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Effects of high versus low-quality preschool education: A longitudinal study in Mauritius

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ABSTRACT

We report on a randomized controlled experiment in Mauritius by the Joint Child Health Project. This longitudinal study followed a cohort of children from different socio-economic backgrounds to examine educational outcomes among children in high and low-quality preschools. The findings show that quality of preschool education had no significant effect on children's overall educational attainment. However, academic performance of children in the experimental group was higher for children with poorly educated fathers, but lower for children with poorly educated mothers. Hence, the effects of high-quality preschool education worked in opposing directions—equalizing by compensating for the effect of father's level of education, and disequalizing by reinforcing the effect of mother's level of education.

1. Introduction

Extensive academic research has explored the effects of preschool programs in enhancing the educational achievements of children from disadvantaged socioeconomic backgrounds (Almond & Currie, 2011; Attanasio, 2015; Barnett, 2011; Burger, 2010; Currie, 2001; Heckman, 2008,2013; Nores & Barnett, 2010). This research has created an understanding of early childhood as the root of equal opportunity—or, alternatively, inequality—in education. Studies have found high rates of return of high quality preschool education (Barnett & Masse, 2007; Belfield, Milagros, Barnett, & Schweinhart, 2006; Heckman, Hyeok Moon, Pinto, Savelyev, & Yavitz, 2010). For these reasons, academics, policy makers and practitioners have argued for redistribution of resources from schooling to early childhood education and care (Barnett, 2011; Gormley, 2011; Heckman, 2008; Heckman & Masterov, 2007).

Most evidence in support of this view is based on studies of disadvantaged children, comparing children who attended high-quality preschools and children who stayed at home. Generally, it is assumed that higher quality preschool education is associated with better long term outcomes (Burchinal, Vandergrift, Pianta, & Mashburn, 2010; Burger, 2010; La Paro & Pianta, 2000; Melhuish, 2011). Randomized controlled experiments generally have found positive effects of professional development of pre-school educators on children's cognitive outcomes (Jensen & Rasmussen, 2016; Markussen-Brown et al., 2017; Schachter, 2015). However, most studies comparing high and low-quality preschool have been natural experiments rather than randomized controlled experiments—for example, the British Effective Pre-School, Primary and Secondary Education project study (Sammons et al., 2007)—or based on secondary analyses of databases (Bowne, Magnuson, Schindler, Duncan, & Yoshikawa, 2017).

Focusing on children's test scores at age 11, we provide further evidence of the potential effects of participation in high-quality preschool education. Our data came from a randomized controlled experiment conducted by the Mauritius Joint Child Health Project (JCHP) with children from the 1969 birth cohort. Children aged three to four years were assigned randomly to high-quality preschools that were created for the experiment or to existing *petites*

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écoles (that is, low-quality preschools). Our study was different in two ways from other randomized controlled trials on effects of quality of preschool education. First, we compared a high-quality preschool intervention with participation in low-quality preschool. Second, children in our study were heterogeneous in terms of socio-economic background. This allowed us to assess whether high-quality preschool compensated or reinforced the effect of children's socio-economic background as measured by parental schooling levels. We found high-quality preschool compensated for the effect of the father's education but reinforced the effect of the mother's education. These findings are significant for education theory and practice for several reasons.

First, policy makers in many countries argue for universal high-quality preschool education, rather than making high-quality preschools available to disadvantaged children only. Recent quasi-experimental evidence has shown that high-quality universal preschool education has positive effects on children's cognitive skills. In a natural experiment in Australia, Chor, Andresen, and Kalil (2016) found positive effects of high-quality universal preschool education for children across socio-economic status as measured by maternal education. However, using data from the United States, Gormley and Gayer (2005) and Cascio and Schanzenbach (2013) found greater effects of high-quality universal preschool education for disadvantaged children.

Cascio and Schanzenbach (2013) and Cascio (2017) suggest that this result might be due to positive peer effects associated with universal preschool education programs. In our experiment, the children in both types of preschools came from heterogeneous socio-economic backgrounds. For this reason, differences in peer effects between the two types of preschool had no effect on cognitive skills of children in our study. Moreover, the alternative to high-quality preschool education in our experiment was universal low-quality preschool. In other studies on this topic, the alternative to high-quality preschool education has been whatever setting children end up in without universal high-quality preschool: low-quality preschool for some children and home-based care for the others.

Second, fathers worked in more than 95% of households in Mauritius in the early 1970s. Mothers worked in fewer than 20% of households, and mothers were the principal caregiver in more than 95% of households. Hence, fathers' education related closely to family resources (income), while mothers' education determined the quality of in-home care for children. These factors facilitated easier interpretation of the results of our study compared to recent experiments in developed countries where many parents share work and caregiving responsibilities. In line with Duncan and Sojourner (2013) and Havnes and Mogstad (2015), our results suggest that universal high-quality preschool education can compensate for differences in families' monetary resources.

In addition, our results suggest it is more difficult for high-quality preschool education to compensate for differences in the intellectual resources of families' primary caregiver. Our review of the existing literature suggests that no previous study has reached this finding. Our experiment shows that high-quality preschool education that increases parental involvement through home visits and establishes active parent-teacher associations can increase the effects of the caregiver's education on schooling outcomes. This shows that high-quality preschool education that increases parental involvement can replace the effect of the family income gap on children's achievement with another effect—that of the caregiver education gap.

This paper does not identify causal effects of characteristics such as father's and mother's education on children's test scores. Instead, we identify differences in reduced form effects between low and high quality preschool education. This is consistent with existing literature on the effects of socioeconomic, wealth or income gradients, or other circumstances that, normatively speaking, should not correlate with children's level of achievement.[1] High-quality preschool education can decrease the correlation between test scores and some of these characteristics and at the same time increase the correlation between test scores and other characteristics. We then say that high-quality preschool education compensates for the former characteristics and reinforces the latter. In our study, high-quality preschool education compensated for the effect of fathers' education on children's test scores and reinforced the effect of mothers' education.

The structure of this paper is as follows. The next section describes the experiment. Section 3 outlines the hypotheses tested, Section 4 describes the data, and Section 5 the research methodology. Results are outlined in Section 6 and discussed in Section 7. The final section concludes the paper.

2. The experiment

Mauritius is a small African island in the Indian Ocean. Mauritius gained independence from the United Kingdom in 1968. It is a multi-ethnic country that is characterized by its stable and democratic political system, rapid socio-economic development since independence, and generous public welfare provisions (Dommen, Dommen, Mehrotra, & Jolly, 1997). In the 1970s, Mauritius introduced free universal primary education for boys and girls (Parsuramen, 2006) and free universal primary healthcare (Dommen et al., 1997).

We studied the effects of high-quality early childhood education and care (ECEC) in a longitudinal perspective. Data were taken from the JCHP, an experimental longitudinal study. The 1795 children that participated in the JCHP were from the 1969 birth cohort. Children were invited to participate in the JCHP based on polio vaccination records from Quatre Bornes and Vacoas, two large cities. These cities had similar ethnic composition to the rest of Mauritius (Raine, Liu, Venables, Mednick, & Dalais, 2010). From the original JCHP cohort, 100 children were selected randomly and paired with another child from the cohort on the basis of sex, ethnicity, and electro-dermal activity at age three.

These criteria were introduced because the study was designed to investigate early predictors of later psychopathologies. Random number tables were used to assign one member of each pair of children to a new nursery school or high-quality preschool (the treatment group) and the other to an existing petites écoles (the control group). All parents of the children selected for nursery schooling agreed to participate and send their children to the nursery school, which was provided free of charge. Children in the control group attended the petites écoles (Raine et al., 2001). Only low-quality preschools were available in Mauritius when the JCHP study began.

In 1979, a cyclone destroyed more than 7,000 homes in Mauritius. For this reason, some of the children in the sample of JCHP participants could not be located for follow-up data collection at age 11 (Raine et al., 2001, 2010).[2] This reduced our sample to 175 children. For one child in our sample, data was missing about an important variable (the child's housing situation). As a result, our final sample included 84 children in the treatment group and 90 children in the control group.[3] Children in the treatment and

[1] See Reardon (2011); Rubio-Codina, Attanasio, Meghir, Varela, and Gratham-McGregor (2015); Schady et al. (2015). For recent surveys of the equality of opportunity literature, see Ferreira and Peragine (2016), Roemer and Trannoy (2015) and Ramos and Van de Gaer (2016).

[2] We found no differences in characteristics between children in the treatment and control samples on one hand and children that could not be traced on the other hand.

[3] While the number of observations is limited, it is larger than in the two most influential randomized control experiments in the field: the Perry Preschool Program, which had a treatment group of 58 and a control group of 65; and the

control groups came from diverse socio-economic and demographic backgrounds and were between three and four years old when the experiment began.

Children in the treatment group attended two experimental nursery schools for two full academic years until they entered primary school. The JCHP intervention included several components considered beneficial to children's educational development (Burchinal et al., 2010; Magnuson and Shager, 2010). The program ran daily from 9 am to 4 pm on weekdays. Educators received pre-service training in basic kindergarten knowledge, psychology, physical health, social welfare, and practical kindergarten activities. Other in-service training sessions for educators were organized throughout the intervention period (Raine et al., 2001). The pupil-educator ratio ranged from 1:5 to 1:10 depending on the type of activity.

The program included outdoor trips (for example, field trips with parents), and sessions on elementary hygiene, nutrition, health care, and physical exercise for the children. The curriculum encouraged the development of verbal (Creole, English and French), visuospatial, visuomotor, conceptual and memory skills. A structured nutritional program provided fruit juice in the morning, a hot meal at lunchtime and milk in the afternoon. The program encouraged parental involvement by setting up a parent-educator association. Parents were required to make regular visits to the nursery schools to observe children's daily activities. School personnel engaged in regular home visits and offered counseling services to parents.

The control group attended traditional Mauritian *petites écoles*. *Petites écoles* were community preschools that provided children with basic learning in reading, writing and counting. They were "of poor educational quality, providing traditional and very rudimentary education" (Raine et al., 2001, page 258). These kindergartens were privately owned, staffed by child-minders with little training, had median pupil to educator ratios of 1:30, and operated for five hours on school days. This included one hour of play (Raine et al., 2001, 2010). Lunch and snacks were not provided, resulting in most children going home for lunch or bringing packed lunches, typically rice or bread. In 1983, a report by the Ministry of Education of Mauritius described poor conditions in community preschools. Most community preschools in Mauritius were designed as childcare facilities rather than for educational purposes (Ministry of Education of Mauritius, 1983). Upon completion of preschool, children in the treatment and control groups were enrolled in public primary schools of similar quality.

Our analysis compares test score results from the Mauritius Certificate of Primary Education (CPE) exam among children who attended nursery schools and children who attended the *petites écoles*. Children in Mauritius sit the CPE exam at 11 years of age on completion of primary school. The exam screens children for access to secondary education (Manrakham, Vasishtha, & Vadamootoo, 1991). Children with the highest exam scores are eligible to attend one of the few public secondary schools in Mauritius, or to sit an exam that determines the allocation of government scholarships for tuition at private schools. Historically, poor scores in the CPE exam have correlated with poor employment prospects and greater risk of poverty and social exclusion (Manrakham et al., 1991).

Previous studies on the JCHP dataset are summarized in Raine et al. (2010). To date, research using data from the JCHP has focused on identifying early predictors of later psychopathologies. No research using this data has studied educational outcomes or compensating versus reinforcing effects of high-quality ECEC. Most previous studies have adjusted for socio-economic status, gender and ethnicity in the estimation of treatment effects. They have performed analyses of variance, and published results in psychology journals (see, for example, Raine et al., 2001). Research based on the larger, non-experimental JCHP dataset looked at educational or intelligence quotient (IQ) outcomes at age 11. Analysis of this larger dataset found children that were malnourished at age three had lower cognitive ability at age 11 (Liu, Raine, Venables, Dalais, & Mednick, 2003) and children that sought high stimulation at age three had higher IQs at age 11 (Raine, Reynolds, Venables, & Mednick, 2002).

3. Hypotheses

There is an extensive literature on the interaction between children's cognitive development and academic achievement and their family's socio-economic status (SES)—for example, see Sirin (2005). Based on their review of the existing literature, Duncan and Magnuson (2012) argue that family income and mothers' level of education are the main socio-economic determinants for children's cognitive functioning.[4] Income determines families' resources. Mothers' level of education is a predictor of early language development. In addition, it influences children's school performance (Carneiro, Meghir, & Parey, 2013; Coddington, Mistry, & Bailey, 2014; Hoff & Tian, 2005; Kontos, 1991) and likelihood of behavioral problems and grade repetition (Carneiro et al., 2013).

However, other factors than families' SES influence children's educational achievement. Currie and Yelowitz (2000) and Goux and Maurin (2005) show that crowded home environments reduce children's educational attainment. Other authors stress the influence of ethnic background on cognitive development and academic achievement (De Feyter & Winsler, 2009; Tas, Reimão, & Orlando, 2014). In general, Creole families are the most disadvantaged in Mauritius. Recent studies have found significant negative effects of birth order on academic achievement (Black, Devereux, & Salvanes, 2005; Kantarevic & Mechoulan, 2006; Pavan, 2016).UNESCO (2015) reports that gender disparities in primary education remain in almost one third of countries for which data are available. However, Mauritius had closed the gender gap in gross secondary school enrollment when the cohort of students in this study matriculated—by 1980, gross school enrollment in Mauritius was 50.95% for males and 49.11% for females.[5]

Based on these findings, we selected family income and mother's education as measures for the SES of families of children. In all estimates, we controlled for the effects of crowded home environments, ethnic background and birth order. We included these measures for families' SES and controls to estimate CPE scores of children enrolled in the nursery school (that is, in the treatment group) and children enrolled in the *petites écoles* (the control group). We tested three hypotheses:

(1) The *inequality* hypothesis: academic performance of students in the control group correlates with lower SES—that is, lower family income and less educated mothers are associated with poor academic performance;
(2) The *benefit* hypothesis: children in the treatment group demonstrate better academic performance than children in the control group;
(3) The *equalizing* hypothesis: in the treatment group, the correlation

(*footnote continued*)
Abcedarian Program, which had a treatment group of 57 and a control group of 54 (Currie, 2001). Our sample sizes should allow us to detect a difference in standardized means of 0.3 at a five percent level of significance.

[4] In addition, the employment status of parents might influence children's educational achievements as a proxy for the availability and stability of family income (Davis-Kean, 2005; Pancsofar & Vernon-Feagans, 2010; Paxson & Schady, 2007). However, after controlling for family income, parents' employment status has no clear effect (Duncan & Magnuson, 2012).

[5] Data from http://www.indexmundi.com/facts/mauritius/school-enrollment (UNESCO).

between school performance and SES is less than in the control group.

4. Data

At the time of the JCHP study, the Mauritian education system included six years of primary education leading to a Certificate of Primary Education (CPE), followed by five years of secondary education leading to the Cambridge School Certificate. Children's total CPE scores on completion of primary school were drawn from the registry of the Mauritius Examination Syndicate (Raine et al., 2010). They were calculated using the Ministry of Education's weights for four subjects: score for English*3 + score for French*2 + score for Math*3 + score for Environmental Studies*2 (MES, 1991). Scores ranged from zero to 50. Children's total CPE scores were the dependent variable in our analysis.

In 1972, when children in this study were three years old, data were collected on factors believed to be associated with children's developmental outcomes. Of these factors, we considered the SES of children's families and the control factors identified in the previous section. The JCHP collected data on “Father's years of schooling,” “Mother's years of schooling,” and control variables.

The study reported the number of people per room in the family home as a proxy for the degree to which children lived in crowded home environments. This variable is labeled “Crowdedness.” In the estimated equation, we used “Ln Crowdedness,” the natural logarithm of this variable.[6] Hindus, Muslims, and Tamils in Mauritius are descendants of indentured laborers brought to Mauritius under British colonial rule in the 19th century. Most Creole in Mauritius are descendants of slaves brought to the island in the 18th and 19th centuries under French colonial rule (Addison & Hazareesingh, 1984; Dommen et al., 1997). Previous research in Mauritius found that children from Creole backgrounds typically performed worse than other children in the CPE (Chinapah, 1983; Palmyre, 2007). For this reason, we coded the ethnicity variable as a dummy variable—“Creole.” We included the dummy variable “Eldest sibling” to examine the effect of birth order. We coded the child's gender variable by a dummy variable, “Male”.

The JCHP collected data when the children in the study were three years old on other variables to describe the situation of the children and their families. The parent's work status variable was recorded in two dummy variables, “Father works” and “Mother works.” We created a dummy variable for each parent in case their employment status was unknown. A dummy variable, “Mother is caregiver,” is equal to one if the mother was the child's primary caregiver at home and zero otherwise. The dummy variable “Mother (Father) had training” indicates whether the mother (father) had training outside regular schooling, such as on-the-job training. All data mentioned so far were collected through interviews with parents (Raine et al., 2010).

Data on malnutrition (“Height for Age”), cognitive skills (“BTBC child”) and anemia (“Hemoglobin in blood”) at age three were collected through laboratory tests. Further variables were dummy variables to indicate mother's health (“Mother's health below average”), whether the child had suffered from serious illness before age three (“Serious illness of child”), the child's intellectual (physical) development (“Child's intellectual (physical) development below average”), normality of the mother's delivery (“Normal delivery”), and that the mother had no illness episodes while pregnant (“Normal pregnancy”).[7]

[6] This improved the fit of the regression slightly but had no effect on our conclusions. Compare, for instance, Specifications 1 and 2 in Table A1 in the Appendix.

[7] More detailed information about the variables is given in Online Appendix

Table 1
Descriptive statistics of children in the sample (174 observations).

	Treatment	Control	Z-Dif
(a) CPE scores at age 11			
Mean	27.30	26.04	0.47
Standard deviation	17.49	17.81	0.96
(b) Parental years of schooling and control factors			
Mother's years of schooling	5.21	4.67	1.01
Father's years of schooling	5.48	5.51	−0.06
Crowdedness	3.96	3.92	0.15
Creole	0.25	0.32	−1.05
Eldest sibling	0.24	0.27	−0.43
Male	0.50	0.51	−0.15
(c) Variables at age three			
Mother works	0.15	0.19	−0.62
Mother works missing	0.07	0.07	0.12
Father works	0.98	0.95	0.77
Father works missing	0.02	0.04	−0.75
Mother is caregiver	0.94	0.97	−0.82
Mother had additional training	0.78	0.73	0.78
Mother additional training missing	0.08	0.07	0.42
Father had additional training	0.90	0.91	−0.13
Father additional training missing	0.06	0.02	1.25
Height for age	−0.03	−0.09	0.41
Height for age missing	0.07	0.07	0.12
Hemoglobin in blood	0.02	−0.04	0.23
Hemoglobin in blood missing	0.07	0.14	−1.54
BTBC child	103.30	101.67	0.65
BTBC child missing	0.26	0.19	1.15
Mother's health below average	0.06	0.03	0.82
Serious illness of child	0.74	0.81	−1.15
Child's int. dev. below average	0.05	0.06	−0.24
Child's phys. dev. below average	0.05	0.06	−0.24
Normal delivery	0.98	0.91	1.84*
Normal pregnancy	0.87	0.86	0.26

Notes: CPE scores are between 0 and 50, “Mother's (Father's) years of schooling” is the completed years of schooling of the mother (father), “Crowdedness” gives the number of people per room in the house. “Height for age” and “Hemoglobin in the blood” are standardized to have mean zero and standard deviation one for children of age three in Mauritius. BTBC is standardized to have mean 100 and standard deviation 15 for children aged three in Mauritius. All other variables indicate proportions and are defined in Section 4 of the paper. The Column “Z-Dif” reports the standardized difference between the values in the Treatment and Control column, except in Part (a), Standard deviation, which reports the F-value for the standard test for equal variances (not significant here). *** denotes significance at one percent level, ** at five percent level, * at 10% level.

Table 1 gives the descriptive statistics of the children in the treatment and control sample. Panel (a) shows that the mean CPE score in the treatment sample was slightly higher than in the control sample but, as the first entry in the last column shows, the difference was statistically insignificant. Both samples had similar standard deviation of CPE scores. Panel (b) shows the statistics on parental years of schooling and the control factors. Fathers had completed more years of schooling than mothers. On average, children lived in home environments with around four people per room. One quarter of the children were the firstborn in their family. About half the children were male. Differences in composition of the treatment and control sample in this panel were insignificant.

Differences in composition between the treatment and control groups in terms of variables at age three that the estimations did not control for could interfere with identification of the treatment effects. Panel (c) reports whether the treatment and control group were different in terms of these characteristics. We found one statistically

Table 2
Treatment and CPE.

	(1)	(2)	(3)	(4)	(5)
Treatment (T)	1.253	0.228	0.187	0.252	2.619
	(2.676)	(2.376)	(2.333)	(2.375)	(2.905)
Mother y of schooling		1.640***	0.914*		
		(0.375)	(0.466)		
Father y of schooling		0.881**	1.672***		
		(0.347)	(0.372)		
Mother has > 6 ysc				13.280***	6.531
				(3.262)	(4.464)
Father has > 6 ysc				7.402**	17.802***
				(3.185)	(3.618)
Mother ysc * T			1.519**		
			(0.661)		
Father ysc * T			−1.610***		
			(0.576)		
Mother > 6 ysc * T					11.128*
					(5.746)
Father > 6 ysc * T					−18.930***
					(5.416)
Constant	26.044***	27.504***	27.058***	22.706***	21.444***
	(1.877)	(2.179)	(2.158)	(2.270)	(2.365)
R-squared	0.001	0.280	0.311	0.254	0.298
Number of observations	174	174	174	174	174

Notes: in estimations (2)–(5) we controlled for Crowdedness, Creole, Eldest Sibling and Male. The coefficient estimates for these controls are reported in Online Appendix D, Table 2. Specifications 4 and 5 used discrete versions of parental education. We constructed two dummies for education: “Mother (Father) has not more than six years of schooling” (reference category) and “Mother (Father) has more than six years of schooling.” These variables were not mean-deviated. Robust standard errors reported in parenthesis. *** denotes significance at one percent level, ** at five percent level, * at 10% level.

significant difference between the groups, for the variable “Normal delivery” at 10%.

We performed 21 balanced tests—as such, finding one significant difference at 10% was not unexpected. On this basis, we concluded that the samples were balanced. Panel (c) also shows that almost all fathers of children in the study worked outside the home. In contrast, fewer than 20% of mothers worked outside the home. Hence, the variable “Father's years of schooling” was a good proxy for family income, one of our measures of families' SES.[8] Mothers were almost always the primary caregiver of the children. Therefore, the variable “Mother's years of schooling” was a good proxy for the quality of the primary caregiver, and was our second measure of families' SES.

5. Method

We modeled the CPE score of each child *i*, CPE_i, as a linear function of dummy variable T_i that indicated whether the child attended nursery school ($T_i = 1$) or *petite écolé* ($T_i = 0$), the mean-deviated father's years of schooling, E_i^f, the mean-deviated mother's years of schooling, E_i^m, and K control factors at age three, X_i^k ($k = 1,\ldots, K$). In our specification, we included interaction terms between parental years of schooling and the treatment dummy, and a general idiosyncratic error term ε_i. This resulted in the following specification:

$$CPE_i = \beta_0 + \gamma_0 T_i + \beta_1 E_i^f + \beta_2 E_i^m + \gamma_1 E_i^f T_i + \gamma_2 E_i^m T_i + \sum_{k=1}^{K} \delta_k X_i^k + \varepsilon_i. \quad (1)$$

For children that were not treated, each additional year of father's schooling was associated with an increase in CPE score of β_1. Each additional year of mother's schooling was associated with an increase in CPE score of β_2. Hence, if, for $j = 1$ or 2, the null hypothesis $\beta_j = 0$ is rejected in favor of the alternative $\beta_j \neq 0$, the evidence supports the inequality hypothesis.

The intercept for children who were not treated was β_0, and for treated children $\beta_0 + \gamma_0$. As E_i^f and E_i^m are mean-deviated, γ_0 measured the average increase in CPE score for treated children regardless of the value of the control factors. When the null hypothesis $\gamma_0 = 0$ is rejected in favor of the alternative $\gamma_0 > 0$, the estimates support the benefit hypothesis.

The association between father's years of schooling and CPE score for children that were treated was $\beta_1 + \gamma_1$, and $\beta_2 + \gamma_2$ for mother's years of schooling and CPE score. Hence, when, for $j = 1$ or 2, β_j and γ_j were significantly different from zero and had opposite signs (and the absolute value of their sum was smaller than β_j), estimates suggested that the treatment decreased the association between the corresponding parent's years of schooling and the CPE score. However, when β_j and γ_j had the same sign, and $\beta_j + \gamma_j$ was significantly different from zero, the treatment reinforced the association between the corresponding parent's years of schooling and CPE score. In that case, the equalizing hypothesis must be rejected. Eq. (1) was estimated with least squares.

6. Results

Table 2 contains the main results from least squares estimation of different versions of Eq. (1). Specification 1 confirmed Table 1 (a)—that is, the difference in mean CPE score between treatment and control groups was statistically insignificant, at 1.25 points. Specification 2 included parental years of schooling. In Specification 3, these factors were interacted with the treatment dummy. Specifications 4 and 5 were similar to 2 and 3, respectively, but with years of schooling replaced by

(*footnote continued*)
A.

[8] The JCHP did not collect data on family income. Using data from the 2000 Census in Mauritius, Chintamanee (2007) estimates the return per year of schooling in Mauritius at seven percent. Unfortunately, no estimates are available for the 1970s.

a dummy variable that equaled one if the parent had strictly more than six years of schooling and zero otherwise. We begin our analysis of the implications of the results for each of the three hypotheses by looking at Specification 3, our basic specification. In the last subsection, we examine the robustness of our findings when alternative specifications are used.

6.1. Inequality hypothesis

In the absence of treatment, there was a positive association between CPE scores and mother's and father's years of schooling. The increase in CPE score was 0.91 points for each year of mother's schooling and 1.67 points for each year of father's schooling. Since the standard deviation of CPE scores was about 17.65—see also Table 1 (a)—these associations are substantial. In the absence of treatment, CPE scores correlated significantly with father's years of schooling at one percent and with mother's years of schooling at 10%. These estimates provided clear support for the inequality hypothesis.

6.2. Benefit hypothesis

The first entry in Specification 3 shows that the effect of being treated, γ_0, on CPE score was 0.187 points—not significantly different from zero. When controlling for parental education levels and the other controls, we found no evidence for the benefit hypothesis.

6.3. Equalizing hypothesis

The coefficient estimates in Specification 3 show that, without treatment, each additional year of father's schooling was associated with an increase in test scores of 1.67 points. However, with treatment, the association was reduced by 1.61 points to an insignificant 0.06 points. Hence, treatment fully compensated for the association of father's schooling and CPE scores. However, treatment widened the gap between children of mothers with different years of schooling. Each additional year of mother's schooling was associated with an increase in CPE scores of 0.91 points in the absence of treatment. Treatment enhanced the association by 1.52 points to 2.43 points, which is significant at 1%.[9] Hence, treatment reinforced the association between mother's schooling and CPE scores, and the equalizing hypothesis must be rejected. Before interpreting the results, we will verify their robustness to alternative specifications.

6.4. Alternative specifications

Table 2 outlines the first set of alternatives to Specification 3. In Specification 5, we replaced parents' years of schooling with dummy variables to indicate that parents had received strictly more than six years of schooling. The dummy variable for mother's years of schooling was statistically insignificant in Specification 5. However, all other conclusions drawn from basic Specification 3 held true for Specification 5.[10] The interaction terms were dropped in Specifications 2 and 4. For this reason, these specifications do not allow to investigate the equalizing hypothesis. However, they support the inequality hypothesis and reject the benefit hypothesis.

Table 3
Correlation between parental schooling levels: alternative specifications.

	(1)	(2)	(3)
Treatment (T)	0.363	0.001	1.313
	(2.363)	(2.408)	(2.440)
Mother years of schooling	0.237	1.711***	
	(0.922)	(0.433)	
Father years of schooling	1.175**		1.940***
	(0.457)		(0.347)
Mother ysc * Father ysc	0.101		
	(0.085)		
Mother ysc * T	1.730	0.703	
	(1.162)	(0.577)	
Father ysc * T	−1.560*		−1.077*
	(0.837)		(0.631)
Mother ysc * Father ysc * T	−0.022		
	(0.119)		
Constant	26.881***	27.003***	25.866***
	(2.198)	(2.268)	(2.257)
R-squared	0.317	0.254	0.215
Number of Observations	174	174	174

Notes: in all estimations we controlled for Crowdedness, Creole, Eldest Sibling and Male. The coefficient estimates for these controls are reported in Online Appendix D, Table 3. Robust standard errors reported in parenthesis. *** denotes significance at one percent level, ** at five percent level, * at 10% level.

The correlation between mother and father's years of schooling made it difficult to identify their differential interaction effects with treatment. In Table 3, we provide two alternative ways to deal with this correlation. Specification 1 includes interaction terms between mother and father's years of schooling. Naturally, this reduced the size of the association between CPE scores and both parents' years of schooling as the significance of these factors' interaction with treatment decreases. However, the interaction coefficients had the same sign as in Specification 3 (see Table 2), and the interaction with father's years of schooling was significant at 10%.

Due to this correlation, the estimated heterogeneity of the treatment effect of one parent's schooling was conditional on heterogeneity in the other parent's schooling. Specification 2 (3) eliminated father's (mother's) years of schooling from the regression. This increased the association with mother's (father's) years of schooling compared to Table 2, Specification 3. In addition, the interaction terms became smaller and lost significance. However, they kept the same sign—that is, they remained positive for mother's years of schooling and negative for father' years of schooling. The latter was significant at 10%.

Online Appendix C shows the results were robust to inclusion of the variables used for the balance test, listed in Panel (c) in Table 1. Without treatment, there was a positive association, significant at 5% between the coefficients of both parents' years of schooling and CPE scores. The interaction terms with the treatment dummy had the same sign as in Table 2, Specification 3. The interaction with father's years of schooling was significant, at 10%.

The Appendix contains further sensitivity analyses. In Specification 1 in Table A1, we added interactions between the controls with the treatment dummy to basic Specification 3 of Table 2. These interactions were insignificant (See Online Appendix D, Table A1) and influenced the coefficient estimates for the other variables only marginally. Specification 2 replaced the "Ln Crowdedness" variable with "Crowdedness." The other coefficient estimates were not affected and this

[9] The interaction coefficients for mother's and father's years of schooling were opposite in sign and similar in size. Treatment was not associated significantly with CPE scores where parents had the same years of schooling. However, the correlation coefficient was only 0.45 (see Online Appendix B for further discussion).

[10] To compute the average treatment effect, we had to account for the proportions for which the dummy variables were equal to one. This gave an average treatment effect equal to 2.62 + 11.13 (36/174) − 18.93 (43/174) = 0.24, which was not significantly different from zero. Online Appendix E shows that the subsamples based on these parental schooling dummies were balanced.

variable was not statistically significant. In Specifications 3–5 in Table A1, we replaced the continuous variables "Crowdedness" and "Mother/Father years of schooling" with discrete versions, and found the same conclusions as before.

Table A2 shows that results for the language (Specification 1) and science (Specification 2) components of the CPE were similar and in line with basic Specification 3 in Table 2. In addition, we reported the regression for boys (Specification 3) and girls (Specification 4) separately in Table A2. Sample sizes became small in this part of our analysis. Among girls in our data, fewer coefficients were statistically significant and the interaction terms became smaller. However, the interaction terms retained the same sign as for the entire sample. The results of the basic specification were confirmed for boys.

It is possible that mother's schooling correlated positively with child intelligence or nutritional status at the start of treatment, and that more intelligent or better nourished children benefitted more from the treatment. This could be one explanation for the positive interaction effect between treatment and mother's years of schooling. In Table A3, Specification 1, we added results for the cognitive skills-based Boehm Test of Basic Concepts (BTBC) at age three, and height for age at age three (z-standardized height for age) to the basic specification. Children's BTBC scores had a statistically significant association with their test scores at age 11. Height for age at age three had no association. The coefficients of these two variables interacted with treatment were insignificant. In Specifications 1–3, the interaction effect of treatment with mother's years of schooling remained significantly positive. The interaction effect with father's years of schooling remained significantly negative.[11]

Table A4 gives the descriptive statistics for four other outcomes. We used the same correlates as in the basic specification to obtain the results reported in Table A5. JHCP researchers collected two alternative tests of cognitive skills at age 11—a full-scale IQ test and a test of word recognition. Specifications 1 and 2 in Table A5 show no association between mother's years of schooling and these test scores in the absence of treatment. However, all other results aligned with the results of Specification 3 in Table 2. In addition, we report the results for the children's number of absences during academic year 1975–76 (Specification 3) and access to books at age 11 (Specification 4). None of the variables from the basic specification were significant for the number of absences during academic year 1975–76. Father's years of schooling was significant for children's access to books at age 11. The interaction effects, though not significant, had the same sign as for the cognitive tests. Consistent with the effects of treatment on test scores, this suggests that the treatment made households where the mother (father) had more years of schooling buy more (less) books.

Overall, the alternative specifications in the Appendix and Online Appendix C confirmed the inequality hypothesis and rejected the benefit and equalizing hypotheses. The alternative specifications supported that the treatment reinforced the association between mother's years of schooling and CPE scores, and reduced the association between father's years of schooling and CPE scores.

7. Discussion

It is always complicated to generalize findings related to an experiment in a specific context and time. Nevertheless, the data from the JHCP study contributes to current discussions on the equalizing potential of high-quality universal ECEC. Inequalities in educational opportunities measured through differences in CPE scores at age 11 were associated significantly with mother and father's years of schooling in the control group. According to basic Specification 3 in Table 2, children of mothers with six years of primary schooling had an increase in CPE score of 0.31 standard deviations. Children of fathers with six years of schooling had an increase in CPE scores of 0.57 standard deviations. These findings align with the consensus in the relevant literature that early childhood is the foundation for children's future learning, and that disadvantage in children's preschool years leads to inequalities in educational attainment later in life (Macours, Schady, & Vakis, 2012; Paxson & Schady, 2007).

The existing literature presents high-quality interventions for preschool-aged disadvantaged children as potential equalizers. This emphasis on early childhood care and education is based on evidence from longitudinal studies in the United States (Barnett, 2011; Cunha & Heckman, 2006; Heckman & Masterov, 2007). In particular, two experimental studies that started in the 1960s and 1970s are cited on this topic: the Perry Preschool Program (PPP) and the Abecedarian Program (ABC) (Magnuson & Shager, 2010). In these studies, preschool interventions were designed to provide high-quality services to disadvantaged children.[12]

These studies' findings underline that high-quality preschool education enriched the educational experience of children from disadvantaged backgrounds (Cunha & Heckman, 2006). In particular, both programs had improved children's IQ test scores on completion of the program at age five. However, improvements in children's IQ diminished over time, and disappeared for boys by age 10 (Burger, 2010 and Walters, 2015). There is some evidence for positive long-term effects of high-quality preschool education for boys, and consistent positive effects have been found on female teenagers and adults (Anderson, 2008). The programs' persistent effect on non-cognitive personality skills might reconcile the diminished benefit of high-quality preschool education on children's cognitive skills and persistent positive adult education outcomes (Heckman, Pinto, & Savelyev, 2013). As we study the effect on test scores at age 11, fading-out of benefits for children's cognitive skills might explain the lack of evidence to support the benefit hypothesis.

In contrast to other randomized controlled trials on the effects of quality of preschool education, the JHCP study compared effects of high-quality preschool intervention with effects of low-quality preschool education. Recent data from the Head Start Impact Study demonstrates the importance of counterfactuals—for example, control groups—in evaluating the effects of preschool education. Feller, Grindal, Miratrix, and Page (2016), Kline and Walters (2016) and Walters (2015) show positive effects of Head Start for children who otherwise would have been in home-based care. However, effects were close to zero for children who otherwise would have been in center-based care. The second counterfactual (center-based care) is similar to the counterfactual in the JHCP study. This is another possible explanation for the lack of evidence in the JHCP data for benefits of high-quality preschool education.

The Perry Preschool and Abecedarian programs examined benefits of high-quality ECEC for relatively homogeneous groups of

[11] Specifications 2–3 in Table A3 included only one of the two new variables, the BTBC test or height for age. None of the conclusions were affected. Excluding the years of schooling of one parent gave Specifications 4 and 5 in Table A3, with results similar to those in Specifications 2 and 3 in Table 3.

[12] The PPP targeted African American children with low IQ and low parental income and education. The ABC program targeted children with lower educated mothers and mothers with low IQ, most of whom were African American. Both programs delivered high-quality preschool education through low pupil to educator ratios—ranging from 3:1 to 6:1—and extensive training for educators (Magnuson & Shager, 2010). Both programs' pedagogy focused on children's intellectual and social development through stimulating cognition, language, and adaptive behavioral skills (Magnuson & Shager, 2010). In addition, both programs provided free transportation, feeding, health care and family nurse and pediatrician services (Cunha & Heckman, 2006). In addition, the programs included parental education through home visits and counseling.

disadvantaged children. Neither program examined the equalizing effects of high-quality universal ECEC. Examining equalizing effects of high-quality universal ECEC would require comparison of children with parents of different socio-economic statuses (Ferreira & Gignoux, 2011; Van de gaer, Vandenbossche, & Figueroa, 2014). Our study is one of the few randomized controlled studies on children with parents from different socio-economic backgrounds.

We found that participation in the JCHP nursery schools from ages three to five erased the association between children's CPE test scores and father's schooling. However, the intervention increased the association between test scores and mother's schooling. The effects worked in opposing directions—equalizing by compensating for the effect of father's schooling, and disequalizing by reinforcing the effect of mother's schooling.

It is not possible to connect the effect of each component of the JCHP preschool intervention to children's educational outcomes later in life. However, the distinct effects of father's and mother's schooling on children's educational attainment might relate to the different roles of fathers and mothers in Mauritius. Much of the literature on early childhood considers the effects of spouses' socioeconomic status as complementary (or better, mutually reinforcing). In Mauritius in the 1970s, most fathers were employed, and most mothers did not work outside the home. For this reason, father's education among children in the JCHP was related closely to household income. Therefore, our results might indicate that, in Mauritius in the 1970s, high-quality preschool compensated in part for the effect of income inequality on school results. Duncan and Sojourner (2013) and Havnes and Mogstad (2015) also found that high quality preschool compensated for the effect of differences in families' monetary resources on children's educational attainment.

However, the JCHP nursery schools increased the association between test scores and mother's schooling. Increased parental involvement is one possible explanation for this. Gelber and Isen (2013) show that parental involvement with children increased during and after children were enrolled in Head Start. The authors note that other factors than children's enrolment in high-quality preschools might account for this increase in parental involvement. Other possibilities are that parents perceive their involvement as complementary to changes in unobserved characteristics in their child, such as non-cognitive skills, or that children in high-quality preschool become more pleasant to be with.

In Mauritius in the 1970s, mothers were primary caregivers in most households, and so parental involvement in children's schooling meant mothers' involvement. Involvement of higher educated mothers is likely to have larger effects on children's educational attainment than involvement from lower educated mothers. In particular, the JCHP encouraged parental involvement through two channels—parent-educator associations and home visits.[13] As primary caregivers, mothers were the parent most likely to participate in parent-educator associations. It is possible that these associations were more appealing for—or responsive to the desires of —better educated mothers. With mothers the primary caregivers in Mauritius, home visits might have enhanced interactions between mothers and children in particular. These interactions might have larger effects in children of better educated mothers. This implies that children's school results are shaped by the educational climate at home. High-quality ECEC might not be able to compensate fully for this factor (Azzi-Lessing, 2011). On the contrary, home visiting programs that stress parental involvement might benefit children with better educated caregivers over children with poorly educated caregivers.

8. Conclusion

The JCHP longitudinal study allows comparison of effects of high-quality ECEC with low-quality preschool for equally diverse populations. For this reason, results of the study offer insights for education policymaking in developing and developed countries with universal pre-school education systems without mechanisms to target disadvantaged children.

Our analysis of the JCHP data found a positive association between fathers and mothers years of schooling and test scores at age 11 for children at low-quality preschools. The JCHP intervention had no effect overall on children's test scores at age 11. High-quality ECEC reduced the positive association between father's schooling and children's test scores. However, it increased the positive association with mother's schooling. Fathers were the breadwinner in Mauritian families in the 1970s. In contrast, fewer than 20% of mothers worked, and mothers were the caregiver in almost all families. For this reason, father's education indicates families' material resources. Duncan and Sojourner (2013) showed that ECEC could compensate for the effect of income on IQ scores. This could be because ECEC compensated or substituted for lower levels of parental investments in children's education among low-income families.

We found that the JCHP intervention increased the effect of mother's schooling on children's educational attainment. The JCHP intervention encouraged parental involvement and, in Mauritius in the 1970s, mothers were the primary caregiver in almost all families. Even if the JCHP intervention led to equal increases in poorly educated and highly educated mothers' motivation to support their child's education, less educated mothers might have lacked the capacity to provide this support. This consideration might need to be taken into account in the design of future ECEC programs. In particular, children with poorly educated mothers as their primary caregiver might require special attention to benefit from ECEC.

The results of our data analysis were robust for other measures of cognitive skills at age 11. However, JCHP data reflect the study design, context and timing. Even so, the data confirm the complex nature of the relationship between socio-economic inequalities in adolescence and adulthood and early childhood education and care. Further research is needed to examine the effect of each feature of ECEC on parental involvement and children's later academic performance. There is robust evidence that children benefit from high quality center-based childcare and education, although these benefits do not necessarily improve children's cognitive skills at age 11. However, parental support programs based on home visits and parent-teacher interaction can reinforce the association between children's educational outcomes and their primary caregiver's schooling. The challenge remains to organize home visits and parent-teacher interactions to compensate for this reinforced association among disadvantaged children and their families.

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[13] Several researchers have found that home visits are crucial for preschool interventions to be successful (Özler et al., 2016, Walters, 2015).

Appendix. Sensitivity analysis of the association between the treatment and CPE score

Table A1
Alternative specifications and interaction effects with control factors.

	(1)	(2)	(3)	(4)	(5)
Treatment (T)	−0.575	0.008	−1.749	0.371	2.619
	(3.709)	(3.711)	(4.734)	(4.136)	(2.924)
Mother ysc	0.821*	0.860*			
	(0.461)	(0.485)			
Father ysc	1.619***	1.664***			
	(0.390)	(0.401)			
Mother has > 6 ysc			6.477	6.305	6.839
			(4.636)	(4.342)	(4.383)
Father has > 6 ysc			18.451***	18.434***	18.558***
			(3.820)	(3.635)	(3.639)
Mother ysc * T	1.734**	1.730**			
	(0.683)	(0.695)			
Father ysc * T	−1.636***	−1.671***			
	(0.605)	(0.609)			
Mother > 6 ysc * T			11.919*	11.395*	10.736*
			(6.364)	(6.056)	(5.943)
Father > 6 ysc * T			−19.495***	−18.178***	−18.436***
			(5.757)	(5.512)	(5.459)
Constant	27.267***	26.902***	25.729***	24.653***	23.494***
	(2.539)	(2.558)	(3.402)	(2.763)	(2.433)
R-squared	0.320	0.311	0.290	0.278	0.275
Number of Obs	174	174	174	174	174

Notes: in all estimations we controlled for Crowdedness, Creole, Eldest Sibling and Male, and, except for Specification 5, interacted these controls with the treatment dummy. The coefficient estimates for these additional variables are reported in Online Appendix D, Table A1. Specification 1 measured Crowdedness by “Ln Crowdedness” (the logarithm of the number of people per room in the household), Specification 2 by “Crowdedness” (the number of people per room in the household), and Specification 3 by “Crowdedness dummy” (a dummy variable equal to one if there are four or more people per room in the household). Specifications 4 and 5 used discrete versions of parental education. We constructed two dummies for education: “Mother (Father) has not more than six years of schooling” (reference category) and “Mother (Father) has more than six years of schooling.” These variables were not mean-deviated. Robust standard errors reported in parenthesis. *** denotes significance at one percent level, ** at five percent level, * at 10% level

Table A2
CPE language and science, boys and girls.

	Language (1)	Science (2)	Boys (3)	Girls (4)
Treatment (T)	0.002	0.185	2.283	0.535
	(1.210)	(1.171)	(3.264)	(3.390)
Mother ysc	0.486**	0.428*	0.921	0.869
	(0.236)	(0.241)	(0.609)	(0.724)
Father ysc	0.824***	0.848***	1.920***	1.497**
	(0.191)	(0.189)	(0.446)	(0.694)
Mother ysc * T	0.793**	0.725**	1.851**	1.016
	(0.348)	(0.329)	(0.849)	(0.974)
Father ysc * T	−0.872***	−0.738**	−2.635***	−0.531
	(0.298)	(0.291)	(0.649)	(1.004)
Constant	13.908***	13.150***	26.303***	26.182***
	(1.095)	(1.107)	(2.982)	(2.607)
R-squared	0.296	0.313	0.390	0.315
Number of Observations	174	174	88	86

Notes: in all estimations we controlled for Crowdedness, Creole, Eldest Sibling and Male. The coefficient estimates for these controls are reported in Online Appendix D, Table A2. Robust standard errors reported in parenthesis. *** denotes significance at one percent level, ** at five percent level, * at 10% level.

Table A3
Intelligence and health at age three as additional controls.

	(1)	(2)	(3)	(4)	(5)
Treatment (T)	0.745	0.637	0.329	0.579	1.916
	(2.298)	(2.296)	(2.329)	(2.375)	(2.391)
Mother ysc	0.977**	0.976**	0.913*	1.733***	
	(0.442)	(0.445)	(0.465)	(0.395)	
Father ysc	1.597***	1.633***	1.641***		1.901***
	(0.379)	(0.375)	(0.379)		(0.361)
BTBC	0.117***	0.117***		0.121***	0.108***
	(0.042)	(0.043)		(0.044)	(0.041)
Height for age	−1.459		−1.214	−2.016	−1.341
	(1.889)		(1.857)	(1.998)	(1.868)
Mother ysc * T	1.275*	1.380**	1.376**	0.547	
	(0.651)	(0.638)	(0.676)	(0.570)	
Father ysc * T	−1.458**	−1.565***	−1.497**		−1.032*
	(0.560)	(0.560)	(0.576)		(0.593)
BTBC * T	−0.074	−0.068		−0.077	−0.043
	(0.055)	(0.055)		(0.056)	(0.056)
Height for age * T	−0.599		−1.245	0.002	−2.003
	(2.560)		(2.509)	(2.629)	(2.720)
Constant	27.029***	26.691***	27.404***	26.991***	25.992***
	(2.144)	(2.110)	(2.202)	(2.246)	(2.249)
R-squared	0.366	0.358	0.321	0.314	0.285
Number of Observations	174	174	174	174	174

Notes: in all estimations we controlled for Crowdedness, Creole, Eldest Sibling and Male. The coefficient estimates for these controls are reported in Online Appendix D, Table A3. The variables "BTBC" and "Height for age" were mean-deviated. Robust standard errors reported in parenthesis. *** denotes significance at one percent level, ** at five percent level, * at 10% level.

Table A4
Descriptive statistics alternative outcomes.

	Average	SD	Min	Max
IQ	103.305	15.923	54.814	140.264
Holborn reading scale	84.303	46.126	0	175
# of absences 1975–76	7.644	12.549	0	75
Access to books	0.233	0.424	0	1

Table A5
Alternative outcomes.

	IQ (1)	Holborn reading scale (2)	# of absences 1975–76 (3)	Access to books (4)
Treatment (T)	4.194*	1.196	0.015	0.078
	(2.253)	(4.613)	(0.252)	(0.483)
Mother ysc	−0.026	1.078	−0.049	0.118
	(0.437)	(1.056)	(0.056)	(0.104)
Father ysc	1.593***	2.194**	−0.009	0.194**
	(0.407)	(0.935)	(0.041)	(0.081)
Mother ysc * T	1.283**	3.748**	0.012	0.128
	(0.571)	(1.562)	(0.074)	(0.148)
Father ysc * T	−1.077**	−3.954***	−0.031	−0.145
	(0.543)	(1.322)	(0.072)	(0.123)
Constant	97.653***	92.051***	1.692***	−2.201***
	(2.236)	(4.439)	(0.269)	(0.537)
R-squared	0.291			
Number of observations	162	162	163	163

Notes: in all estimations we controlled for Crowdedness, Creole, Eldest Sibling and Male. The coefficient estimates for these controls are reported in Online Appendix D, Table A5. The specifications are: OLS for (1), Tobit for (2), Poison for (3) and Logistic for (4). Robust standard errors reported in parenthesis. *** denotes significance at one percent level, ** at five percent level, * at 10% level.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.econedurev.2018.06.006.

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