Modelling Economic Policy Issues

Long-term benefits of early childhood education on educational attainment in rural China: kindergarten V.S. preschool

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ABSTRACT

This paper estimates the long-term benefits of kindergarten and preschool on postcompulsory educational attainment in rural China. Drawing on the data from the 2016 China Rural Development Survey (CRDS) with a nationally representative sample covering 2,000 rural households at 100 villages in 5 provinces, we employed family fixed effects model (FFE) and instrumental variable (IV) approaches to overcome the endogeneity of ECE experience. The results show that rural people with any ECE experience (including kindergarten and preschool) were 12.5 percentage points more likely to be enrolled in academic senior high school. Further analysis reveals that these effects are primarily attributable to kindergarten experience rather than preschool experience. We do not find any heterogeneous effects by gender, age, birth order, or mother's education. The results from the instrumental variable approach remain substantially the same. These findings imply that investing in rural kindergarten education contributes to rural human capital accumulation at the post-compulsory level.

1. Introduction

Extensive empirical research has established the profound and lasting effects of early childhood education (ECE) on the development of children's cognitive and social-emotional skills, with demonstrated benefits extending well into adulthood (Knudsen et al., 2006; Almond and Currie, 2011). A seminal longitudinal study of the Perry Preschool Program in the United States found that ECE led to significant improvement across multiple life domains, including educational attainment, labor market outcomes, marriage, and healthy behaviors, while reducing crime activity and welfare dependence in later life (Heckman et al., 2010). Consistent research findings have been documented in other countries of South America (Berlinski et al., 2008; Bietenbeck et al., 2019).

Building upon this robust evidence base, many countries have substantially expanded their investments in ECE (OECD, 2023). For example, China has allocated over US$ 7 billion to ECE in the past decade. This sustained investment has yielded significant outcomes: national ECE enrollment rates surged from 56.6 percent in 2010 to 89.7 percent in 2022 (MOE, 2012a, 2023). Concurrently, per child public expenditure on ECE rose from US$ 972 to US$ 1,373, with a growth rate surpassing that of other education levels (MOE et al.,

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2019, 2023).

Beyond the well-documented increases in enrollment into ECE, a critical question remains: What are the long-term benefits of ECE experience? Parents enroll their children in ECE with the expectation of fostering a strong foundation for future educational success (Crosnoe and Barbara, 2010) – a particularly salient motive in areas where educational resources are scarce and alternative childcare options are of comparatively lower quality (Ressler et al., 2020). However, despite China's substantial efforts to improve access to quality ECE, rigorous empirical evidence on the long-term effects of ECE experience on educational attainment among rural people remains strikingly limited. Existing studies tend to focus on the effects of ECE experience (e.g., preschool and kindergarten performance) on the short- or medium-term outcomes, and their findings exhibit considerable variation in both the sign and magnitude of effect (Rao et al., 2012; Chen and Liu, 2017; Fang and Huang, 2020). This inconsistency not only complicates the interpretation of results but also undermines evidence-based policy-making in this crucial domain.

This study aims to estimate the long-term benefits of ECE on post-compulsory educational attainment among rural people in China. We further distinguish between two major types of ECE – kindergarten and preschool to assess their different impacts. Using a unique nationally representative rural household survey dataset with three generations of people from the same family but different households, we employ a family fixed effects (FFE) approach and find that rural individuals with ECE experience exhibit significantly higher enrollment rates in academic senior high school than their peers without such experience. Further analysis reveals that these effects are primarily attributable to kindergarten experience rather than preschool experience. The results from the instrumental variable approach remain substantially the same.

The remainder of this paper is organized as follows. Section 2 briefly introduces the ECE in rural China and reviews the literature. Section 3 describes the sampling and data. Section 4 presents results, discussion, limitations, and future directions. Section 5 concludes with implications.

2. Institutional background and literature review

2.1. ECE in rural China

Since the late 1970s, China's ECE has been characterized by two distinct institutional types with different education objectives: kindergarten and preschool. According to the Regulations of City Kindergarten issued in 1979, three-year kindergartens were designed to provide comprehensive development for children aged 3 to 6 or 7 years, including health and nutrition services, behavior habits formation, fundamental motor skill development, cognitive development (e.g. emphasizing attention, observation, memory, imagination, linguistic abilities), and social-emotional and aesthetics perception (MOE, 1989). In contrast, the one-year preschool was supposed to ensure 5-6 years old children's health, cultivate their good behavior, enlighten their learning interest, and develop foundational academic habits (MOE, 1991). Historically, preschool dominated rural ECE provision before 1983. Since the 1990s, the aim of one-year preschool has been supplemented with preparing children for entering primary school (MOE, 1991). Despite these institutional developments, ECE enrollment remained quite low at 50.9 percent and pronounced urban-rural disparities (Su et al, 2020).

Since 2010, China has made a lot of efforts to improve the access to qualified ECE in China. For examples, the State Council issued the Several Suggestions on the Current Development of Early Childhood Education. This was immediately followed by the implementation of the first Three-year Early Childhood Education Action Plan (2011-2013), making the beginning of a sustained policy commitment. The success of this intervention led to three subsequent extensions of the Action Plan: 2014-2016 cycle, 2017-2019 cycle, and 2021-2025 cycle (currently ongoing). These concerted efforts have yielded remarkable results in the enrollment rate of ECE, with the growth from 62.3 percent in 2011 to 89.7 percent in 2022 (MOE, 2012b, 2023). However, despite this impressive national progress, recent research indicated that as of 2022, only 43 percent of villages had kindergarten facilities (Luo et al., 2022), highlighting ongoing challenges in achieving equitable access to qualified ECE across all regions.

2.2. Literature review: long-term effect of ECE on school enrollment

The benefits of ECE on children's human capital development have been theoretically supported by relevant natural science and economic literature. Extensive research from brain sciences, genetics, and neurosciences has consistently shown that early childhood was a crucial window to lay a solid foundation not only for physical health, but also for the development of language, motor, cognitive, and socio-emotional skills for the entire life cycle (e.g., Dahl, 2004). Meanwhile, Cunha and Heckman (2008) developed a model of life-cycle skill formation from the perspective of economics. A key idea from this model is "self-productivity" as captured by "skills beget skills". This model has two important implications. First, early investments matter more than late ones for skill formation as the plasticity during early childhood renders children more susceptible to relevant interventions and earlier investments because of more time to reap their benefits. Second, it is not always possible to remediate early skill deficits completely with later investments (Heckman and Rubinstein, 2001; Heckman et al., 2006).

Consistent with the above theories, a plenty of empirical evidence worldwide has shown that ECE experience exerts positive effects on individual's developmental indicators across the life cycle, such as academic performance (Barnett and Jung, 2021; Weiland and Yoshikawa, 2013), cognitive skill (Campbell et al., 2008; Burger, 2010), social-emotional ability (Camilli et al., 2010), physical and mental health (Thompson, 2018; Carneiro and Ginja, 2014; Baker et al., 2015), school enrollment (Berlinski et al., 2008; Havnes and Mogstad, 2011; Bingley and Westerard-Nielsen, 2012), employment and earnings (Heckman et al., 2010; Havnes and Mogstad, 2015; Guo et al., 2024).

As to educational attainment, existing findings across different study contexts have demonstrated a positive impact of ECE. For examples, Bastos et al. (2017) found children with access to ECE were 3.0 percentage points more likely to be enrolled in primary school in Guatemala. Harvnes and Mogstad (2011) found that subsidized child care would increase the probability of attending college by almost 7 percentage points in Norway. Moreover, Berlinski et al. (2008) identified a significant positive effect of preschool attendance on the completed years of schooling in Uruguay. Dumas and Lefranc (2012) found that the time spent in ECE had a significant and positive effect on the probability of graduating from high school in France.

Comparatively speaking, studies in the context of China have been rare. To the best of our knowledge, only three studies have assessed the effect of ECE on academic performance in China. Specifically, Rao et al. (2012) drew on a sample of 205 pupils in a southwestern county in China and found a positive effect of ECE experience on primary students' academic performance in grade one. Chen and Liu (2017), focused on those 15-years old children who took the Programme for International Student Assessment (PISA) in Shanghai, found that ECE experience significantly improved their PISA test performance. Fang and Huang (2020) used data from a national representative sample and reported a positive effect of ECE experience on academic performance of the students in junior high school.

However, the three studies in the context of China cited above focused on the impact of ECE on academic performance, with little attention to its effect on educational attainment. More importantly, none of the three studies took into account the potential differentiated impacts of two major types of ECE with significantly different training goals and curriculum arrangements in China, namely kindergarten and preschool as mentioned above.

3. Data and empirical specifications

3.1. Data

This study draws on data from the China Rural Development Survey (CRDS) conducted by the authors. The initial CRDS survey wave was conducted in 2005 and a four-step stratified random sampling procedure was used to select a nationally representative sample of 2,000 households at 100 villages in 50 townships from 25 counties across 5 provinces. In the first step, one province was randomly selected from each of China's five major agroecological zones, which gives us five sample provinces: Jiangsu, Sichuan, Shaanxi, Jilin, and Hebei provinces. In the second step, the counties in each sample province were ranked and divided into five quintiles with descending order according to their per capita gross industrial output value (GIOV). Then, one county was randomly selected from each quintile thus five counties in each sampling province were selected. In the third step, for each selected county, the townships were divided into two groups according to their per capita GIOV: "above the mean" and "below the mean". Then one township was randomly selected from each group. Finally, the survey team randomly selected 20 households from each village, with a total of 2000 sample households. Due to budget, eight of 20 sample houseolds in each sample village were interviewed one-on-one by trained enumerators with questionnaires and others interviewed in small group. Since then, five follow-up surveys with questionnaires have been conducted for all sample households in 2008, 2012, 2016, 2019, and 2023 to maintain the panel structure of the dataset.

For this analysis, we utilize the data from the 2016 survey wave, which provides comprehensive demographic information on all core and extended family members (i.e., those who have separated from their original households). Data from this wave is particularly valuable as it tracked three generations of people from the same family but different households, including the household head and his/her spouse, their children and spouse as well as their grandchildren. In the context of this study, the term "family" refers to an extended family of three generations. By "household" we mean a nuclear family comprised of parents and their children in the three-generation extended family. In other words, family is bigger than household (Fig. 1). This unique multigenerational data structure not only gives us more sample individuals, but also makes it possible for us to use family fixed effects as the identification strategy, as we will elaborate in the subsequent methodological discussions of this section.

Each CRDS survey wave collected detailed information at the individual, household, and village levels. For this particular study, we
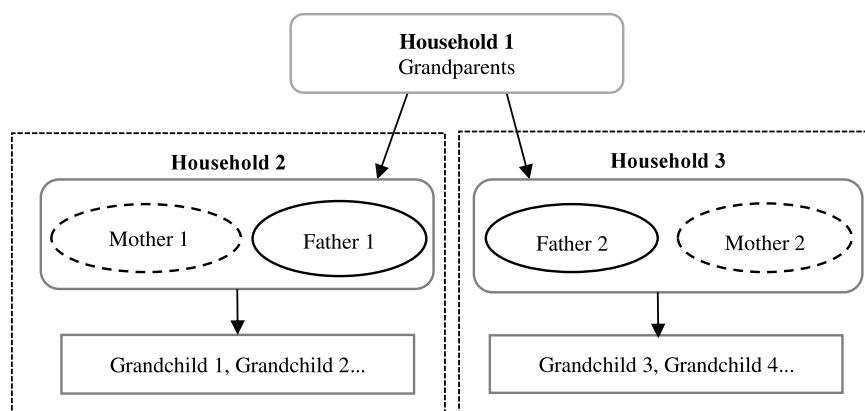

Fig. 1. A three-generation extended family with multiple households.

primarily use two key survey modules. One is the individual and household characteristics module, which provides critical variables including individual's age, gender, education, ECE experience, the type of ECE experience (distinguishing between kindergarten and preschool), and self-reported academic performance, as well as birth order, sibling count and parents' years of schooling. The other is the village characteristics module, which particularly documented the initial year when any type of ECE was available in the village.

To construct the analytical sample, we apply two key selection criteria. First, we retain the individuals who had completed their formal education by 2016 to ensure accurate measurement of long-term educational outcomes. Second, we exclude the cases with missing data on siblings' or parents' educational attainment, as these variables serve as essential controls in our regression models. These selection procedures yielded a final sample of 5,379 individuals.

3.2. Measurements

3.2.1. Measurements of post-compulsory educational attainment

In Chinese educational system, there are two broadly defined education levels post the compulsory education. One is senior high school level, and the other is higher education level (including associate college and college). There are two institutional types of senior high schools in China: academic senior high school and VET. We construct the variable named *Academic senior high school* to measure post-compulsory educational attainment due to the following two facts. First, having senior high school education is the basic requirement for the country trying to over the middle-income trap (Glawe and Wagner, 2020). Second, the enrollment in other post-compulsory education was comparatively quite low in our study sample (4.60% for vocational training, 6.94% for associate college, whereas 3.54% for college, against 18.45% for academic senior high school). Therefore, we think it makes more sense to focus on enrollment in academic senior high school. *Academic senior high school* is a dummy variable that takes the value of one if any individual had ever attended academic senior high school and zero otherwise.

3.2.2. Measurements of ECE experience

There are two types of ECE in rural China: kindergarten and preschool. To analyze their differential impacts, we constructed three measurements of ECE experience. *Any ECE* is a dummy variable that takes the value of one if an individual had ever attended kindergarten or preschool and zero otherwise. *Kindergarten* is a dummy variable that equals to one if an individual had ever attended any kindergarten but not preschool and zero otherwise. *Preschool* is a dummy variable that equals to one if an individual had ever attended any preschool but not kindergarten and zero otherwise.

3.2.3. Covariates

We follow the literature and incorporate a comprehensive set of control variables across multiple levels to account for potential confounding factors. Specifically, at the individual level, we include three variables: *female* (1 = yes, 0 = no), *age (years)*, and *birth order (1=first child, 2=second child, 3=third child, 4=fourth and above child)*. We also include two variables that are highly related to children's educational attainment at the household level: *father's education* and *mother's education* measured by their years of schooling (Kantarevic and Mechoulan, 2006; Lee, 2008; Carneiro et al., 2013; Holmlund et al., 2011; Black et al., 2018; Dong et al., 2019, 2020). The number of siblings is excluded as it is highly correlated with *age* and *birth order*. The correlation coefficients are 0.615 and 0.612, respectively. Table 1 presents the descriptive statistics of these key variables.

3.3. Identification strategy

To address potential endogeneity concerns of ECE experience due to omitted variable and sample selection bias, we take a family fixed effect approach in the benchmark model. This methodological strategy leverages the unique multigenerational structure of our dataset, which contains multiple individuals from different households under the same family.

Table 1
Descriptive statistics of key variables.

	Variables	Obs	Mean	St. D.	Min	Max
Outcome variables						
(1)	Academic senior high school (1=yes)	7,149	0.18	0.39	0	1
ECE experience						
(2)	Any ECE experience (1=yes)	7,149	0.21	0.41	0	1
(3)	Kindergarten (1=yes)	7,149	0.12	0.32	0	1
(4)	Preschool (1=yes)	7,149	0.14	0.35	0	1
Covariates						
(5)	Female (1=yes)	7,149	0.39	0.49	0	1
(6)	Age (Years)	5,379	36.02	10.60	16	64
	Birth order (Reference group: Fourth and above child)					
(7)	First child	5,379	0.44	0.50	0	1
(8)	Second child	5,379	0.29	0.45	0	1
(9)	Third child	5,379	0.14	0.35	0	1
(10)	Father's education (years)	5,379	5.95	3.73	0	22
(11)	Mother's education (years)	5,379	3.57	3.73	0	16

In rural households of China, educational decisions for children are shaped by two broad key factors, which help to justify our employment of the family fixed effect (FFE) model. One factor is liquidity constraints. Many rural households face financial limitations, particularly during children's pre-and post-compulsory education stage, where tuition fees and associated costs are far from negligible compared to the household's disposal income (Li, 2007; Liu et al., 2009; Chen et al., 2013; Bai et al., 2017). To address these constraints, parents often rely on informal financial support, such as loans or contributions from extended family members, including those in second-generation households of the same extended family (Coleman 1988; Bradley and Corwyn, 2002; Connelly and Zheng, 2003). This interdependence reinforces the shared economic strategies captured by the FFE model. The other factor is the household's perception about the value of education (e.g., Bourdieu, 1986; Hannum and Adams, 2009). In rural settings of China, attitudes toward education are often shared across households within an extended family (Whyte, 2004; Murphy, 2014). For instance, families prioritizing education as a pathway to social mobility were more likely to allocate resources to schooling, even under financial strain (Ye and Wu, 2021). This shared perception helps explain the dynamics of educational outcomes within extended families, a key assumption of the FFE model.

This allows us to adopt a family fixed effect (FFE) model to eliminate the endogeneity caused by omitting time-invariant unobserved variables at the family level, such as risk preference, genetic endowments, and family culture that may simultaneously influence both ECE experience and later educational outcomes (Dong et al., 2019). The FFE model is specified as follows:

$$Y_{itf} = \beta_0 + \beta_1 ECE_{itf} + \beta_2 I_{itf} + \beta_3 H_{itf} + \vartheta_f + \varepsilon_{itf} \tag{1}$$

where Y_{itf} is the academic senior high school enrollment of individual i from household t of family f. *ECE* is an indicator of ECE experience, which takes any of the three dummy variables defined above one at a time, including *Any ECE, Kindergarten,* or *Preschool. I* and H are vectors of control variables at the individual and household levels, respectively. ϑ_f is family fixed effects. It is worth noting that families are above households, a family has at least one household. β_1 is the parameter to capture the impact of ECE experience on academic senior high school enrollment. ε is the error term.

To further address potential endogeneity concerns that may persist even after implementing FFE, we take an instrumental variable (IV) approach as a robustness check by referring to previous studies (Duflo, 2001; Chen et al., 2023). The IV approach is employed to exploit the exogenous variations in the availability of ECE services at the sample individuals' ECE age in the village. Specifically, we construct a village-level instrumental variable based on the historical presence of ECE facilities before each individual reached primary school age (6 years old). We use a binary indicator called *preschool_v* that equals to one if any ECE services were available in the village before the individual's pre-primary school years (6 years old) and zero otherwise as an IV for *Any ECE experience*. Similarly, we construct the IV for *Kindergarten (Preschool)* that equals to one if there was any kindergarten (preschool) in the village before the individual's pre-primary school years and zero otherwise.

The validity of IVs is supported by their relevance and exclusion criteria. In terms of relevance, our first-stage of 2SLS results demonstrate statistically significant (P<0.01) and economically meaningful effects: rural individuals from villages with ECE services during their pre-primary school years were 10.6, 9.8, and 9.6 percentage points more likely to access any ECE, kindergarten, and preschool, respectively (Appendix Table 1). The strong predictive power of our IVs is further confirmed by first stage F-statistics exceeding the conventional threshold of 10, indicating no weak instrument concerns. As to the exclusion criterion, it is understandable that the ECE service availability in the village during the individual's pre-primary school year affects his/her post compulsory educational attainment only through his/her ECE experience. To further strengthen this assumption, we control for village fixed effects to account for all time-invariant factors at the village level and above that might independently affect individual's post-compulsory educational attainment.
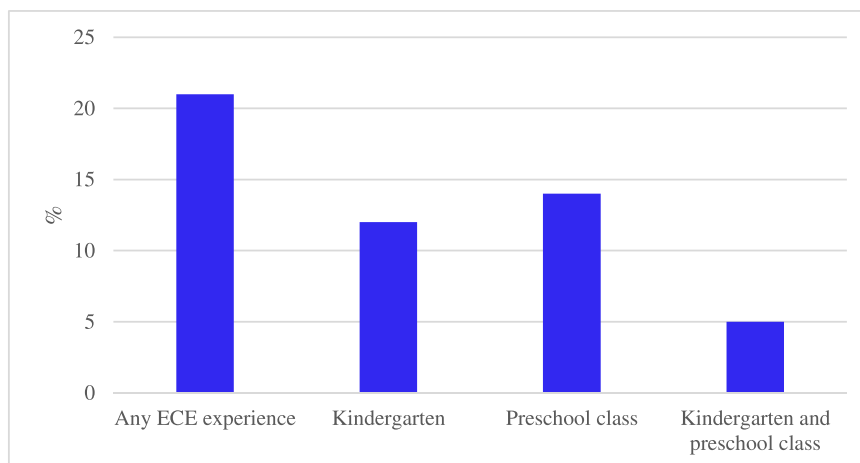

Fig. 2. ECE experience of sample individuals.

4. Results

4.1. Descriptive analyses

Our analysis reveals several interesting facts in ECE experiences and educational attainment among rural people. First, we find that 21 percent of sample rural individuals ever had any ECE experience. Among them, 12 percent ever attended kindergarten, 14 percent ever attended preschool, and the rest 5 percent attended both kindergarten and preschool (Fig. 2). Given the small size and potential confounding effects among those who attended both kindergarten and preschool, we will exclude them in the subsequent analysis of this paper.

As to post-compulsory school enrollment, our data show an obvious decreasing trend in enrollment rates as education level progresses. Specifically, about 23 percent of rural individuals had ever enrolled in any senior high schools, of which 18.45 percent in academic senior high school and the rest 4.6 percent in VET school. Only 6.94 percent had ever enrolled in associate college whereas 3.54 percent in college (Fig. 3), which are significantly lower than the national averages reported in the 2015 Survey Report of Migrant Workers in China (NBS, 2016).

Results from descriptive analyses also show obvious variations in academic senior high school enrollment by ECE type. As shown in Table 2, rural individuals with any ECE experience demonstrated significantly higher enrollment rates in academic senior high school compared to their non-ECE counterparts (33.38 percent vs 14.55 percent, a gap of 18.83 percentage points) (p<0.01) (Column 1). The gap was even more pronounced when we compare those with kindergarten experience against those without any ECE experience (37.40 percent vs 15.91 percent) (p<0.01) (Column 2). In contrast, the difference in enrollment in academic senior high school between those with preschool experience and those without any ECE experience was much smaller (32.30 percent vs 16.12 percent), although still statistically significant (p<0.01) (Column 3). These patterns suggest that while both ECE types confer benefits, kindergarten experience may be more effective than preschool experience in facilitating enrollment in post-compulsory education in rural China.

4.2. Results from multivariate analyses

Results from multivariate analyses are presented in Table 3. Columns 1 and 2 present the results from the unadjusted FFE model, FFE adjusted for individual characteristics, respectively. Column 3 reports FFE adjusted for individual and household characteristics, which we call the full FFE model. We focus on the results from the full FFE model as its goodness of fit is higher than that of Columns 1 and 2. The full FFE model not only provides more reliable effect estimates by accounting for potential confounders at multiple levels, but also demonstrates the robustness of our findings across different model specifications. The results from the IV approach are presented as a robustness check (Columns 4-6).

4.2.1. The impact of ECE on academic senior high school enrollment

When we examine the likelihood of enrolling in academic senior high school, the results show a statistically significant and positive impact. Regression results from the full FFE model indicate that those with any ECE experience were 12.5 percentage points more likely to enroll in academic senior high school than their peers of non-ECE group (p<0.01) (Panel A, Column 3).

Consistent with our descriptive analyses above, the regression results from full FFE model reveal both kindergarten and preschool experience contribute to enrollment in academic senior high school among rural people, although the magnitude of kindergarten is
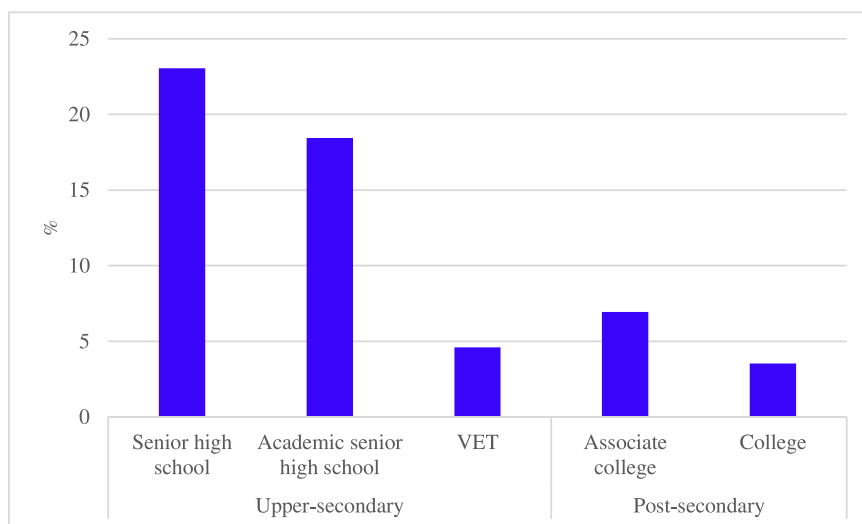

Fig. 3. Enrollment in post-compulsory education among sample individuals.

Table 2

Academic senior high school enrollment, by ECE experience.

		Any ECE experience	Kindergarten	Preschool
(1)	Yes	33.38	37.40	32.30
(2)	No	14.55	15.91	16.12
(3)	Dif = (1) - (2)	18.83	21.49	16.17
(4)	P-value (Chi-squared)	0.000***	0.000***	0.000***

*** p<0.01,
* p<0.1.
** p<0.05,
Notes:

Table 3

Impacts of ECE experience on academic senior high school enrollment.

	Variables	FFE			IV		
		(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Any ECE experience							
(1)	Any ECE experience	0.240***	0.135***	0.125***	0.414***	0.397**	0.440**
		(0.014)	(0.023)	(0.023)	(0.047)	(0.184)	(0.181)
(2)	Individual characteristics	No	Yes	Yes	No	Yes	Yes
(3)	Household characteristics	No	No	Yes	No	No	Yes
(4)	Family fixed effects	Yes	Yes	Yes	No	No	No
(5)	Village fixed effects	No	No	No	Yes	Yes	Yes
(6)	*N*	7,120	5,379	5,379	7,149	5,379	5,379
(7)	R-squared	0.055	0.103	0.107	0.026	0.055	0.052
(8)	Number of families	1,995	1,832	1,832			
Panel B: Kindergarten							
(9)	Kindergarten	0.252***	0.113***	0.104***	0.557***	0.374**	0.401***
		(0.018)	(0.027)	(0.027)	(0.070)	(0.157)	(0.154)
(10)	Individual characteristics	No	Yes	Yes	No	Yes	Yes
(11)	Household characteristics	No	No	Yes	No	No	Yes
(12)	Family fixed effects	Yes	Yes	Yes	No	No	No
(13)	Village fixed effects	No	No	No	Yes	Yes	Yes
(14)	*N*	7,120	5,379	5,379	7,149	5,379	5,379
(15)	R-squared	0.037	0.099	0.104		0.079	0.090
(16)	Number of families	1,995	1,832	1,832			
Panel C: Preschool							
(17)	Preschool	0.234***	0.085***	0.077***	0.405***	0.052	0.071
		(0.016)	(0.025)	(0.025)	(0.073)	(0.257)	(0.251)
(18)	Individual characteristics	No	Yes	Yes	No	Yes	Yes
(19)	Household characteristics	No	No	Yes	No	No	Yes
(20)	Family fixed effects	Yes	Yes	Yes	No	No	No
(21)	Village fixed effects	No	No	No	Yes	Yes	Yes
(22)	*N*	7,120	5,379	5,379	7,149	5,379	5,379
(23)	R-squared	0.038	0.098	0.102	0.033	0.114	0.139
(24)	Number of families	1,995	1,832	1,832			

Notes: a. Standard errors in parenthesis, *** p<0.01, ** p<0.05, * p<0.1. b. Individual characteristics include *gender, age,* and *birth order*. Household characteristics include *father's education,* and *mother's education.*

larger than that of preschool. Specifically, rural people with kindergarten experience were 10.4 percentage points more likely to enroll in academic senior high school than their peers of non-ECE group (p<0.01) (Panel B, Column 3), compared to an impact of 7.7 percentage points from preschool experience (p<0.01) (Panel C, Column 3).

Results from the robustness check using the IV approach are substantially consistent with those from the full FFE model. Specifically, rural people with any ECE experience were 44 percentage points more likely to enroll in academic senior high school than their peers of non-ECE group (p<0.01) (Panel A, Column 6). This finding was mainly driven by people with kindergarten experience as they were 40.1 percentage points more likely to enroll in academic senior high school than their peers of non-ECE group (p<0.01) (Panel B, Column 6). In contrast, IV results provide little evidence about the effect of preschool experience on the enrollment in academic senior high school (Panel C, Column 6).

In sum, the regression results from both FEE and IV approaches consistently show that ECE experience has positive causal effects on rural people's academic senior high school enrollment in China. Moreover, this positive effect is mainly driven by kindergarten experience.

4.2.2. Heterogeneity analyses

It is important to understand whether ECE experience exerts heterogeneous long-term effects on educational attainment for

different subgroups of rural people for better informing the design of targeted ECE interventions. According to the literature, four key dimensions of heterogeneity deserve close examination. First, gender difference in cognitive and non-cognitive skill development trajectories (Andreoni et al., 2020) and varying sensitive periods for social-emotional learning (Nakajima et al., 2020) may lead to divergent long-term impacts of ECE between males and females. Second, different age in China were exposed to different education policies/programs. For example, those born after 1980 experienced the one-child policy, compulsory education, and enrollment expansion of higher education. Third, the birth order is highly related to the education investment in the household (e.g., Ejrnaes and Pörtner, 2004; Fors and Lindskog, 2023). Fourth, maternal education − a strong predictor of children's academic achievement and cognitive development (e.g., Havnes and Mogstad, 2011) − may moderate ECE effectiveness.

To empirically test these heterogeneity effects, we follow previous studies (Berlinski et al., 2009; Borraz and Cid, 2013; Blanden

Table 4
Heterogeneous effects of ECE on academic senior high school enrollment.

	Variables	Any ECE experience		Kindergarten		Preschool	
		FFE (1)	IV (2)	FFE (3)	IV (4)	FFE (5)	IV (6)
Panel A: Heterogeneity by gender							
(1)	Kindergarten	0.093***	0.570**	0.064**	0.537**	0.057**	0.039
		(0.026)	(0.269)	(0.031)	(0.245)	(0.028)	(0.491)
(2)	Kindergarten * Female	0.078***	-0.327	0.089**	-0.307	0.050	0.055
		(0.027)	(0.212)	(0.035)	(0.202)	(0.031)	(0.414)
(3)	Individual characteristics	Yes	Yes	Yes	Yes	Yes	Yes
(4)	Household characteristics	Yes	Yes	Yes	Yes	Yes	Yes
(5)	Family fixed effects	Yes	No	Yes	No	Yes	No
(6)	Village fixed effects	No	Yes	No	Yes	No	Yes
(7)	*N*	5,379	5,379	5,379	5,379	5,379	5,379
(8)	R-squared	0.109	0.019	0.105	0.066	0.103	0.138
(9)	Number of families	1,832		1,832		1,832	
Panel B: Heterogeneity by age							
(10)	Kindergarten	0.092	1.023**	0.054	1.189**	0.039	0.053
		(0.063)	(0.474)	(0.079)	(0.549)	(0.070)	(0.868)
(11)	Kindergarten * age	0.001	-0.029**	0.002	-0.036**	0.001	0.001
		(0.002)	(0.015)	(0.003)	(0.018)	(0.003)	(0.029)
(12)	Individual characteristics	Yes	Yes	Yes	Yes	Yes	Yes
(13)	Household characteristics	Yes	Yes	Yes	Yes	Yes	Yes
(14)	Family fixed effects	Yes	No	Yes	No	Yes	No
(15)	Village fixed effects	No	Yes	No	Yes	No	Yes
(16)	*N*	5,379	5,379	5,379	5,379	5,379	5,379
(17)	R-squared	0.107	0.105	0.104	0.096	0.102	0.138
(18)	Number of families	1,832		1,832		1,832	
Panel C: Heterogeneity by birth order							
(19)	Kindergarten	0.227***	23.938	0.410***	21.956	0.138**	-0.955
		(0.063)	(60.838)	(0.128)	(30.624)	(0.068)	(11.538)
(20)	Kindergarten * first child	-0.087	-23.407	-0.297**	-21.742	-0.049	1.053
		(0.064)	(59.822)	(0.129)	(30.507)	(0.069)	(11.364)
(21)	Kindergarten * second child	-0.155**	-23.410	-0.340***	-21.775	-0.125*	0.972
		(0.066)	(59.656)	(0.131)	(30.488)	(0.071)	(11.315)
(22)	Kindergarten * third child	-0.122*	-23.109	-0.375***	-21.806	-0.017	1.027
		(0.070)	(58.872)	(0.137)	(30.406)	(0.075)	(11.135)
(23)	Individual characteristics	Yes	Yes	Yes	Yes	Yes	Yes
(24)	Household characteristics	Yes	Yes	Yes	Yes	Yes	Yes
(25)	Family fixed effects	Yes	No	Yes	No	Yes	No
(26)	Village fixed effects	No	Yes	No	Yes	No	Yes
(27)	*N*	5,379	5,379	5,379	5,379	5,379	5,379
(28)	R-squared	0.109		0.106		0.104	0.094
(29)	Number of families	1,832		1,832		1,832	
Panel D: Heterogeneity mother's education							
(30)	Kindergarten	0.067*	4.474	-0.002	1.116	0.076**	0.647
		(0.036)	(9.316)	(0.051)	(0.746)	(0.038)	(2.236)
(31)	Kindergarten * Mother's education	0.011**	-0.481	0.017**	-0.105	0.000	-0.060
		(0.005)	(1.044)	(0.007)	(0.084)	(0.006)	(0.259)
(32)	Individual characteristics	Yes	Yes	Yes	Yes	Yes	Yes
(33)	Household characteristics	Yes	Yes	Yes	Yes	Yes	Yes
(34)	Family fixed effects	Yes	No	Yes	No	Yes	No
(35)	Village fixed effects	No	Yes	No	Yes	No	Yes
(36)	*N*	5,379	5,379	5,379	5,379	5,379	5,379
(37)	R-squared	0.108		0.105		0.102	0.035
(38)	Number of famillES	1,832		1,832		1,832	

Notes: a. Standard errors in parenthesis, *** $p<0.01$, ** $p<0.05$, * $p<0.1$. b. Individual characteristics include *gender, age,* and *birth order*. Household characteristics include, *father's education,* and *mother's education*.

et al., 2016) and extend our analysis by incorporating interaction terms between ECE experience and gender (female indicator), age, birth order, and mother's education, respectively, and rerun the full FFE model and IV model. As shown in Table 4, our results do not provide any consistent evidence that the causal effects of ECE experience on enrollment in academic senior high school are heterogenous by gender, age, birth order, or mother's education. Such finding of little heterogeneous effects was in contrast with those found in Borraz and Cid (2013), Blanden et al. (2016), and Berlinski et al. (2009) who found heterogeneous effects of ECE experience or policies on children's school attendance or performance during the compulsory education stage.

4.3. Discussion

Results from both descriptive and multivariate analyses above have provided consistent and strong evidence that kindergarten experience had a positive causal effect on the enrollment in academic senior high school among rural people but preschool experience had no such long-term benefits. We try to explore the potential mechanism underlying this finding.

We first sort out the reasons for discontinuing education beyond the compulsory level among sample individuals. Our data reveals three predominant barriers: academic underperformance and failing entrance examinations (38.09 percent), low educational aspirations (30.42 percent), and liquidity constraint (28.47 percent). This pattern indicates that school-related factors – particularly academic preparedness and motivation – together constitute almost 70 percent of cases where people discontinue education beyond compulsory education in rural China. As our data does not have enough information on liquidity constraint, when we discuss the potential mechanisms, we focus on the two key risk factors for educational discontinuation: poor academic performance and low schooling motivation.

Using standardized educational performance metrics as outcome variables in the FFE model, we find that kindergarten experience was associated with a 19.5 percentage points reduction in dropout risk due to academic failure ($p<0.1$) and a 38.9 percentage points higher probability of achieving a good academic ranking ($p<0.1$) (Table 5).

ECE, particularly through structured programs like kindergartens, is posited to foster personality traits, cognitive abilities, and non-cognitive skills that underpin later educational success (Heckman and Kautz, 2012). For instance, kindergarten attendance, with its longer duration and access to trained educators, may enhance traits such as conscientiousness and self-discipline, which are critical for academic persistence in rural settings of China in those days when educational resources were scarce. Similarly, cognitive abilities, such as early literacy and numeracy skills, developed through ECE exposure, may improve performance in entrance examinations, a key barrier to post-compulsory education identified in our data (38.09% of non-continuing students cited academic underperformance and exam failure).

Non-cognitive skills, including motivation and educational aspirations, are also likely pathways. Our findings indicate that low educational aspirations account for 30.42% of cases where students discontinue education after compulsory schooling. Kindergarten programs, which often emphasize socialization and structured learning, may cultivate higher aspirations compared to preschools, which are typically shorter and less resource-intensive. Additionally, liquidity constraints (28.47 percent of cases) suggest that socioeconomic factors interact with ECE's effects, potentially amplifying the role of non-cognitive skills like resilience in overcoming financial barriers to education.

While these mechanisms cannot be directly tested with our current dataset, the theoretical discussion aligns with prior studies (e.g., Duncan and Magnuson, 2013) and underscores the differential impacts of kindergarten and preschool. Future research with richer data on psychological and cognitive outcomes could empirically test these pathways, offering deeper insights into how ECE shapes educational attainment in rural China.

We propose several possible reasons behind the little heterogeneous effects of ECE in rural China based on available evidence and contextual factors given data availability. First, China's longstanding emphasis on educational equality as a fundamental policy principle (Zhang, 2025) has likely promoted relatively uniform access to and quality of ECE services in rural areas (Rao et al., 2023), potentially reducing variation in program impacts across different subgroups. Second, rural ECE development has primarily focused on meeting basic service provision under the "ensuring the basics" policy guidelines, resulting in highly standardized curricula and limited capacity for tailored interventions targeting specific needs by sub-groups (Luo et al., 2012; Hu et al., 2022). Third, the slower pace of educational improvement in rural regions compared to urban areas (Jing, 2025) implied that children from different birth

Table 5

Impacts of kindergarten experience on school performance.

	Variables	Unwilling to continue education (1=yes)	Dropout due to poor academic performance (1=yes)	Self-reported academic performance (1=good)
(1)	Kindergarten	0.095	-0.195*	0.389*
		(0.211)	(0.104)	(0.212)
(2)	Individual characteristics	Yes	Yes	Yes
(3)	Household characteristics	Yes	Yes	Yes
(4)	County fixed effects	Yes	Yes	Yes
(5)	*N*	996	996	715

Note: a. Standard errors in parenthesis, *** $p<0.01$, ** $p<0.05$, * $p<0.1$. b. The rural individuals having kindergarten or preschool education are included in the sample. Those having preschool education are the reference group. c. FFE estimation is adopted. d. Individual characteristics include *gender, birth cohort*, and *first child*. Household characteristics include *number of siblings, father's education*, and *mother's education*. e. The county dummy variables rather than village dummy variables are controlled due to small sample size.

cohorts experienced relatively similar preschool environments, suggesting little generational differences in ECE effects. Furthermore, the pervasive liquidity constraints faced by rural households during our study period - when agricultural income dominated family budgets (National Bureau of Statistics, 2025) – they were constrained to make complementary educational investments. This economic context may have attenuated the potential moderating effects of maternal education, as even children of relatively more educated mothers faced substantial resource limitations that restricted their educational development opportunities.

4.4. Limitations and future directions

We acknowledge three limitations of our study. First, although we have employed both FFE and IV approaches to address the endogeneity of ECE experience, we are unable to purge out all the potential unobserved confounders. The causal relationships of ECE experience and one's academic senior high school enrollment are still worth further explorations with a more robust identification strategy, say with an exogenous shock like the establishment of kindergartens, etc..

Second, it is a pity that our dataset does not have information on psychological and cognitive dimensions, such as personality traits, cognitive abilities, and non-cognitive skills, which may mediate the relationship between ECE and post-compulsory school enrollment. Thus, we are unable to empirically examine how ECE experience affects these intermediate factors due to data constraints. Specifically, our data lack measures of such traits as conscientiousness, self-regulation, or cognitive test scores. Prior literature suggests these traits were critical pathways through which ECE affects long-term educational trajectories (Heckman et al., 2013; Cunha and Heckman, 2008). Future studies with direct measures of psychological and cognitive outcomes are worthwhile. For instance, longitudinal surveys capturing preschoolers' personality traits (e.g., Big Five traits), cognitive abilities (e.g., IQ or literacy skills), and non-cognitive skills (e.g., grit or motivation) could enable regression analyses to quantify their mediating roles. Such studies would be particularly valuable in the context of rural China where access to quality ECE varies significantly, potentially amplifying the importance of these mechanisms in shaping educational track selection. Future studies may also consider complementary evidence from qualitative approaches, such as interviews with families or educators, to explore contextual factors influencing post-compulsory education decisions.

Finally, the ECE nowadays in China is much better in terms of both access and quality than the ECE that our sampled individuals have attended. Thus, the magnitude of the effects of ECE experience nowadays may be bigger than our estimates. In other words, our estimates can be interpreted as a lower bound of the effect of ECE experience on educational attainment among rural people in China.

5. Conclusion

This study provides empirical evidence on the long-term effect of ECE experience on the post-compulsory school enrollment among people in rural China and compares the effects between kindergarten and preschool using data from a nationally representative sample of rural households. By employing family fixed effect and IV approaches, we find significant positive effects of ECE experience on rural children's school enrollments of academic senior high school. Particularly, kindergarten experience has a positive effect on rural individuals' enrollment in academic senior high school but preschool experience has no such long-term benefits. We do not find any heterogeneity by gender, age, birth order, and mother's education in the effects of ECE on one's academic senior high school enrollment.

Despite the above-mentioned limitations, we can draw at least three policy implications from our study. First, our findings about the long-term benefits of ECE experience on academic senior high school enrollment suggest that improving the access to ECE might serve as an effective measure to further improve human capital in rural China. Given the limited access to ECE in rural areas (Luo et al., 2022), more efforts should be made to facilitate ECE attendance among children from rural households. Second, the finding that it is kindergartens rather than preschool that benefit rural children more in their academic senior high school enrollment implies that the types of ECE should be considered when designing or improving ECE policies or programs. Finally, this finding also implies the need to distinguish ECE types when evaluating the benefits of ECE programs in developing countries in future research.

Data availability statement

The data and codes will be available on request.

CRediT authorship contribution statement

Yunli Bai: Writing – original draft, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Yuhe Guo:** Writing – original draft, Methodology, Formal analysis. **Shaoping Li:** Writing – original draft. **Chengfang Liu:** Writing – review & editing, Investigation, Funding acquisition, Conceptualization. **Linxiu Zhang:** Supervision, Investigation, Funding acquisition.

Declaration of competing interest

There is no interest conflict of this study.

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71925009, 71333012).

Appendix

Table A1

Table A1
Results from the first-stage of IV regressions.

	ECE experience	Any ECE Experience (1=yes)		Kindergarten (1=yes)		Preschool (1=yes)	
		(1)	(2)	(3)	(4)	(5)	(6)
(1)	Any ECE service available in the village before the individual under discussion reached 6 years old? (1=yes)	0.321*** (0.019)	0.106*** (0.022)	0.263*** (0.019)	0.098*** (0.021)	0.274*** (0.025)	0.096*** (0.026)
(2)	Individual characteristics	No	Yes	No	Yes	No	Yes
(3)	Household characteristics	No	Yes	No	Yes	No	Yes
(4)	Village fixed effects	No	Yes	No	Yes	No	Yes
(5)	Observation	7,149	5,379	7,149	5,379	7,149	5,379
(6)	R-squared	0.059	0.322	0.055	0.285	0.033	0.244
(7)	F value	288.45	88.85	189.5	46.46	124.79	44.56

Notes: a. Standard errors in parenthesis, *** $p<0.01$, ** $p<0.05$, * $p<0.1$. b. Individual characteristics include gender, birth cohort, and first child. Household characteristics include number of siblings, father's education, and mother's education.

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