt's disadvantaged youth.[10]

Although there is not a unique effect for the disadvantaged, all these different specifications indicate that ECCE increases educational attainment. The fact that there is such a substantial difference between the estimated ECCE effect in the simple unadjusted mean difference models and the models controlling for observed characteristics suggests a nontrivial role for selection bias resulting from unobservable characteristics as well.[11] Although the adjusted *R*-squared of 27.2% for Specification 2 is substantial, much variation in years of schooling remains unexplained. Unobserved differences, such as parents valuing education and therefore investing in both ECCE and later schooling, may be confounding these estimates.

5.2.3. *Within-family estimates*

Unobservables are likely to be much diminished, if not entirely removed, by comparing children within families. In the next set of analyses, family fixed effects models are used to control for unobserved family-specific characteristics that may be associated with educational attainment in order to generate causal estimates of the impact of ECCE. Table 4 presents within-family estimates for sibling youth who ever entered school and were living with their parents at the time of the survey. Only coefficients for ECCE are presented; gender and birth cohort variables are also included in the model but not shown. Table 1 shows that the youth used for within-family comparisons are actually more representative of the overall population than the ECCE receiving population that identified the ECCE effect in OLS.[12]

[10] The lack of a differential ECCE effect for poorer children could be due to there truly being no different impact, or a variety of confounding factors. For instance, poorer children might receive greater benefits when attending the same quality of ECCE as wealthier children, but usually attend lower quality ECCE, which has smaller benefits. The greater benefit to the poor could be washed out by their lower quality ECCE.

[11] As well as OLS models, propensity score models were estimated to account for selection on observable characteristics; results (available from the author upon request) were very similar to those with OLS.

[12] Additionally, the youth used in the within-family models, which require at least two siblings to compare, have only slightly larger families than the general population. The average number of siblings for a youth in the within-family sample is 3.14. The average number of siblings (for a youth living with their parents) in the entire youth sample is 2.72.

Table 3
OLS years of schooling.

Outcome: years of schooling	Specification 1 Restricted to 18–29	Specification 2 Restricted to 18–29 ever-entered
ECCE	1.791***	1.090***
	(0.103)	(0.082)
Female	−0.562***	0.259***
	(0.088)	(0.073)
Father's education		
Primary	0.388**	0.321**
	(0.145)	(0.119)
Preparatory	0.262	0.440*
	(0.227)	(0.184)
General secondary	1.197*	1.042*
	(0.540)	(0.427)
Vocational secondary	0.997***	0.951***
	(0.195)	(0.156)
Post-secondary institute	1.216**	1.177***
	(0.410)	(0.324)
University and above	0.827**	0.969***
	(0.253)	(0.201)
Missing	−0.132	0.124
	(0.139)	(0.116)
Mother's education		
Primary	0.410**	0.127
	(0.134)	(0.108)
Preparatory	0.494*	0.329
	(0.251)	(0.200)
General secondary	0.693	0.678
	(0.525)	(0.414)
Vocational secondary	0.542**	0.598***
	(0.205)	(0.163)
Post-secondary institute	0.356	0.654
	(0.521)	(0.411)
University and above	0.612*	0.700**
	(0.300)	(0.238)
Missing	−0.955***	−0.835***
	(0.134)	(0.113)
Wealth quintile		
Second	1.363***	0.563***
	(0.132)	(0.117)
Third	2.471***	1.198***
	(0.133)	(0.115)
Fourth	3.701***	2.189***
	(0.145)	(0.123)
Highest	5.117***	3.586***
	(0.177)	(0.148)
Constant	5.913***	7.648***
	(0.288)	(0.242)
Adj. R-squared	0.319	0.272
N	8,486	7,522

Source: Author's calculations based on SYPE 2009 data.
Notes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.
Standard errors in parentheses.
Reference case: male, father illiterate, mother illiterate, lowest wealth quintile. Birth cohort (1979 reference), governorate of birth (Cairo reference) and rural dummies are also included. Governorate of birth was only available for youth who answered the migration module, that is, youth 15–29. Current governorate of residence used as governorate of birth for youth 10–14.

Specification 3 uses family fixed effects to compare all youth within a family where at least one youth attended ECCE and at least one did not. Within families, ECCE predicted a significant additional 0.39 years of schooling. This finding was robust to when the oldest family member attended ECCE and others did not (Specification 4, 0.59 years), and when the youngest attended ECCE and others did not (Specification 5, 0.52 years). The finding was, however, different by gender. Within families, comparing only males when at least one male attended ECCE and at least one did not (Specification 6), ECCE attendance predicted an additional 0.61 years of schooling. For females (Specification 7), ECCE attendance was not significant and was in fact a small negative. The relatively small number of observations and groups with variation between two females may contribute to this finding. Spillovers, especially between females, may also be an issue.

Table 4
Years of schooling—within-family OLS (only ever-entered youth).

Outcome: years of schooling	Specification 3 All	Specification 4 Oldest treated	Specification 5 Youngest treated	Specification 6 Males only	Specification 7 Females only
ECCE	0.393***	0.586***	0.522**	0.613**	−0.026
	(0.086)	(0.153)	(0.183)	(0.178)	(0.190)
R-squared within	0.640	0.688	0.636	0.648	0.807
R-squared between	0.475	0.488	0.482	0.364	0.678
R-squared overall	0.544	0.577	0.547	0.510	0.730
N	2,482	1,021	1,526	604	324
N groups	996	401	616	285	154

Source: Author's calculations based on SYPE 2009 data.
Notes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.
Standard errors in parentheses, corrected for household clusters.
Regressors included for gender and birth cohort.
Includes family fixed effects (within-family estimates).
Reference case: male, born 1979.
Very few ($N = 37$) youth in the within-family analysis had birth governorates different from their other family members. Additionally, some variation may be due to the lack of birth governorate data for 10–14 year olds requiring the use of current governorate. Therefore, birth governorate variables were not used in this model.

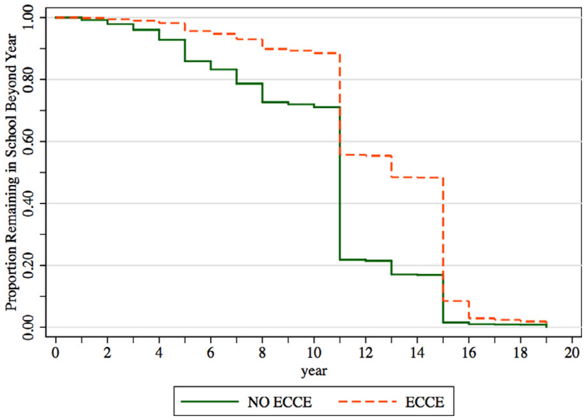

Fig. 3. Kaplan-Meier survival function for all ever attendees. Source: Author's calculation based on SYPE 2009 data.

It is noteworthy that the within-family estimates of ECCE's impact are substantially smaller than those generated by OLS, suggesting that OLS suffered from selection on unobservables. Although the youngest treated and oldest treated both demonstrate a positive and significant ECCE effect, the fact that many of the within-family youth are currently in school may also be biasing the size of the coefficient downward. Likewise, in the OLS models, while the regressions limited to 18–29 year-olds diminish the censoring generated by current students in the sample, they do not do so completely. Nor do they tell us *when* the additional schooling is occurring and whether the ECCE effect dissipates.

5.2.4. Hazard model estimates

To investigate the timing of ECCE effects and properly account for youth still in school, survival analysis methods are required. These methods are applied for the ever-entered sample and then the within-family sample. To illustrate the relationship between ECCE and years of schooling, Kaplan–Meier survival functions, which account for right censoring, are computed. Fig. 3 presents this survival function for all ever-attendees. It displays the proportion of youth remaining in school beyond a given year by ECCE status.[13]

The survival function, like the regressions without covariates, suggests a substantial advantage in school attainment for those who attend ECCE. Differences are small in the first few years of primary, but widen substantially by year 5, the end of primary. Differences continue to widen between years 6 and 8, during preparatory. There is also a substantial difference between those who exit school at year 8, the end of preparatory and compulsory schooling, on the basis of ECCE. The gap does not widen in the additional years of secondary, suggesting the fade out of a positive educational effect on drop out during those years. There is, however, the largest gap at the decision to stop at year 11, the end of secondary, or continue to university.

ECCE attendees, have, however, been shown to be substantially advantaged by their backgrounds in a number of dimensions. The real question is the effect of ECCE after accounting for these differences. Table 5 shows the hazard model for the ever-entered sample,[14] the results of which remain generally consistent with the survival function, but are substantially less dramatic. In the hazard model, ECCE is now time interacted.[15] Otherwise the same covariates are

[13] The data collected is on years of schooling completed or attained, not attended. So, for instance, if an individual entered but did not complete their fourth year of primary school, they would be counted as having attained three years of schooling, and having then failed (not successfully continued) at the end of year 3. It is therefore not possible to distinguish between those who do not continue at the end of year 3 and those who fail before the end of year 4; these groups are both considered as having attained three years. Additionally, those who entered but failed during their first year ($N = 30$) are excluded from the analysis in order to maintain comparability in attainment as the failure at the end of a year or failure to fully complete the subsequent year.

[14] This model was estimated with the Efron method for ties. All the hazard models were also estimated without weights; very little difference was observed in coefficients with and without weights using the Breslow method for ties, and the other methods for handling ties cannot handle weights.

[15] Time interactions were only included through the end of the fourth year of tertiary (end of university) as sample size diminished drastically beyond that point, and ECCE effects had also substantially faded out.

Table 5
Hazard model and simulated changes in attainment for ever entered sample.

	Hazard ratio	Standard error	% Attain without ECCE	% Attain with ECCE	Change due to ECCE
ECCE's impact at each year					
Primary					
End at year 1	0.310**	(0.111)	0.7	0.2	−0.5
End at year 2	0.510**	(0.114)	1.1	0.6	−0.5
End at year 3	0.351***	(0.076)	1.6	0.6	−1.0
End at year 4	0.370***	(0.060)	2.8	1.0	−1.7
End at year 5 (attain primary)	0.516***	(0.051)	6.0	3.2	−2.8
Preparatory					
End at year 6	0.413***	(0.075)	2.4	1.1	−1.3
End at year 7	0.485***	(0.065)	4.1	2.2	−1.9
End at year 8 (attain preparatory)	0.611***	(0.068)	5.5	3.7	−1.7
Secondary					
End at year 9	0.931	(0.270)	0.6	0.7	0.0
End at year 10	0.999	(0.250)	0.8	1.0	0.1
End at year 11 (attain secondary)	0.606***	(0.026)	48.9	34.1	−14.8
University					
End at year 12	0.599	(0.274)	0.3	0.4	0.1
End at year 13	0.847	(0.100)	4.4	7.7	3.3
End at year 14	0.326	(0.273)	0.2	0.1	−0.1
End at year 15 (attain university)	1.169*	(0.081)	17.9	39.8	21.9
Above university					
End at year 16			1.6	2.4	0.8
End at year 17			0.2	0.2	0.0
End at year 18			0.2	0.2	0.1
End at year 19			0.9	0.8	−0.1
Total for attainments			100.0	100.0	0.0
Female	0.965	(0.025)			
Father's education					
Primary	0.869**	(0.038)			
Preparatory	0.769***	(0.055)			
General secondary	0.711*	(0.114)			
Vocational secondary	0.628***	(0.038)			
Post-secondary institute	0.543***	(0.078)			
University and above	0.558***	(0.048)			
Missing	0.921	(0.039)			
Mother's education					
Primary	0.952	(0.039)			
Preparatory	0.939	(0.069)			
General secondary	0.532**	(0.107)			
Vocational secondary	0.625***	(0.043)			
Post-secondary institute	0.525**	(0.109)			
University and above	0.498***	(0.052)			
Missing	1.441***	(0.059)			
Wealth quintile					
Second	0.813***	(0.033)			
Third	0.668***	(0.027)			
Fourth	0.475***	(0.021)			
Highest	0.253***	(0.014)			
N	13,826				

Source: Author's calculations based on SYPE 2009 data.
Notes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.
Coefficients are hazard ratios.
Standard errors (in parentheses) can be used to test whether hazard ratios are significantly different from 1.
Efron method used for ties.
Reference case: male, father illiterate, mother illiterate, lowest wealth quintile. Birth cohort (1979 reference), governorate of birth (Cairo reference) and rural dummy are also included but not shown.

included in this model as in the OLS regressions. Coefficients are hazard ratios and can be interpreted as deviations from one. For instance, the time interacted ECCE hazard for the end of year 1 indicates the hazard (chance or probability) of leaving at the end of year 1 is a third (0.31) of what it would otherwise be without ECCE. In this model, ECCE diminishes by half or more the hazard of leaving school for every year through the end of year 7. The hazard of leaving the schooling system at the end of preparatory is also decreased, but to a lesser degree. As was suggested by the survival function, during secondary there appears to be no real additional advantage to ECCE. However, whether individuals continue on for higher education is impacted substantially by ECCE. With ECCE a youth has only three-fifths (0.61) of the risk of stopping at the end of secondary that one would without ECCE. Hazard ratios during tertiary are not significant, except for a slight decrease in the chances of continuing on to above university education if one has ECCE.[16] Hazard ratios for other covariates are as expected from the OLS models. Compared to the (disadvantaged on most dimensions) reference case, improved background characteristics decrease the hazard of exiting school.

These changes in hazard can also be used to simulate the additional years of schooling and changed final attainments associated with ECCE. Table 5 presents the final attainments that an ever-attending youth would, on average, attain without ECCE and with ECCE.[17] Ending during or before the end of primary and preparatory education is substantially diminished by ECCE. By summing the changes in the survival function, it is also possible to estimate the change in years of schooling, which is an increase of 1.63 years on average due to ECCE. This estimate, after accounting for right censoring, is substantially higher than the OLS estimate for 18–29 year olds by nearly half a year.[18]

Comparing the within-family and OLS models for years of schooling, it was clear that the within-family models showed smaller ECCE impacts. However, that difference could have been due either to the greater share of youth still in school in the within-family models, or because the OLS estimates were inflated by selection or omitted variables. Survival analysis using family fixed effects provides an opportunity to generate a reliable estimate of ECCE impact while both managing censoring and addressing selection. Fig. 4 presents the survival function for the within-family sample.

The within-family survival function indicates a much reduced but still sizeable difference in educational attainment based on ECCE when compared with the entire ever-entered school population (Fig. 3). The survival functions of ECCE and non-ECCE individuals start to diverge towards the end of primary, remain separated (but without much further divergence) through preparatory, diverge further in continuing to secondary, and show an important gap in

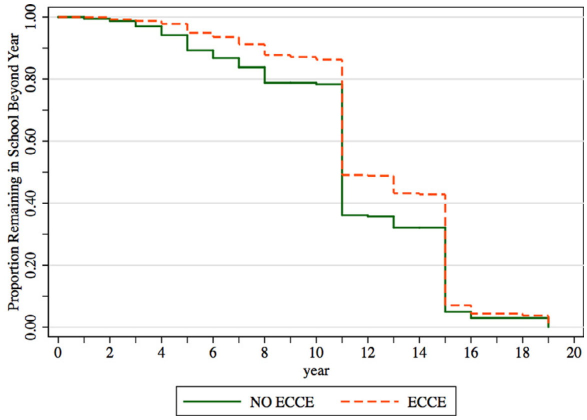

Fig. 4. Within-family Kaplan-Meier survival function. Source: Author's calculation based on SYPE 2009 data.

continuing for higher education. These survival functions do not account for individuals' characteristics. Although there are limited observable differences within a family, it is important to fully control for differences in children, such as gender and birth cohort. Therefore, within-family estimates using hazard models are generated (Table 6). Because of a limited sample of families with two individuals who went through secondary and varied in ECCE, ECCE's effects on the hazard of drop out are estimated only through the effect in continuing on after preparatory (at which point the impact was observed to dissipate). These changes in hazard ratios will nonetheless affect the entire course of education, as individuals who do not drop out during primary and preparatory will then be able to continue through later years.

The within-family ECCE coefficients are jointly significant, and always reduce the hazard of leaving school, but are not significant for every individual year. Insignificant coefficients may be due to reduced sample size and multi-collinearity. The general trend is for ECCE to have the greatest impact early. ECCE substantially lowers the hazards of dropping out during primary. For instance, ECCE decreases by three-quarters the probability of ending at years 3 or 4 and halves the probability of stopping at the end of primary (year 5). The hazard is decreased by three-fifths for ending during or at the end of preparatory. The hazard ratios are insignificant during preparatory, but significant for the chances of an individual continuing on to secondary at the end of preparatory. The impacts at the end of primary and end of preparatory are particularly important in practical terms, as the baseline hazards at those times are much greater.

The projected differences in educational attainment if the population had entirely not had ECCE or entirely had ECCE remain striking (Table 6). A much greater proportion of the population completes compulsory education. Assuming that ECCE has no differential effect beyond preparatory,[19] nearly half of the population (48.1%) attains a secondary education,

[16] Wald tests were performed for the joint equivalence of ECCE effects across all years and also for the years within levels. There were significant differences across all the years and across years within some levels. Specifically, the test for equivalence across all the years had a *p*-value of less than 0.001. The test for the equivalence of the primary level effects (years 1–5) had a *p*-value of 0.191. The test for the equivalence of the preparatory level effects (years 6–8) had a *p*-value of 0.137. The test for the equivalence of the secondary level effects (years 9–11) had a *p*-value of 0.051. The test for the equivalence of the university level effects (years 12–15) had a *p*-value of 0.024.

[17] These attainments are based on an estimate of the underlying 'No ECCE' survival function for those who did receive ECCE, had they not, combined on a proportional population basis with the survival function of those who did not receive ECCE and then compared to the survival of those who did receive ECCE, and an estimate of what those who did not would have attained, had they received ECCE. Essentially the population estimated to be entirely without ECCE has its hazard diminished by the hazards in Table 5.

[18] A model with interactions between different (grouped) cohorts and the time-interacted ECCE effects was estimated to test whether ECCE effects varied by cohort. A Wald test showed that the interactions were jointly insignificant (*p*-value 0.490).

[19] The estimated hazard ratios for primary and preparatory indicate a greater proportion of young people will persist through preparatory. In simulating their final attainments, no differential effects beyond preparatory are

Table 6
Within-family hazard model (only ever-entered youth) and simulated changes in attainment.

	Hazard ratio	Standard error	% Attain without ECCE	% Attain with ECCE	Change due to ECCE
ECCE's impact at each year					
Primary					
End at year 1	0.090*	(0.107)	1.2	0.1	−1.1
End at year 2	0.742	(0.478)	1.0	0.7	−0.2
End at year 3	0.259**	(0.129)	1.7	0.5	−1.3
End at year 4	0.241**	(0.121)	3.2	0.8	−2.4
End at year 5 (attain primary)	0.458**	(0.131)	6.2	3.0	−3.2
Preparatory					
End at year 6	0.428	(0.214)	2.3	1.1	−1.2
End at year 7	0.466	(0.253)	4.1	2.1	−2.0
End at year 8 (attain preparatory)	0.401*	(0.150)	6.4	2.9	−3.5
Secondary					
End at year 9			0.6	0.7	0.1
End at year 10			0.8	1.0	0.2
End at year 11 (attain secondary)			39.9	48.1	8.2
University					
End at year 12			0.3	0.4	0.1
End at year 13			5.0	6.0	1.0
End at year 14			0.1	0.2	0.0
End at year 15 (attain university)			23.2	27.8	4.6
Above university					
End at year 16			2.4	2.8	0.5
End at year 17			0.2	0.3	0.0
End at year 18			0.2	0.3	0.0
End at year 19			1.1	1.4	0.2
Total for attainments			100.0	100.0	0.0
Female	0.676**	(0.094)			
N	2478				
N groups	996				

Source: Author's calculations based on SYPE 2009 data.
Notes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.
Coefficients are hazard ratios.
Standard errors can be used to test whether hazard ratios are significantly different from 1.
Exact partial method used for ties.
Regressors included for birth cohort.
Stratified on family to generate family fixed effects (within-family estimates).
Reference case: male, born 1979.

an 8.2 percentage point increase. Under these assumptions there is also an important increase in university attainment, rising from 23.2% without ECCE to 27.8% with ECCE. The resulting simulated difference in total years of schooling is 1.09, substantially less than the 1.63 simulated using the full ever-entered sample hazard model. Since selection on unobservables is an issue, the within-family hazard estimates are the most credible. However, it is notable that across both ordinary least squares and within-family estimation methods ECCE has a consistently positive effect on years of schooling.

6. Improved educational performance: pathways for ECCE's impact

The increases in educational attainment generated by ECCE indicate that children who attend ECCE progress further in the schooling system. This section investigates additional educational outcomes that might be improved by ECCE, focusing on school performance as measured by test scores, grade repetition, and tracking into the general (university-bound) track of secondary. The impact of ECCE on these other outcomes suggests that a key pathway through which ECCE increases educational attainment in Egypt is by increasing the chances of success in school.

In Egypt, children have to "test out" of each level of school in high-stakes exams. Family fixed effects models were estimated for the impact of ECCE on (recalled) test scores at the end of the primary, preparatory, and secondary levels (Table 7). Test scores are out of 100. At the end of primary the sample's average test score is 80.6,[20] and the within-family estimate is for a statistically significant 1.9 point increase in that score from ECCE. At the end of preparatory, the sample's average test score is 74.3,[21] and the within-family estimate is for a 2.2 point higher test score from ECCE. This is significant only at the 10% level. At the secondary level, controlling for secondary track, the within-family estimate is an

assumed; those who persist until that point are assumed to continue or drop out at rates that are unaffected by ECCE attendance.

[20] The standard deviation for primary test scores is 11.8.
[21] The standard deviation for preparatory test scores is 13.0.

Table 7
Within-family OLS test scores, grade repetition, and secondary tracking.

Outcome	Primary score	Preparatory score	Secondary score	Primary repetition	Preparatory repetition	General secondary (tracking)
ECCE	1.932*	2.200	−0.682	−0.034***	−0.037*	0.078*
	(0.977)	(1.223)	(0.951)	(0.010)	(0.015)	(0.031)
R-squared within	0.088	0.135	0.196	0.019	0.067	0.053
R-squared between	0.010	0.037	0.148	0.004	0.015	0.005
R-squared overall	0.036	0.071	0.149	0.010	0.038	0.021
N	480	387	365	2,482	1,657	790
N groups	209	174	169	996	693	350

Source: Author's calculations based on SYPE 2009 data.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.
Standard errors in parentheses, corrected for household clusters.
Regressors included for gender and birth cohort, and for type of secondary for secondary score.
Reference case: male, born 1979, vocational secondary (for type of secondary in secondary score regression).

insignificant 0.7 point lower test score from ECCE.[22] This pattern of test scores suggests that ECCE provides a cognitive or learning boost during primary and preparatory years. One pathway for ECCE's effect on educational attainment is therefore better test performance, as one of the most common reasons students provide for dropping out of school is poor performance (Population Council, 2011).

Grade repetition is common in Egypt, indicates that a student has not mastered the material, and is also a symptom of poor school performance. At the primary level, around 5.8% of students repeat a grade. At the preparatory level, 11.2% of students repeat a grade. Family fixed effects linear probability models for grade repetition in primary and preparatory are also presented in Table 7. ECCE attendance decreases primary repetition a significant 3.4 percentage points. ECCE also decreases preparatory repetition a significant 3.7 percentage points. The sample does not allow for an estimate of secondary grade repetition, but the evidence from the OLS models suggests there is unlikely to be an ECCE effect (Table A2). No significant ECCE effects were found for vocational secondary repetition, general secondary repetition, or university repetition in the OLS models.[23] The reduction in repetition due to ECCE during basic education is a further indication of ECCE facilitating school success, and suggests that ECCE increases the mastery of basic education. Reducing repetition also improves efficiency and generates savings within the school system by not having to teach the same material to the same student repeatedly. The reduction in repetition and the learning it represents are likely to be an important pathway for ECCE increasing educational attainment as well.

For students who complete basic education and continue on to secondary education, a further key indicator of school success is whether they track into general (university bound) secondary or vocational secondary (almost always a terminal degree). Approximately 40% of those who attend secondary do so on the general track. In the family fixed effects linear probability models, ECCE increases the probability of attending general secondary by 7.8 percentage points (Table 7).[24] This indicates that students who perform better during primary and preparatory school and are less likely to drop out will persist in the education system beyond basic education, as is suggested in the simulated changes in educational attainment (Table 5). In sum, a number of mechanisms related to school success are key pathways for ECCE's effect on educational attainment. ECCE contributes to increases in basic education test scores, decreases in grade repetition, and higher chances of tracking into general secondary and therefore higher education.

7. Checking for selection into ECCE

Comparing siblings in order to control for selection is a recognized technique for identifying the effect of early childhood education on later outcomes (Berlinski et al., 2008; Currie & Thomas, 1995). However, it is possible that selection among siblings into ECCE is contributing to the estimated within-family ECCE effect. A number of tests for selection in terms of gender, birth order, and ability were undertaken.[25] In the within-family hazard model, the effect of ECCE remains statistically significant when the oldest sibling sampled is the one treated, as well as when it is younger siblings who are treated. Hazard ratios on ECCE are generally comparable to those of the entire within-family sample. ECCE also has a significant effect when comparing between two males. The results comparing between two females within a family suffer from too small a sample size to successfully estimate. Selection on gender and birth order is not driving the finding of an ECCE effect.

[22] The within-family estimates are notably lower than the OLS estimates of ECCE's effect on test scores, presented in Table A2, suggesting selection biases OLS results. The overall pattern of a primary and preparatory boost is the same, and the OLS models show positive but insignificant coefficients for secondary and university test scores.

[23] Vocational secondary repetition is 6.6% in the population, general secondary repetition 5.2%, and university repetition 9.0%.

[24] This is notably lower than the OLS estimate of a 12.0 percentage point increase (Table A2).

[25] Results not shown, but available from author upon request.

Selection on ability is the most concerning possibility, as it would substantially bias results. If more (less) able siblings were sent to ECCE, this would bias any estimate of ECCE effect upward (downward) relative to any true effect. Berlinski et al. (2008) used a sibling comparison to examine the effect of preschool on educational attainment in Uruguay. Instrumental variable estimates, used to control for non-random selection of siblings into preschool, led to similar results. This finding suggests that non-random selection of siblings does not bias estimates of ECCE effects.

Although no identifying instruments are available in the SYPE data, to test for selection on ability it is possible to revisit the relationship between self-reported test scores from the end of each level of schooling and ECCE attendance (Table 7). If parents were selecting more able siblings, we would expect *consistently* higher test scores to be associated with ECCE. However, while we see approximately two point higher test scores during primary and preparatory using within-family estimates, at the secondary level the within-family estimate is for an insignificantly *lower* test score due to ECCE. Since we do not see consistently higher test scores, it is unlikely that parents are selecting more able siblings.[26]

8. Discussion and conclusions

For many developing countries, such as Egypt, the core challenge in education has shifted from school entry to ensuring children learn well while in school and complete a basic education. Egypt is now pursuing a major investment in early childhood education in hopes of improving education outcomes (Todd, 2010; UNDP & Institute of National Planning, 2008). Early childhood education may be an effective strategy for improving educational outcomes; it has shown substantial educational impacts and high benefit–cost ratios in the international literature. However, there was not any evidence from an Egyptian context, or from other countries in the MENA region (Janssens et al., 2001; World Bank, 2004). While the international evidence shows the potential for substantial gains from ECCE programs, it also shows substantial heterogeneity in program impacts (Engle et al., 2011; Nores & Barnett, 2010).

Conducting ECCE experiments would require many years of follow up in order to estimate long-term impacts. However, by exploiting the SYPE data, this paper has estimated the impact of ECCE on a number of long-term educational outcomes using a variety of methods. Initially, the paper estimated the impact of ECCE on years of schooling, controlling for observable differences, and focusing on older youth to try to capture final educational attainment. However, unobserved characteristics are likely to bias such estimates. Therefore, within-family comparisons were used to estimate the impact of ECCE on educational outcomes. Additionally, hazard models were estimated to account for current students and allow the effect of ECCE on drop out to vary across years of schooling. Across these methods, ECCE has been consistently shown to increase educational attainment by at least a year, primarily by decreasing primary and preparatory drop out. A key mechanism for ECCE's impact is improved school performance, particularly in basic education, as measured by higher test scores, decreased grade repetition, and greater tracking into university-bound general secondary. These findings are a substantial contribution to the literature on ECCE from developing countries, which has previously focused on short-term impacts of ECCE on cognition or non-final impacts of ECCE on educational attainment (Berlinski et al., 2009, 2008; Hazarika & Viren, 2013; Nores & Barnett, 2010). It is noteworthy that, despite the different context, Berlinski et al.'s (2008) study found a preschool effect of an additional 0.8 years at age 15 in Uruguay, which is consistent with this study's finding of an additional year of schooling. This suggests that ECCE programs are an effective strategy for improving educational outcomes across a variety of contexts.

It is important to be mindful of the limitations of the estimates of ECCE's impact on educational outcomes in Egypt. No information is available on the type, quality, or duration of ECCE, all of which are likely to affect ECCE impacts. Selection into ECCE can bias OLS estimates. Using within-family estimates to remove the relationship between unobservable family characteristics and ECCE is the best option given current data. Selection into ECCE can occur within a family based on child ability. However, the results using test scores indicate that ability is not the driver of the within-family ECCE effect. Additionally, balancing potential upward biases are downward biases due to measurement error (Card, 1999) and spillovers between siblings (Garces et al., 2002; Lokshin et al., 2000).

While only the impact of ECCE within the education system was included in this analysis, the beneficial effect of ECCE on other outcomes is likely to be substantial (Camilli et al., 2010; Reynolds, Temple, White, Ou, & Robertson, 2011). The estimates contained herein are likely a lower bound on the full array of ECCE benefits. Quantifying additional potential benefits from ECCE in Egypt and in other countries would be extremely valuable, as well as comparing ECCE to alternative strategies for promoting school success.

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[26] Although there is some diminution in the sample between primary and preparatory test scores, the samples for preparatory and secondary test scores are quite similar in size, making it unlikely that the difference in test score effects is driven by the sample.

Appendix A. Additional tables

Table A1
OLS years of schooling with gender and wealth interactions.

Outcome: years of schooling	Gender interactions	Wealth interactions
ECCE	1.014***	1.211***
	(0.104)	(0.238)
Female	0.196*	0.266***
	(0.090)	(0.073)
ECCE and female interaction	0.167	
	(0.141)	
Wealth quintile		
Second	0.565***	0.515***
	(0.117)	(0.129)
Third	1.198***	1.290***
	(0.115)	(0.128)
Fourth	2.189***	2.158***
	(0.123)	(0.141)
Highest	3.582***	3.723***
	(0.148)	(0.188)
Wealth quintile interactions		
ECCE and second		0.209
		(0.302)
ECCE and third		−0.399
		(0.284)
ECCE and fourth		−0.011
		(0.276)
ECCE and fifth		−0.301
		(0.294)
Constant	7.675***	7.650***
	(0.243)	(0.245)
Adj. R-squared	0.272	0.272
N	7,522	7,522

Source: Author's calculations based on SYPE 2009 data.
Notes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.
Standard errors in parentheses.
Father's education, mother's education, birth cohort, governorate of birth and rural dummies are also included.
Reference case: male, born 1979 in Cairo, father illiterate, mother illiterate, lowest wealth quintile. Governorate of birth was only available for youth who answered the migration module, that is, youth 15–29. Current governorate of residence used as governorate of birth for youth 10–14.

Table A2
OLS test scores, grade repetition and secondary tracking.

	Primary score	Prep. score	Secondary score	University score	Primary repetition	Prep. repetition	Vocational secondary repetition	General secondary repetition	University repetition	General secondary (tracking)
ECCE	3.607***	3.191***	0.722	1.058	−0.026***	−0.038***	−0.005	0.003	−0.005	0.120***
	(0.437)	(0.466)	(0.374)	(0.751)	(0.005)	(0.008)	(0.011)	(0.012)	(0.017)	(0.014)
Adj. R-squared	0.211	0.244	0.285	0.066	0.034	0.062	0.035	0.033	0.049	0.244
N	4,555	4,462	4,399	855	13,860	10,585	4,304	2,891	2,457	7,196

Source: Author's calculations based on SYPE 2009 data.
Notes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.
Standard errors in parentheses.
Father's education, mother's education, gender, birth cohort, wealth quintile, governorate of birth and rural dummies are also included.
Reference case: male, born 1979 in Cairo, father illiterate, mother illiterate, lowest wealth quintile. Governorate of birth was only available for youth who answered the migration module, that is, youth 15–29. Current governorate of residence used as governorate of birth for youth 10–14.

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