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Impacts of village preschools on student enrollment and longer-term outcomes: New evidence from the poorest regions in China☆

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ABSTRACT

This paper examines the impacts of *both the availability and the quality* of village preschools on student enrollment and longer-term outcomes in the context of the rapid development of early childhood education in the poorest areas of China. After the implementation of one of the world's largest universal preschool programs for a decade, the number of preschools in China has more than doubled while annual enrollments have increased by 60%. Using nationally representative survey data tracking children from 2010 to 2018, we identify the causal impacts of village preschools using a difference-in-differences instrumental variable approach. Building new preschools substantially increased students' access to early childhood education in low-income villages. We also find suggestive evidence of positive impacts on their cognitive skills four years after preschool enrollment, but not their non-cognitive skills. To identify the impacts of preschool quality, we re-examined the "One-Village-One-Preschool" experiment in one of China's poorest counties. High-quality preschools substantially improved students' academic outcomes, particularly among disadvantaged students. Our findings contribute new evidence on how early childhood education affects human capital development in low-income regions.

1. Introduction

Early childhood education is one of the most important human capital investments, the benefits of which far outweigh individual and societal costs (Barnett et al., 2006; Chetty et al., 2010; Deming, 2009; Duncan et al., 2007; G.J. Duncan et al., 2013; Greg J. Duncan et al., 2013; Dynarski et al., 2013; Heckman et al., 2010; Heckman et al., 2013; Ludwig and Miller, 2007). A large body of empirical research has shown that early childhood education stimulates children's abilities in language, literacy, and mathematics in the short term (Atteberry et al., 2019; Bailey et al., 2021; Phillips, 2017; Puma et al., 2010; Weiland and Yoshikawa, 2013), substantially improves children's cognitive skills (Camilli et al., 2010; G.J. Duncan and Magnuson, 2013; Greg J. GregJ. Duncan and Magnuson, 2013; Bietenbeck et al., 2019), and reduces their need for special education and grade repetition (Barnett, 2008; Yoshikawa et al., 2016; Monnet, 2019). In the longer term, early childhood education improves educational attainment, employment competitiveness, and income levels, indicating that early childhood education has persistent and even lifelong impacts on child outcomes (Shonkoff et al., 2000; Heckman, 2012; G.J. Duncan and Magnuson, 2013; Greg J. Duncan and Magnuson, 2013; Elango et al., 2015; Yoshikawa et al., 2016; Phillips et al., 2017; Gray-Lobe et al., 2023).

The importance of providing high-quality early childhood education for children in lower-income regions cannot be overstated (Barr and Gibbs, 2022; Castro and Rolleston, 2018; Duncan et al., 2023; Heckman, 2006; Rao et al., 2021). The existing literature further indicates that

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children from disadvantaged families benefit more than their advantaged peers from high-quality public preschool education (Morris et al., 2014; Bitler et al., 2014; Elango et al., 2015; van Huizen and Plantenga, 2018; Monnet, 2019). Universal access to high-quality preschools provides a formal educational environment for disadvantaged children, effectively addressing educational poverty and reducing the income inequality between rich and poor (Greg J. Duncan and Sojourner, 2013; G.J. Duncan and Sojourner, 2013; Castro and Rolleston, 2018; Dearing et al., 2018; Kawarazaki, 2022).

This paper provides new evidence on the causal impacts of the availability and quality of village preschools on student enrollment and longer-term outcomes in the context of the rapid development of early childhood education in the poorest regions of China.[1] Over the decade, China has implemented one of the largest early childhood education programs in the world. Because of the three waves of the Three-year Action Plans for Preschool Education, the number of preschools (including pre-kindergartens and kindergartens) in China has more than doubled with annual enrollments increasing by more than 60%. This ambitious series of early childhood education programs have focused on low-income, rural areas where children between the ages of three and five have long lacked formal learning opportunities, particularly high-quality preschool opportunities. While this policy effort aims to provide universal public early childhood education for low-income students, however, we know relatively little about whether such large-scale programs improve student outcomes. Moreover, expansion of preschool education has been a recent policy priority in many low- and middle-income countries (UNICEF, 2019), but existing literature focuses on targeted programs or universal programs in developed countries (Baker et al., 2008; Blanden et al., 2022; Cornelissen et al., 2018; Gormley and Gayer, 2005; Williams, 2019), and more importantly, the empirical conclusions on universal programs are still mixed (see a meta-analysis in van Huizen and Plantenga, 2018).

To our knowledge, this paper is one of the first to identify the causal impacts of *both the availability and the quality* of village preschools on student enrollment and longer-term outcomes in the low-income regions of developing countries like China. In a wave of national and local policy experiments with a focus on universal early childhood education, our paper speaks closely to a recent careful study on a large-scale preschool expansion in Ethiopia (Kim, 2022). We provide new evidence from China on the potential policy impacts of building preschools versus building high-quality preschools on child development.

As schooling decisions are likely endogenous and shaped by numerous observable and unobservable factors, rigorously evaluating how preschool education affects the long-term human capital development of children is no easy task. Supply-side (e.g., the availability and quality of preschools) and demand-side (e.g., family socioeconomic status and preferences) factors, which are often unobservable, jointly determine a child's preschool attendance. Simply calculating the correlation between preschool attendance and longer-term outcomes suffers from potential selection bias. Moreover, even when families decide to enroll their children in early childhood education programs, the choice of different programs with varying quality levels likely affects child outcomes as well.

We address these two empirical challenges in two innovative ways. First, based on a research design provided by the rapid policy changes on the national scale, we use high-quality and nationally representative panel data and a quasi-experimental design to examine the impacts of the availability of preschools on students in low-income regions of China. More specifically, we use a difference-in-differences instrumental variable (DID-IV) model, which builds on the plausible exogenous changes in the availability of preschools in a village due to the three waves of the Three-year Action Plans for Preschool Education. As we will show later, controlling for village fixed effects, survey year fixed effects, and student cohort fixed effects, the changes in village schools (more likely to be new buildings) are conditionally random.

After correcting for self-selection bias in whether students receive preschool education, our IV-2SLS results show that the newly increased availability of preschools from building new schools in impoverished rural areas have large effects on preschool enrollment. We also show suggestive evidence that preschool attendance improves students' cognitive skills in elementary school four years after initial enrollment. In contrast, unlike prior literature (Baker et al., 2019; Alvarado-Suárez and Acosta-González, 2022), we don't find any detectable impacts on non-cognitive skills. This might be from the fact that the curricula in most Chinese preschools target academic skills (Yang and Li, 2019) rather than "the whole child" (Jenkins et al., 2018).

Second, while the CFPS data do not allow us to further elucidate how preschool quality impacts children's outcomes, we answer this question by re-examining the China Development Research Foundation's "One-Village-One-Preschool" (OVOP) experiment (Chen et al., 2019; Zhao et al., 2020). The OVOP experiment, starting from 2009, aims to provide low-income children with free, high-quality early childhood education. The project has built more than 2300 preschools or kindergartens in impoverished rural areas in central and western China, where low-income students did not have access to preschools. OVOP represents possibly the highest-quality village preschool programs in China. While the previous part of analysis using the CFPS data shows positive results on the access to *average preschool programs*, the analysis of the OVOP experiment provides further evidence that program quality matters.

Specifically, we improve prior analyses of the OVOP experiment by (a) using a more robust evaluation method and (b) identifying the heterogeneous treatment effects on different groups of children. In doing so, this paper demonstrates that the OVOP program not only has a large, positive effect on students' academic achievement, but also among disadvantaged children, compared with other types of existing preschools (e.g., township public, township, private, county private). Our findings add new evidence to the existing literature that documents mixed conclusions on whether early childhood education program quality matters critically in developed countries (van Huizen and Plantenga, 2018; Oppermann et al., 2023; Schmitt et al., 2023) and developing countries (Morabito et al., 2018).

This paper is organized as follows. Section 2 surveys the relevant literature. Section 3 introduces the institutional context and discusses the rapid development of early childhood education opportunities in rural China. Section 4 presents the data, empirical strategy, and variables used in this study, and Section 5 presents the empirical results using these data. Section 6 discusses the OVOP experiment as a case study. Section 7 concludes with the policy implications.

2. Related Literature

Early childhood experiences—that is, experiences before the age of six—have lifelong effects on children's future cognitive and socioemotional development and even their physical and mental health (Currie and Almond, 2011). Researchers have identified considerable disparities in intelligence and performance in standardized tests in areas like mathematics and reading among five-year-old children from different family backgrounds (Bivens et al., 2016). In this respect, preschool education is advantageous insofar as it provides informational inputs, mobilizes feedback and reflection, improves school readiness in language and mathematics, fosters behavioral norms, and maps out learning resources. The availability of preschools also ensures the

[1] Throughout the paper, we use the terms "kindergarten" and "preschool" interchangeably to refer to early childhood education schools serving students between the ages of three and five (including preschool, pre-kindergarten, and kindergarten). This is because in the low-income regions of developing countries like China, early childhood education is often provided in the same school/building/classroom to a mix of children before age five. The early childhood education programs in China proceed with children's ages, with age 3 in preschool, age 4 in pre-K, and age 5 in K.

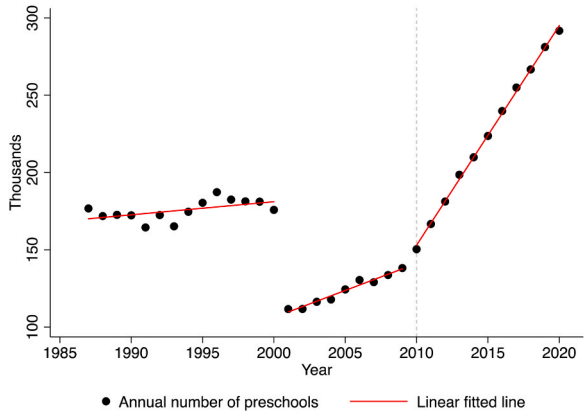

Fig. 1. Trends in the Annual Number of Preschools in China. *Note:* Data are drawn from the China Education Statistical Yearbook. Throughout the study, we use the terms "kindergarten" and "preschool" interchangeably to refer to early childhood education schools serving students between the ages of three and five (including preschool, pre-kindergarten, and kindergarten). The year 2000 marks the beginning of the Rural School Consolidation policy, while 2010 marks the beginning of the Three-year Action Plan.

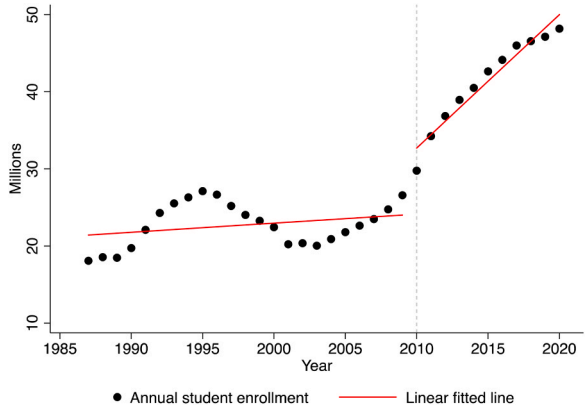

Fig. 2. Trends in the Annual Rate of Preschool Enrollment in China.

provision of balanced resources to children from families of different socioeconomic backgrounds, thereby contributing to poverty reduction and equity in early human capital investments.

The short-term effects of preschool on child development have been well examined in developed countries like the United States. Despite the wide variation of preschool programs, a growing number of studies have reached similar conclusions regarding the positive impact of preschool education on children's learning abilities, particularly in respect to language, literacy, and mathematics skills (Heckman, 2006). This effect is primarily observed in children's standardized test scores (Bivens et al., 2016), with demonstrated superiority by large state preschool programs, including those in Oklahoma, New Jersey, and North Carolina, as well as by Head Start, a U.S. federal preschool program for low-income children founded in 1965 (Hill et al., 2015; Ladd et al., 2014). However, follow-up surveys of children who attended preschool between 1960 and 1980 indicate that the impact of preschool on children's cognitive abilities diminishes over the long term (Lipsey et al., 2018), partly due to the continuity and relevance of later educational settings (Ansari et al., 2017). On the other side, studies also emphasize the sustained and even lifelong effects of preschool on non-cognitive skills such as social-emotional skills (Duncan and Murnane, 2011), with children with preschool education experience found to exhibit higher social skills and fewer behavioral problems over the long term (Schindler et al., 2015). As a result, preschool education serves to improve health conditions, reduce delinquency, and lower the rate of early teenage pregnancy (Weiland and Yoshikawa, 2013).

Studies on early childhood education in China have reached similar conclusions. For instance, based on data from a subsample of adolescents in the Chinese Family Panel Survey (CFPS) and using propensity score matching methods, Gong et al. (2016) found a robust and significant positive relationship between preschool education experience and children's social skills, although they did not identify any significant association with cognitive skills. Meanwhile, using propensity score matching and the China Education Panel Survey (CEPS) data, Duan et al. (2019) observed a contribution of a 1.14% increase, or about 0.1 standard deviation, in children's academic achievement in junior school. The researchers also identified heterogeneity in the effects of preschool education by geography, gender, and single child condition (Duan et al., 2019). Chen et al. (2019) and Zhao et al. (2020) evaluated the "One-Village-One-Preschool" (OVOP) experiment, also using propensity score matching methods. They concluded that OVOP participants significantly outperformed others in elementary school. However, as van Huizen and Plantenga (2018) noted, covariate-adjusted associations or propensity score matching estimates are highly susceptible to selection bias.[2]

3. The rapid expansion of early childhood education in Rural China

Since the China's reform and opening-up, preschool education has been one of the priorities of China's education policy. The Central People's Government promulgated guidelines to expand village preschool education in 1983, and a series of executive plans to develop kindergartens in 1997 and 2003. Consequently, the number of kindergartens and kindergarten classes steadily increased from 1987 to 2000. However, there was a relatively sharp decline in the number of kindergartens in 2000–2001, due to the decline in school-age children and the Rural School Consolidation policy, followed by flat growth from 2001 to 2009.[3] Figs. 1 and 2 illustrate these changes, with Fig. 1 showing the annual number of preschools in China and Fig. 2 showing the simultaneous changes in new enrollment and in-school population.

China's preschool education began developing rapidly in 2010, when the central government promulgated the "National Medium- and Long-Term Education Reform and Development Plan (2010–2020)," which identified the main goals of preschool education development. Later that year, the Chinese government announced a Three-Year Action Plan for Preschool Education that addressed early childhood education enrollment by expanding village preschools. This Three-Year Action Plan renewed twice after the first three years. More specifically, the second term of the Three-Year Action Plan prioritized expanding the overall number of village preschools, while the third term focused on increasing the supply of inclusive preschools, particularly in impoverished areas.

As Fig. 3 shows, the gross enrollment rate and in-school population for early education have expanded rapidly over the past decade. Since the implementation of the Three-Year Action Plan, inclusive preschool education resources have been tilted toward rural areas with concerted efforts to expand the availability of public kindergartens in rural areas. According to the Ministry of Education of China, between 2011 and 2014, significantly more kindergartens were established in rural areas compared with urban areas. Indeed, 86.55% of the 19,672 new

[2] "[E]stimations that do not account for endogenous selection into ECEC may produce completely opposite results, even when using the same sample (Dearing and Zachrisson, 2017; Herbst, 2013)," cited from van Huizen and Plantenga (2018, p. 207).

[3] The Rural School Consolidation policy was one of the most important K-12 education policies in rural China in the early 2000 s, which closed more than half of rural schools (Ding et al., 2016). However, evaluating its impact is beyond this paper's scope as we focus on the new policy changes in the 2010s.

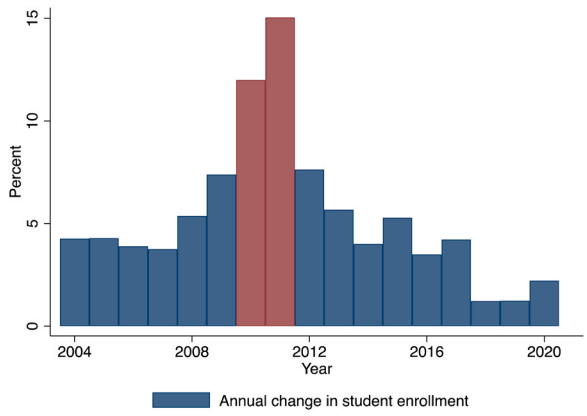

Fig. 3. Annual Change in Preschool Enrollment, 2004–2020. *Note:* In this figure, the year-to-year change in student enrollment is plotted based on the enrollment data in Fig. 2. The years 2010 and 2011, that is, the beginning of the Rural School Consolidation policy, saw the largest increases in preschool enrollment.

to the China's Ministry of Education, the gross enrollment rate of early childhood education reached 88.1% in 2021. For comparison, the gross enrollment rate was 10.6% in 1978, 36.5% in 2000, and 56.6% in 2010.[4] As shown in Fig. 4 and will be discussed later, using the nationally representative survey data, we can also see a steady increasing trend between 2010 and 2018 and an average preschool enrollment rate close to the national statistics. The current early childhood education (including preschools and kindergartens) enrollment rate in China is comparable to the average participation rate of 5-year-olds in the U.S. (91% in 2019 and 84% in 2020)[5] and children aged 3–5 in OECD countries (87% in 2021).[6]

4. Methodology

4.1. Data

The core question of this study is how preschool education affects children's longer-term human capital development, particularly among disadvantaged families in impoverished areas. We primarily use data from the CFPS, one of the most comprehensive and high-quality social

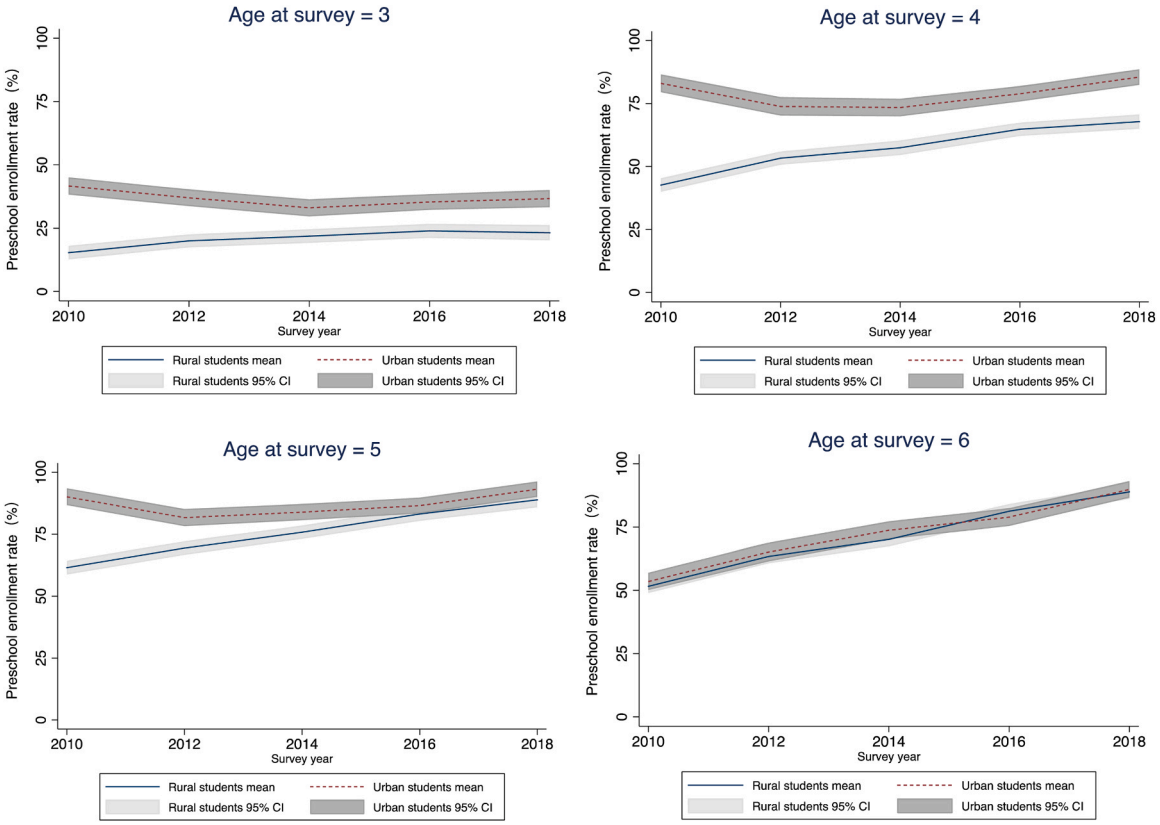

Fig. 4. Rural–Urban Gaps in Preschool Enrollment by Age and Year. *Note:* Data are drawn from the CFPS. Ages three to six correspond to pre-K 3, pre-K 4, preschool, and kindergarten.

government-run kindergartens were in villages and townships, while just 11.83% were distributed in urban areas.

The rapid development of early childhood education in China during the past decade has shaped its universal access to preschools. According

surveys in China. The CFPS data provide a nationally representative

[4] Source: http://www.gov.cn/xinwen/2022–03/01/content_5676225.htm (March 1, 2022 updated; May 10, 2022 accessed). The gross rate in 2000 was estimated, as there is no officially reported number, through dividing the total enrollment in 2000 (22.44 million) by the cohort size of birth cohorts in 1995–1997 (61.37 million).

[5] https://nces.ed.gov/programs/coe/indicator/cfa (June 15, 2022 accessed)

[6] https://www.oecd.org/els/soc/PF3_2_Enrolment_childcare_preschool.pdf (July, 2021 updated; June 15, 2022 accessed)

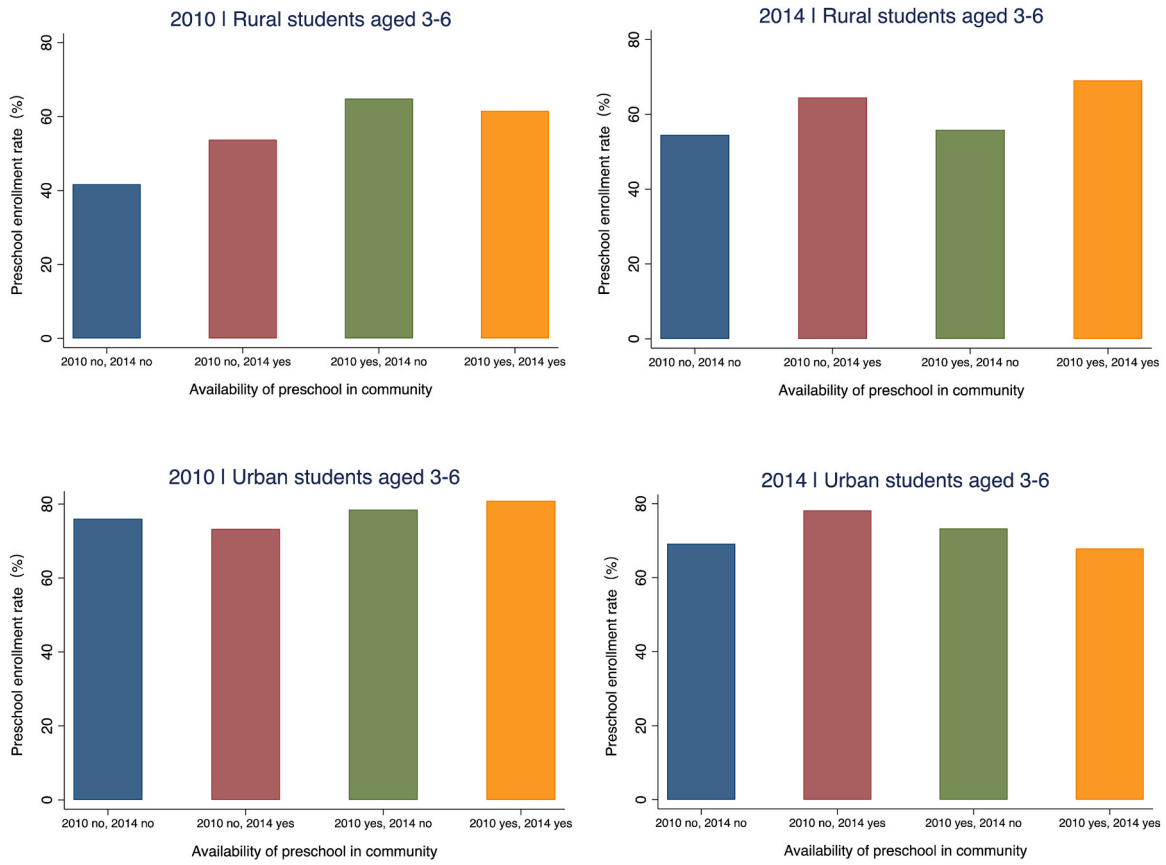

Fig. 5. Community-level Preschool Enrollment Rates by the Availability of Preschool, Urbanicity, and Year. *Note:* Data are drawn from the CFPS. We define the availability of preschools within a community based on the community questionnaire in the 2010 and 2014 surveys. Number of villages or communities in each group are 215 (2010 no, 2014 no), 73 (2010 no, 2014 yes), 51 (2010 yes, 2014 no), 255 (2010 yes, 2014 yes).

sample and tracked panel-data information at the individual, family, and community levels. This study utilizes all data currently available from the CFPS, including five follow-up surveys in 2010, 2012, 2014, 2016, and 2018. The primary sample comprised 16,014 children born between 1995 and 2018, who were matched with their preschool experiences, demographic figures, family characteristics, and community variables.[7] This sample frame enables us to compare children's preschool experiences and development outcomes before and after the rapid expansion of early childhood education in rural China in the past decade.

4.2. Empirical strategy

As the decision to attend preschools depends largely on the endogenous choices of families, simply comparing developmental differences between children in terms of whether they did or did not attend a preschool does not estimate the causal impact of preschool education. All the prior studies on preschool education in China have used propensity score matching by constructing a control group (i.e., not receiving preschool education) with similar observables to the treatment group (i.e., receiving preschool education). However, the propensity score matching approach relies on the strong identification assumption that the treatment and control groups are indifferent in unobservable characteristics, which may result in biased estimates. This bias may be larger when there is insufficient knowledge about the decision-making process behind whether to attend preschool. Particularly, it is likely that important and unobservable influential factors will be overlooked if we fail to understand why two children made different decisions despite sharing similar individual and family backgrounds.

In this paper, we use the instrumental variables (IV) method to identify the effects of the availability of a preschool in a village or neighborhood on a student's preschool enrollment and later developmental outcomes. More specifically, the validity of the IV method assumes that the presence of a kindergarten in the village or neighborhood is exogenous to the educational decisions of children and their families. We use a difference-in-differences model to identify the plausibly exogeneous changes in the availability of a preschool in the village, which are driven by the rapid expansion of preschool education in rural China. We will discuss the empirical details in the next section.

The IV method enables the identification of two parameters of policy interest. On the one hand, the intent-to-treat (ITT) effect estimates the effect of building a preschool in the community on the human capital investment and longer-term development of students (corresponding policy option: provide a kindergarten). On the other hand, the treatment-on-the-treated (TOT) effect estimates the effect of actual preschool attendance (corresponding policy option: encourage students to attend preschool) as a result the new availability of preschools in the community.[8] Because the IV method only identifies the TOT effect locally with compliers who change their schooling decisions based solely on the instrumental variable (i.e., the presence of preschool), i.e., local average treatment effect (LATE), the external validity of the TOT or

[7] The CFPS data do not differentiate different stages of early childhood education.

[8] The Three-Year Action Plan for Preschool Education focused on building new preschools rather than investing heavily in improving existing preschools' quality.

Table 1
Impact of Having Preschools in the Community on Students' Access to Preschool Education.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Outcome: Child attended preschool											
	Full sample					Rural student sample			Urban student sample			
Preschool in community	0.147 * **	0.093 * *	0.089 * *	0.106 * **	0.153 * **	0.110 * **	0.093 * *	0.131 * **	0.015	-0.001	0.016	-0.013
	(0.024)	(0.036)	(0.035)	(0.037)	(0.029)	(0.042)	(0.041)	(0.038)	(0.038)	(0.073)	(0.073)	(0.078)
Female		0.003	-0.000	0.000		-0.011	-0.018	-0.017		0.029	0.030	0.031
		(0.014)	(0.014)	(0.014)		(0.017)	(0.017)	(0.017)		(0.024)	(0.026)	(0.025)
vs. *age 3*												
Age 4		0.323 * **	0.312 * **	0.309 * **		0.286 * **	0.277 * **	0.275 * **		0.401 * **	0.388 * **	0.382 * **
		(0.023)	(0.024)	(0.024)		(0.029)	(0.030)	(0.030)		(0.037)	(0.037)	(0.037)
Age 5		0.514 * **	0.501 * **	0.501 * **		0.517 * **	0.507 * **	0.505 * **		0.516 * **	0.504 * **	0.501 * **
		(0.024)	(0.025)	(0.025)		(0.031)	(0.033)	(0.033)		(0.038)	(0.038)	(0.038)
Age 6		0.371 * **	0.362 * **	0.360 * **		0.411 * **	0.402 * **	0.403 * **		0.293 * **	0.280 * **	0.273 * **
		(0.027)	(0.028)	(0.028)		(0.033)	(0.034)	(0.034)		(0.049)	(0.049)	(0.049)
Survey year in 2014		0.070 * **	0.010	0.004		0.109 * **	0.058	0.092 *		-0.023	-0.086	-0.145 * *
		(0.018)	(0.033)	(0.038)		(0.022)	(0.044)	(0.048)		(0.032)	(0.053)	(0.071)
Minority			0.032	0.041			0.023	0.027			0.077	0.070
			(0.044)	(0.047)			(0.052)	(0.052)			(0.086)	(0.096)
Constant	0.479 * **	0.169 * **	0.140	-0.637	0.430 * **	0.095 * **	0.178	0.239	0.652 * **	0.356 * **	0.084	-1.985 * *
	(0.020)	(0.024)	(0.177)	(0.539)	(0.023)	(0.025)	(0.225)	(0.667)	(0.033)	(0.061)	(0.288)	(0.898)
Additional individual controls	No	No	Yes	Yes	No	No	Yes	Yes	Yes	No	Yes	Yes
Additional community controls	No	No	No	Yes	No	No	No	Yes	Yes	No	No	Yes
Observations	4250	4250	4250	4250	2683	2683	2683	2683	1567	1567	1567	1567
R-squared	0.022	0.400	0.411	0.416	0.022	0.397	0.410	0.418	0.000	0.396	0.412	0.429

Note: Additional individual controls are listed in Table A2 in the Appendix. Additional community controls include total population, ages 0–15 population, new born population, per capita income, fiscal income, fiscal expenditure, as well as community-level aggregated values of students' fetal age, birth weight, and bread-feasting duration that might correlate with community-year changes in local context. Standard errors were clustered at the county level. * ** $p < 0.01$, * * $p < 0.05$, * $p < 0.1$.

LATE effects must be interpreted cautiously. However, as we will show in the next section, building a new preschool in the village increases rural students' preschool attendance by more than 20%, which is a non-trivial share of children affected by the instrumental variable and the corresponding policy changes.

4.3. Variables

4.3.1. Outcomes: Cognitive skills

The CFPS employed the following two parent-rated indicators assessing student cognitive ability: first, how well the child typically performed in language in the previous semester; second, how well the child typically performed in mathematics in the previous semester. Given the continuity of the CFPS survey and the age distribution of the data sample, this study focuses on tracking the Chinese language and mathematics achievements of children aged three to six years between 2010 and 2014 four years after their preschool enrollment. Parents evaluated their child's performance in language and mathematics by selecting from the options of "excellent," "good," "fair," or "poor." Table A1 in the Appendix presents the summary statistics.

4.3.2. Outcomes: Non-cognitive skills

The CFPS surveys used two sources to measure students' cognitive and non-cognitive indicators, namely, students' own responses and parental evaluations. Because our sample included children with ages lower than being eligible for student survey, we use parental evaluations to measure their non-cognitive skill development. The CFPS used multiple well-designed parent-rated indicators to assess a student's non-cognitive abilities. Table A3 presents summary statistics for the non-cognitive measures.

4.3.3. Control variables

We take advantage of the richness of the CFPS data to control for a large set of student and family covariates, as well as village and year fixed effects. More specifically, the control variables at the individual student level comprise the following: gender, age, gestational age, weight at birth, breastfeeding duration, weight, height, number of hospital visits last year, parents' concern for their child's education, total child education expenditures in the last year, average time spent per week on parenting classes/tutoring classes/tutoring, father's age, father's highest education, father's political outlook, whether the father held an administrative position, mother's age, mother's highest education, mother's political outlook, whether the mother held an administrative position. Table 2 A in the Appendix presents the results of the descriptive statistics of the control variables.[9]

5. Results

5.1. The availability of kindergartens in villages and preschool enrollment

Logically, the presence of a kindergarten in the community will increase the probability of a child attending kindergarten. However, this increase is not 100% due to the existence of non-compliance. On the one hand, children may choose not to enroll in kindergarten despite one being available due to various reasons, such as family poverty. On the other hand, children who do not have a kindergarten in their community may consider going to school elsewhere. Overall, the availability of a kindergarten in the community reduces the cost of attendance and can result in more children enrolling in kindergarten. This is confirmed by

[9] It should be noted that, to further control for the factors of the students' non-cognitive and cognitive abilities after four years, this study selected the control variables of weight, height, number of hospital visits, education expenditure, and time spent on parenting, tutoring, homeschooling in 2010/2014 or after four years depending on the dependent variable in each analysis.

Table 2
Heterogeneous Impacts of Having Preschools in the Community on Students' Access to Preschool Education.

	(1) Poverty-Level Bottom Group 1	(2)	(3) Poverty-Level Bottom Groups 1–2	(4)	(5) Poverty-Level Bottom Groups 1–3	(6)	(7) Poverty-Level Top Groups 1–2	(8)
Preschool in community	0.179 * *	0.151 *	0.172 * **	0.168 * *	0.161 * **	0.152 * **	0.063	0.037
	(0.083)	(0.083)	(0.064)	(0.065)	(0.054)	(0.055)	(0.065)	(0.056)
Female	0.028	0.008	-0.002	-0.007	-0.020	-0.028	0.007	0.002
	(0.040)	(0.039)	(0.027)	(0.027)	(0.023)	(0.023)	(0.023)	(0.023)
vs. *age 3*								
Age 4	0.204 * **	0.202 * **	0.205 * **	0.180 * **	0.258 * **	0.250 * **	0.324 * **	0.310 * **
	(0.062)	(0.069)	(0.043)	(0.046)	(0.040)	(0.042)	(0.042)	(0.044)
Age 5	0.442 * **	0.434 * **	0.471 * **	0.436 * **	0.503 * **	0.490 * **	0.540 * **	0.524 * **
	(0.069)	(0.072)	(0.049)	(0.052)	(0.041)	(0.043)	(0.047)	(0.050)
Age 6	0.388 * **	0.371 * **	0.405 * **	0.373 * **	0.465 * **	0.455 * **	0.330 * **	0.318 * **
	(0.061)	(0.067)	(0.048)	(0.048)	(0.041)	(0.043)	(0.054)	(0.055)
Survey year in 2014	0.135 * *	-0.126	0.129 * **	-0.065	0.121 * **	0.025	0.088 * *	0.058
	(0.053)	(0.096)	(0.036)	(0.065)	(0.028)	(0.056)	(0.035)	(0.075)
		0.102		-0.018		0.014		0.088
		(0.085)		(0.070)		(0.066)		(0.085)
Constant	0.011	-0.087	0.011	0.254	0.023	0.095	0.197 * **	0.194
	(0.047)	(0.471)	(0.036)	(0.320)	(0.033)	(0.276)	(0.038)	(0.369)
Additional covariates	No	Yes	No	Yes	No	Yes	No	Yes
Observations	588	588	1128	1128	1611	1611	1072	1072
R-squared	0.374	0.436	0.382	0.415	0.411	0.428	0.365	0.389

Note: Additional covariates are listed in Table A2 in the Appendix. The groups of poor villages and dwellings are classified according to per capita annual net income in the 2010 village questionnaire: Group 1, CNY 0–1000; Group 2, CNY 1001–2000; Group 3, CNY 2001–3000; Group 4, CNY 3000–5000; and Group 5, CNY 5001 or more. Among them, Groups 1 and 2 are potential targets of poverty alleviation and indicative of poor villages, while Group 3 and part of Group 4 are indicative of potentially poor villages.

the results presented in Fig. 4.

As Fig. 4 shows, the urban-rural difference appears among children aged four (pre-k 4). Although this gap was over 30% in 2010, it had narrowed to about 15% by 2018. In contrast, there is almost no difference between urban and rural areas among six-year-olds because there is no significant difference between urban and rural areas in terms of the prevalence of kindergartens attached to elementary schools. Moreover, results indicate that the development of early childhood education over the past decade is likely to expand learning opportunities for five-year-old children in rural areas (preschools).

To formally test the validity of the instrumental variable strategy, we first examined the urban-rural and rich-poor differences in preschool availability—that is, why some communities build new preschools and others close them—to verify the independence assumption. We then examined how this change affects students' preschool education to test the relevance assumption.

To date, CFPS data comprise two rounds of village questionnaires in 2010 and 2014, in which each sample village or urban neighborhood was surveyed in respect to the presence of a preschool/kindergarten. Data from the two survey rounds were matched to obtain a sample of 594 communities, including 309 rural villages and 285 urban neighborhoods. A comparison of the two rounds of data revealed four categories: (1) no preschool/kindergarten in either 2010 or 2014; (2) no preschool in 2010, but a kindergarten in 2014; (3) a preschool in 2010, but not in 2014; and (4) preschool present in both 2010 and 2014. Accordingly, we compared the differences in access to preschool education in each of the four categories.

Fig. 5 presents the results of this comparative analysis for rural students between the ages of three and six in 2010 and 2014. Results show that the percentage of students receiving preschool education from village communities without a preschool in 2010 was significantly lower than those from communities with a preschool. Likewise, Fig. 5 shows that in 2014, the percentage of students receiving preschool education from communities with preschools was significantly higher than those from communities without preschools. Similar trends were observed among urban students, although the differences were relatively smaller. In other words, the presence or absence of a preschool in the neighborhood community in which urban students reside appears to have a smaller effect on whether students receive preschool education.

Results show that the availability of a kindergarten in a child's village of residence influences their preschool enrollment status, thus satisfying the relevance assumption of the IV method. Table 1 presents the ordinary least squares (OLS) regression results that control for a set of additional covariates. Results reveal a strong, statistically significant correlation between the existence of a village kindergarten and preschool enrollment among rural students. The results are also robust to the inclusion of additional covariates. However, results do not indicate a similar pattern among urban students, who are likely able to find other options if there is no preschool in their neighborhood.

The exogeneity assumption of the IV method requires that changes in kindergarten availability in the village are unrelated to unobservable factors influencing an individual's decision to attend preschool. Regarding village-level changes, one possibility is that the establishment or closure of preschools is related to the socioeconomic development or family demand for early childhood education in the village. This raises the question of whether there are different trends for different villages during the period of the Three-year Action Plan in respect to preschool education.

The results of OLS regressions are reported in Table A4 of the Appendix. Column (1) shows that the status in 2010 and 2014 are highly correlated, albeit not 100%, with the previous results, indicating that there are communities with different status of the existence of preschools between 2010 and 2014. Column (2) controls for community fixed effects, that is, inter-community differences that do not vary over time, producing the same results. The regression results in Column (3) only uses the rural sample, demonstrating that this correlation does not differ between urban and rural communities.

Columns (4) and (5) examine whether there are differential trends between poor rural communities and non-poor rural communities. All rural communities were divided into five groups according to the annual net income per capita of the village community in accordance with the 2012 definition of the poverty line, namely, CNY 2300 annually. Results indicate no correlation between community poverty level and changes in the availability of kindergartens. Communities with larger populations tend to have more kindergartens, which is consistent with this finding. In Table A5, the testing of a range of community-level variables similarly revealed no characteristics that were systematically associated with kindergarten variation. Therefore, when controlling for the

Table 3
Effect of Preschool Education on Cognitive Outcomes.

Panel A. Without controlling for community-level covariates				
	(1)	(2)	(3)	(4)
Rural/Urban sample	Full sample	Full sample	Rural sample	Rural sample
Poverty-Level sample		Poverty-Level Bottom Groups 1–3		Poverty-Level Bottom Groups 1–3
First stage: Effect of preschool in community/village				
Preschool attendance when 3–6 years old	0.117 * **	0.223 * **	0.146 * **	0.221 * **
	(0.040)	(0.055)	(0.048)	(0.061)
F-stat	8.447	16.66	9.141	13.16
Second stage (1): Effect (of 4 years after) of preschool attendance				
Math (=Excellent, Good, Fair)	0.148	0.294 *	0.143	0.288
	(0.200)	(0.160)	(0.232)	(0.186)
Chinese (=Excellent, Good, Fair)	0.152	0.071	0.219	0.295
	(0.244)	(0.245)	(0.271)	(0.275)
Second stage (2): Effect (of 4 years after) of preschool attendance				
Math (=Excellent, Good)	0.936 * *	0.606 *	0.960 *	0.717 *
	(0.470)	(0.318)	(0.505)	(0.389)
Chinese (=Excellent, Good)	0.899 *	0.447	1.003 *	0.619 *
	(0.471)	(0.313)	(0.511)	(0.366)
Observations	3064	1241	2006	1194
Panel B. Controlling for community-level covariates				
	(1)	(2)	(3)	(4)
Rural/Urban sample	Full sample	Full sample	Rural sample	Rural sample
Poverty-Level sample		Poverty-Level Bottom Groups 1–3		Poverty-Level Bottom Groups 1–3
First stage: Effect of preschool in community/village				
Preschool attendance when 3–6 years old	0.142 * **	0.264 * **	0.194 * **	0.209 * **
	(0.041)	(0.052)	(0.047)	(0.055)
F-stat	11.78	25.58	16.86	14.43
Second stage (1): Effect (of 4 years after) of preschool attendance				
Math (=Excellent, Good, Fair)	0.172	0.282 * *	0.128	0.292
	(0.172)	(0.123)	(0.174)	(0.181)
Chinese (=Excellent, Good, Fair)	0.219	0.029	0.139	0.163
	(0.211)	(0.205)	(0.214)	(0.269)
Second stage (2): Effect (of 4 years after) of preschool attendance				
Math (=Excellent, Good)	0.773 * *	0.538 *	0.674 *	0.652
	(0.378)	(0.274)	(0.358)	(0.407)
Chinese (=Excellent, Good)	0.815 * *	0.418	0.731 * *	0.585
	(0.385)	(0.275)	(0.363)	(0.390)
Observations	3064	1241	2006	1194

Note: Each cell in the second stage is produced by a separate 2SLS regression using the first-stage regression in the corresponding column. All the regressions include the full set of individual covariates, and Panel B controls for additional community-level covariates. Math and Chinese are measured in four levels: Excellent, Good, Fair, and Poor. The sample distribution is 8%, 24%, 29%, and 39%. We code dummy indicators in two different ways: Excellent or Good = 1, Excellent or Good or Fair = 1. Results should be interpreted with caution when there are weak first stages.

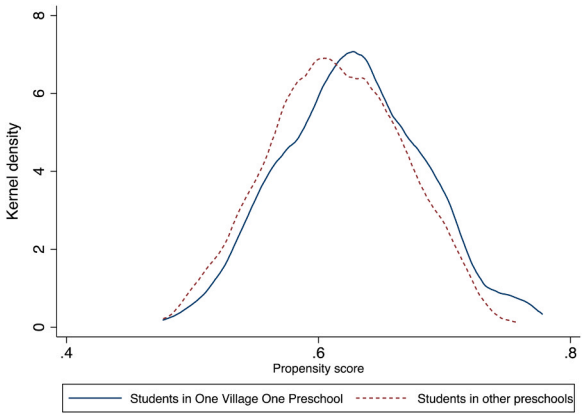

Fig. 6. Distribution of the Predicted One-Village-One-Preschool (OVOP) Enrollment Probability Between Two Groups. *Note:* This figure uses OVOP administrative data. The Predicted OVOP Enrollment Probability is estimated using a logit model with all the covariates listed in Table A7 in the Appendix.

observable characteristics of the community, the presence or absence of kindergartens is fairly random. Accordingly, preschool existence variation may be more likely to occur because of exogenous policy factors (e.g., local policy implementation or school district reform) or market factors (e.g., the hosting or closing of private kindergartens). These factors primarily influence households' preschool decisions by affecting the availability of preschools (i.e., the exogenous nature of the instrumental variable).

5.2. First-stage results of the instrumental variables approach: impact of preschool availability on preschool education access

We used the conditional quasi-random availability of preschools—including preschools, pre-kindergartens, and kindergartens—at the village level as an instrumental variable in ascertaining whether a child received early childhood education between the ages of three and six. For the first-stage analysis, we estimated the following DID model:

$$Z_{ijt} = \beta \quad K_{jt} + \gamma \quad X_{ijt} + \theta_j + \lambda_t + \varepsilon_{ijt},$$

in which Z_{ijt} is the outcome variable (e.g., preschool attendance), K_{jt} indicates the availability of preschool in village j in year t, X_{ijt} includes individual characteristics (and community-level time-varying covariates in some specifications), θ_j is the village (community) fixed effect, and λ_t is year fixed effect. Standard errors were clustered at the county level.

Table 1 presents the regression results. For each sample, additional covariates were added in a stepwise manner. Columns (3), (6), and (9) control for a range of characteristic variables of students and their families. Results show that the presence of a preschool in the community increased the probability of rural students attending preschool by 9 percentage points. Accordingly, as approximately 43% of rural students in communities without preschools attend preschool on average, building a new preschool in a community would increase the number of students attending preschool by more than 20%. Results showed no statistically significant impacts on urban children because urban children have more external options for early childhood education.

We further examined the poverty gaps within the rural student sample. Table 2 shows that preschools only significantly increase the probability of students attending preschool in low-income rural communities. As such, this policy effect is very large, with more than 17 percentage points—that is, a 40% increase compared to the rural sample mean of 43%—in the bottom two quintiles of villages based on their average incomes (Column 4). In a similar universal preschool setting in Oklahoma and Georgia in the U.S., Monnet (2019) find that the availability of preschools increases the probability of preschool participation

Table 4
Effect of Attending One-Village-One-Preschool (OVOP) on Test Scores.

	(1) First grade	(2)	(3) Third grade	(4)	(5)	(6) Fifth grade	(7)	(8)
Attended OVOP	0.045	0.061	0.118 *	0.123 *	0.122 *	0.452 * **	0.446 * **	0.445 * **
	(0.063)	(0.067)	(0.068)	(0.068)	(0.068)	(0.066)	(0.066)	(0.066)
First-grade score					0.013			0.019
					(0.029)			(0.030)
Constant	-0.103	-0.278	-0.094 * *	-0.299	-0.296	-0.252 * **	-0.038	-0.033
	(0.194)	(0.189)	(0.044)	(0.193)	(0.193)	(0.041)	(0.190)	(0.191)
Exact matching group fixed effects	No	Yes	No	Yes	Yes	No	Yes	Yes
Observations	1314	1314	1314	1314	1314	1314	1314	1314
R-squared	0.008	0.128	0.147	0.148	0.149	0.163	0.164	0.165

Note: Each column is produced by a separate OLS regression. All the regressions include the full set of covariates as listed in Table A7 in the Appendix.

Table 5
Heterogeneous Effects of Attending OVOP on Test Scores.

	(1) First grade	(2) Third grade	(3) Fifth grade	(4) First grade	(5) Third grade	(6) Fifth grade
	Disadvantaged children (Poor, orphaned, left behind)			Non-disadvantaged children		
Attended OVOP	-0.050	0.111	0.399 * **	0.165 *	0.128	0.484 * **
	(0.098)	(0.099)	(0.097)	(0.091)	(0.094)	(0.091)
First-grade scores		-0.017	-0.001		0.034	0.031
		(0.045)	(0.047)		(0.037)	(0.039)
Observations	652	652	652	662	662	662
	Children in poverty			Children not in poverty		
Attended OVOP	-0.223	0.261	0.405 *	0.099	0.090	0.455 * **
	(0.194)	(0.202)	(0.211)	(0.071)	(0.072)	(0.070)
First-grade scores		-0.342 * **	0.126		0.050 *	0.006
		(0.099)	(0.096)		(0.030)	(0.031)
Observations	193	193	193	1121	1121	1121
	Orphans			Non-orphans		
Attended OVOP	-0.054	0.010	0.463 * *	0.073	0.136 *	0.445 * **
	(0.234)	(0.223)	(0.189)	(0.070)	(0.072)	(0.070)
First-grade scores		0.031	-0.059		0.011	0.027
		(0.088)	(0.095)		(0.030)	(0.032)
Observations	163	163	163	1151	1151	1151
	Left-behind children			Non-left-behind children		
Attended OVOP	-0.007	0.106	0.418 * **	0.093	0.133	0.457 * **
	(0.120)	(0.118)	(0.115)	(0.081)	(0.084)	(0.081)
First-grade scores		0.068	-0.002		-0.008	0.027
		(0.054)	(0.058)		(0.034)	(0.035)
Observations	419	419	419	895	895	895
	Girls			Boys		
Attended OVOP	0.199 * *	0.179 *	0.325 * **	-0.044	0.068	0.541 * **
	(0.100)	(0.107)	(0.099)	(0.090)	(0.089)	(0.088)
First-grade scores		0.077 *	0.018		-0.043	0.024
		(0.043)	(0.044)		(0.039)	(0.041)
Observations	606	606	606	708	708	708

Note: Each column of each panel is produced by a separate OLS regression. All the regressions include the full set of covariates as listed in Table A7 in the Appendix.

for children from low-education households by 19.4 percentage points.

Table 3 reports the first-stage results using the child outcome samples and the corresponding F statistics of the relevance tests. Consistent with previous results, across samples, the availability of preschools in the neighborhood predicts increased preschool attendance. Current practice in Instrumental Variable models relies on the first-stage F-statistic exceeding a threshold, which is often 10 as a rule of thumb, as a criterion for compelling t-ratio inferences. Our results in columns (1) and (3) using full sample do not meet this criterion so that the results should be interpreted with caution.

5.3. Second-stage results of the instrumental variables approach: long-term effects of preschool on students

The second stage of the two-stage least squares (2SLS) analysis identified the effect of preschool education on students' cognitive and non-cognitive abilities using the presence or absence of a kindergarten in the village residence as an instrumental variable to predict kindergarten attendance. We estimated the following second-stage equation:

$$Y_{ijt} = \alpha + \beta \quad \widehat{Z_{ijt}} + \gamma \quad X_{ijt} + \theta_j + \lambda_t + \varepsilon_{ijt},$$

where Y_{ijt} is the outcome variable characterizing the student's cognitive and non-cognitive abilities, $\widehat{Z_{ijt}}$ is the first-stage predicted value of kindergarten attendance, X_{ijt} includes individual characteristics (and community-level time-varying covariates in some specifications), θ_j is the village (community) fixed effect, and λ_t is year fixed effect. Standard errors are clustered at the county level.

Table 3 reports the regression results on cognitive skills measured four years after initial enrollment in preschool. We measure outcomes using dummy indicators whether students were reported to be excellent, good, or fair in math and Chinese. Across different sample definitions and between mathematics and Chinese reading performance, results show that preschool attendance had a large impact on students' longer-term cognitive skill development. For example, in column 4 of panel A,

Table A1
Descriptive Statistics of Outcome Variables.

Variables	Non-missing observations	Mean	S.D.	Min	Max
Parents' evaluation of their child's non-cognitive abilities (2010 survey; mainly parents' observations of three-year-old children)					
Optimistic by nature	1638	4.038	0.64	1	5
Will wait for their turn in games or other activities	1619	3.397	1.008	1	5
Cautious and well-organized	1620	3.507	0.953	1	5
Curious and exploratory; enjoys new experiences	1614	3.897	0.739	1	5
Will think before doing something; not impulsive	1611	3.227	1.04	1	5
Gets along well with peers	1641	3.812	0.769	1	5
Tolerates peers' mistakes in games or other activities	1614	3.278	1.005	1	5
Enjoys helping others in games or other activities	1615	3.711	0.794	1	5
Usually follows parents' instructions	1635	3.698	0.828	1	5
Can easily overcome irritability	1626	3.106	1.039	1	5
Popular with peers	1635	3.917	0.626	1	5
Tries to be independent	1632	3.545	0.944	1	5
Parents' evaluation of their children's non-cognitive abilities (2014 survey)					
Studies very hard	3439	3.056	1.19	1	5
Concentrates on tasks	3532	3.061	1.145	1	5
Will check their schoolwork several times before finishing it	3435	3.053	1.16	1	5
Disciplined	3531	3.063	1.226	1	5
Like placing things in order	3532	3.031	1.172	1	5
Only plays after completing schoolwork	3437	3.07	1.204	1	5
Finishes something once they have started it	3529	2.98	1.149	1	5
Parents' evaluation of their child's cognitive ability (2014 survey)					
Evaluation of performance in Chinese in the previous term	3122	2.914	0.976	1	4
Evaluation of their performance in Mathematics in the last term	3122	2.987	0.975	1	4

Note: Data are drawn from the CFPS.

Table A2
Descriptive Statistics of Control Variables.

Variables	Non-missing observations	Mean	S.D.	Min	Max
Gestational age (months)	3859	9.342	0.6	5	12
Weight at birth (pounds)	2255	6.397	1.144	2	14
Breastfeeding time (months)	2717	11.578	7.656	0	60
Father's age	3940	33.21	5.588	19	72
Father's schooling years	3924	8.313	3.874	0	21
Mother's age	3917	31.192	5.334	19	58
Mother's schooling years	3907	7.472	4.224	0	19
Net income per capita (RMB in 2010)	3937	8386.263	18186.51	0.833	814600
	Non-missing observations	Value	Frequency	Relative Frequency	
		0	3949	92.92	
		1	301	7.08	
Age (at survey)	4250	3	1066	25.08	
		4	1004	23.62	
		5	1096	25.79	
		6	1084	25.51	
Gender (Female = 1)	4250	0	2285	53.76	
		1	1965	46.24	
Parents care about their children's education (agree and/or strongly agree = 1), 2010	4213	0	2086	49.51	
		1	2127	50.49	
Parents care about their children's education (agree and/or strongly agree = 1), 2014	3277	0	2108	64.33	
		1	1169	35.67	
Father's political status (CCP member = 1)	3681	0	3450	93.72	
		1	231	6.28	
Father holds an administrative position (yes = 1)	2731	0	2517	92.16	
		1	214	7.84	
Mother's political status (CCP member = 1)	3677	0	3621	98.48	
		1	56	1.52	
Mother holds an administrative position (yes = 1)	2189	0	2091	95.52	
		1	98	4.48	

for the most disadvantaged children (leaving in the bottom poverty groups rural areas), preschool attendance decreases their probability of being labeled as "poor" in math and Chinese by 71.7 percentage points and 61.9 percentage points, respectively. However, limited by the small sample size, the estimates are under-powered to exceed the conventional statistical significance (e.g., 5%).[10] Moreover, results in columns (1) and (3) using full sample should be interpreted with caution due to weak first stage results. Panel B controls for additional community-level time-varying covariates. The first stage becomes stronger and the estimated causal impacts of preschool attendance remain qualitatively unchanged.

We also tested a set of non-cognitive measures collected by the CFPS surveys, finding neither economically nor statistically significant impacts (Appendix Table A6). We find some evidence that students who attended preschool tended to study hard four years later; this impact did not emerge two years after preschool attendance. These results suggest that, although new preschools in villages provide new learning opportunities for children, these village preschools focus more on subject learning ("primary schooling in preschools") that results in less desirable non-cognitive development outcomes.

[10] According to the recent developments in the statistical inferences of IV models (Lee et al., 2022), when the first stage F value exceeds 16.74 (as in column 2 of Table 3), the corresponding critical value for the coefficient t-test would be 2.758 rather than 1.96.

6. Case study: High-quality village preschools for low-income students

Results presented in the previous sections using CFPS data show the importance of access to preschool education on the human capital development of children in impoverished rural areas. The development of preschool education is of great significance in terms of poverty alleviation and regional development in rural China. After resolving the "availability" issue, the more important policy question pertains to what kind of preschool education should be provided. This section uses the OVOP project promoted by the China Development Research Foundation over the past decade as a case study to explore the heterogeneity of preschool education quality in China.

Initiated by the China Development Research Foundation in 2009, the OVOP experiment aims to provide free, high-quality preschool education in impoverished rural areas in central and western China. To date, the project has established 2300 preschools/kindergartens in 23 counties of 10 provinces (Zhao et al., 2020). Chen et al. (2019) and Zhao

Table A3
Descriptive Statistics of Cognitive and Non-Cognitive Measures.

Variables	Non-missing observations	Value	Frequency	Relative Frequency
Parents' evaluation of their child's non-cognitive abilities (from 2010 and 2014 surveys; mainly parents' observations of three year-old children)				
Optimistic by nature	1638	1	9	0.55
		2	75	4.58
		3	26	1.59
		4	1262	77.05
		5	266	16.24
Will wait for their turn in games or other activities	1619	1	21	1.3
		2	469	28.97
		3	73	4.51
		4	959	59.23
		5	97	5.99
Cautious and well-organized	1620	1	11	0.68
		2	390	24.07
		3	95	5.86
		4	1015	62.65
		5	109	6.73
Curious and exploratory; enjoys new experiences	1614	1	6	0.37
		2	148	9.17
		3	53	3.28
		4	1207	74.78
		5	200	12.39
Will think before doing something; not impulsive	1611	1	23	1.43
		2	580	36
		3	97	6.02
		4	830	51.52
		5	81	5.03
Gets along well with peers	1641	1	9	0.55
		2	190	11.58
		3	45	2.74
		4	1254	76.42
		5	143	8.71
Tolerates peers' mistakes in games or other activities	1614	1	23	1.43
		2	526	32.59
		3	101	6.26
		4	907	56.2
		5	57	3.53
Enjoys helping others in games or other activities	1615	1	11	0.68
		2	218	13.5
		3	89	5.51
		4	1205	74.61
		5	92	5.7
Usually follows parents' instructions	1635	1	12	0.73
		2	250	15.29
		3	59	3.61
		4	1212	74.13
		5	102	6.24
Can easily overcome irritability	1626	1	26	1.6
		2	667	41.02
		3	96	5.9
		4	782	48.09
		5	55	3.38
Popular with peers	1635	1	6	0.37
		2	100	6.12
		3	57	3.49
		4	1332	81.47
		5	140	8.56
Tries to be independent	1632	1	15	0.92
		2	369	22.61
		3	71	4.35
		4	1066	65.32
		5	111	6.8
Parents' evaluation of their children's non-cognitive abilities (from 2014 and 2018 surveys, almost 4 years after)				
Studies very hard	3439	1	35	1.02
		2	695	20.21
		3	134	3.9
		4	2085	60.63
		5	490	14.25
Concentrates on tasks	3532	1	65	1.84
		2	1015	28.74
		3	98	2.77
		4	2017	57.11
		5	337	9.54
Will check their schoolwork several times before finishing it	3435	1	128	3.73
		2	1181	34.38
		3	85	2.47
		4	1742	50.71
		5	299	8.7
Disciplined	3531	1	31	0.88
		2	337	9.54
		3	44	1.25
		4	2540	71.93
		5	579	16.4
Like placing things in order	3532	1	120	3.4
		2	1193	33.78
		3	64	1.81
		4	1812	51.3
		5	343	9.71
Only plays after completing schoolwork	3437	1	55	1.6
		2	568	16.53
		3	56	1.63
		4	2273	66.13
		5	485	14.11
Finishes something once they have started it	3529	1	50	1.42
		2	782	22.16
		3	127	3.6
		4	2202	62.4
		5	368	10.43
Parents' evaluation of their child's cognitive ability (2014 and 2018 surveys, almost 4 years after)				
Evaluation of performance in Mathematics in the previous term	3122	1	247	7.91
		2	763	24.44
		3	895	28.67
		4	1217	38.98
Evaluation of performance in Chinese in the previous term	3122	1	262	8.39
		2	846	27.1
		3	914	29.28
		4	1100	35.23
Parents' evaluation of their children's non-cognitive abilities (from 2012 and 2016 surveys, almost 2 years after)				
Studies very hard	3155	1	28	0.89
		2	588	18.64
		3	105	3.33
		4	2088	66.18
		5	346	10.97
Concentrates on tasks	3665	1	61	1.66
		2	1033	28.19
		3	107	2.92
		4	2212	60.35
		5	252	6.88
Will check their schoolwork several times before finishing it	3140	1	85	2.71
		2	1104	35.16
		3	78	2.48
		4	1674	53.31
		5	199	6.34
Disciplined	3659	1	25	0.68
		2	421	11.51
		3	63	1.72
		4	2771	75.73
		5	379	10.36
Like placing things in order	3662	1	142	3.88
		2	1213	33.12
		3	81	2.21
		4	1969	53.77
		5	257	7.02
Only plays after completing schoolwork	3157	1	53	1.68
		2	577	18.28
		3	75	2.38
		4	2150	68.1
		5	302	9.57
Finishes something once they have started it	3651	1	55	1.51
		2	872	23.88
		3	150	4.11
		4	2301	63.02
		5	273	7.48

Table A4
Poverty Level of Villages and Changes in Preschool Availability.

	(1)	(2)	(3)	(4)	(5)
	Outcome variable: Villages with preschools in 2014 = 1				
Villages with kindergartens in 2010 = 1	0.580 * **	0.568 * **	0.527 * **	0.440 * **	0.441 * **
	(0.035)	(0.038)	(0.062)	(0.068)	(0.133)
Compared with Village Group 1 (Poorest group)					
Poor Group 2				-0.043	-0.039
				(0.066)	(0.080)
Poor Group 3				-0.076	-0.061
				(0.065)	(0.083)
Poor Group 4				-0.106	-0.116
				(0.066)	(0.083)
Poor Group 5				-0.012	-0.037
				(0.083)	(0.122)
Interaction item					
Had kindergartens in 2010 * Group 2					-0.022
					(0.187)
Had kindergartens in 2010 * Group 3					-0.045
					(0.158)
Had kindergartens in 2010 * Group 4					0.022
					(0.175)
Had kindergartens in 2010 * Group 5					0.062
					(0.221)
Logarithm of village population in 2010				0.205 * **	0.205 * **
				(0.038)	(0.039)
Constant	0.253 * **	0.260 * **	0.218 * **	-1.203 * **	-1.201 * **
	(0.027)	(0.025)	(0.028)	(0.269)	(0.274)
Fixed effects of village	No	Yes	Yes	Yes	Yes
Observations	594	594	287	287	287
R-squared	0.340	0.386	0.407	0.458	0.459

Note: The groups of poor villages and dwellings are classified according to per capita annual net income in the 2010 village questionnaire: Group 1, CNY 0–1000; Group 2, CNY 1001–2000; Group 3, CNY 2001–3000; Group 4, CNY 3000–5000; and Group 5, CNY 5001 or more. Among them, Groups 1 and 2 are potential targets of poverty alleviation and indicative of poor villages, while Group 3 and part of Group 4 are indicative of potentially poor villages.

et al. (2020) compared discrepancies in cognitive skill development among students with different preschool experiences using first-, third-, and fifth-grade test score data from 1962 students in 70 elementary schools in Ledu District, Qinghai Province. Using propensity score weighting to reduce selective bias in preschool education, these two studies found that, at the elementary school level, children from the OVOP program performed better than children who had no preschool education or had attended other kindergarten types (e.g., township public kindergarten, township private kindergarten, county private kindergarten). Although the children who benefited from the OVOP program did not outperform those in the better-resourced county public kindergartens, their academic performance improved more quickly.

We reexamined the same dataset provided by the China Development Foundation research group. Building on Chen et al. (2019), we answer two new questions: (1) What is the impact of OVOP on students compared with its closest competitor, namely, other types of preschools? (2) What is the heterogeneity of the effects of OVOP, especially on relatively poor and disadvantaged children? Although the first question was addressed in Chen et al. (2019) and Zhao et al. (2020), we improve upon these studies by further controlling for strata fixed effects (exact matching) as well as baseline achievement in a value-added framework.

As Chen et al. (2019) note, the central challenge in estimating the impact of OVOP is to address the selection bias. Different households may choose different types of preschools for unobservable reasons. Accordingly, we do not consider the two other groups of students—namely, those who attended county public preschools, the highest-quality schools in rural areas, and those who did not attend preschool—because they are essentially different from those who choose OVOP in villages. In other words, the availability of a village preschool in a rural area does not affect the choice of students who attend a county public preschool. A very large percentage of children who do not attend kindergarten come from families with unemployed parents, which is also significantly different from those who attend an OVOP school or other village preschools. The results of the OLS regression and inverse probability weighting regression estimated by Chen et al. (2019) and Zhao et al. (2020) are almost identical, indicating that either (1) the selectivity bias is small or that, which is more likely (2) there are some unobservable and important selection variables left out due to the limitation of control variables in the data.

Therefore, we compared OVOP with its closest competitor, namely, other types of preschools in villages or towns. On the one hand, these are the two types of preschools most likely to have substitution effects in the village preschool market. On the other hand, students attending these two types of preschools are generally matched in respect to observable variables.

Fig. 6 compares the predicted probabilities of attending an OVOP school for the two groups of students: who already attended OVOP schools and who attended other types of preschools in villages or towns. Results show that the distributions of the predicted probabilities for the two groups are very similar. Combined with the analysis in the previous sections of this paper, it is more likely that the decision to attend an OVOP school or another type of preschools was influenced by the exogenous changes in the availability of an OVOP school in one's village. If no OVOP school was present, students were more likely to choose the counterfactual – other types of preschools in villages or towns.

In addition to OLS regression and propensity score weighting, we adopted another approach to robustness analysis: exact matching. We compared differences in achievement between two students who had identical personal characteristics (gender, whether left behind, whether in impoverished condition, whether orphaned, and parental occupation) but attended different types of preschools. The results of this regression analysis are presented in Table A7 in the Appendix. Unlike Zhao et al. (2020), we converted raw exam scores (total of Chinese and Mathematics) across grades to standardized scores with a mean of 0 and a standard deviation of 1 for cross-grade comparisons. We also examined the robustness of the results by limiting the analysis to a subsample with a larger number of students in each exact matching group based on student characteristics. Overall, results were consistent across different sample definitions. Table 4 presents the full set of regression results on

Table A5
Predictors of Changes in Preschool Availability.

	(1)	(2)	(3)	(4)	(5)	(6)
	Outcome variable: Preschool availability change from 2010 to 2014					
Urban communities (=1)	-0.048	-0.087	-0.081			
	(0.061)	(0.072)	(0.160)			
Per capita community area		0.002	0.003		0.002	0.005
		(0.004)	(0.008)		(0.007)	(0.010)
Community area changed in 2010–14 (=1)	0.002	-0.067	-0.070	-0.015	-0.041	-0.120
	(0.089)	(0.111)	(0.291)	(0.166)	(0.239)	(0.339)
Household in 2010	0.000	0.000	0.000	0.000	-0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Change in household in 2010–14	0.000 * **	0.000 * **	0.001	0.000	0.000	0.000
	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)
Share of residents in 2010	-0.280	-0.005	0.403	-0.387	-0.423	0.234
	(0.201)	(0.237)	(0.711)	(0.482)	(0.641)	(0.912)
Change in share of residents in 2010–14	0.114	0.314 *	0.523	0.158	0.303	0.222
	(0.137)	(0.163)	(0.478)	(0.217)	(0.298)	(0.580)
Share of 0–15 aged population in 2010			-0.057			0.270
			(0.795)			(0.957)
Change in share of 0–15 aged in 2010–14			-0.260			0.149
			(0.567)			(0.783)
Number of newborns in 2010		0.000	0.001		-0.001	0.001
		(0.000)	(0.007)		(0.007)	(0.012)
Change in newborns from in 2010–14		0.000	0.003		-0.001	0.006
		(0.000)	(0.005)		(0.002)	(0.008)
Share of low-income households in 2010		0.215	-0.097		0.413	-0.190
		(0.233)	(0.790)		(0.537)	(0.951)
Change in share of low-income in 2010–14		0.007	-0.309		0.195	-0.571
		(0.017)	(0.847)		(0.411)	(1.040)
Share of public employees in 2010	-1.995	-5.215	-7.814	-0.804	-13.940	-11.078
	(5.351)	(10.088)	(22.342)	(8.349)	(19.295)	(28.803)
Change in share of public employees in 2010–14		3.253	-1.686		-4.573	-4.798
		(4.152)	(9.750)		(9.076)	(12.492)
Distance to market	0.000	-0.000	-0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Distance to county downtown	0.000	-0.000	0.001	0.002	0.000	0.000
	(0.001)	(0.002)	(0.003)	(0.002)	(0.003)	(0.003)
Per capita income in 2010			-0.000			-0.000
			(0.000)			(0.000)
Change in per capita income in 2010–14			-0.000			0.000
			(0.000)			(0.000)
Per capita fiscal revenue in 2010			0.051			-0.049
			(0.086)			(0.138)
Change in pp fiscal revenue in 2010–14			0.051			0.063
			(0.056)			(0.108)
Per capita fiscal expenditure in 2010			0.012			0.130 *
			(0.069)			(0.069)
Change in pp fiscal expenditure in 2010–14			-0.025			-0.008
			(0.032)			(0.027)
Constant	0.295	0.034	-0.418	0.338	0.509	-0.288
	(0.187)	(0.220)	(0.593)	(0.454)	(0.591)	(0.821)
Observations	578	458	229	282	240	188
R-squared	0.328	0.403	0.541	0.386	0.434	0.587

Note: The outcome variable indicates the change in preschool availability in 2010–2014, taking three values (−1, 0, 1). All the covariates are at the village/community level. County fixed effects are included.

test scores at grades 1, 3, and 5.

As Table 4 shows, in the first grade, students who attended an OVOP school had slightly higher scores than those who attended other types of preschools; however, this difference was not statistically significant. Even when controlling for group fixed effects (i.e., comparing students of the same type) and adjusting for sample selection, the results remained consistent. Further examination of the long-term effects in grades 3 and 5 revealed that the positive impacts of OVOP on student achievement gradually increased with grade level. As Column (4) shows, in the third grade, the achievement of students who attended an OVOP school was 0.123 standard deviations (significant at the 10% level) higher than students who attended other types of village preschools. In the fifth grade, the gap expanded to 0.446 standard deviations (significant at the 1% level). Finally, controlling for differences in students' first-grade performance and using a value-added model, the results in Columns (5) and (8) remained consistent.

Our final question of interest is whether the impact of OVOP on student achievement is heterogeneous, that is, whether only some students benefit from it. If poor students do not benefit from the program, then the targeted poverty alleviation effect of the OVOP experiment will be reduced. Table 5 estimates the impact of OVOP on different groups of students. Results confirm that OVOP schools have a relatively greater impact on non-disadvantaged children compared with other types of village preschools. Nonetheless, disadvantaged children (i.e., poor, orphaned, and left behind) also benefit from the OVOP project, particularly in the longer term (i.e., fifth grade). It is worth noting that the effect of OVOP schooling was negative (statistically insignificant) for disadvantaged children and boys in the first grade, possibly because these students experienced adjustment difficulties during the transition from kindergarten to elementary school. Further research and policy attention are necessary to address this issue.

We found that the OVOP project had a positive impact on student academic achievement compared with other preschools (e.g., township public or private, county private). From an education policy perspective,

Table A6
Effect of Preschool Education on Non-cognitive Outcomes.

	(1) Full sample	(2)	(3) Rural sample	(4)
	Poverty-Level Bottom Groups 1–3		Poverty-Level Bottom Groups 1–3	
	OLS	IV	OLS	IV
Outcomes: parents' evaluation of their child's non-cognitive abilities (from 2010 and 2014 surveys; mainly parents' observations of three-year-old children)				
Optimistic by nature (=1, if >=3)	0.011	-0.904	0.018	-1.046
	(0.034)	(1.915)	(0.037)	(4.207)
Observations	609	609	571	571
Will wait for their turn in games or other activities (=1, if >=3)	-0.009	-1.406	-0.006	-1.188
	(0.060)	(4.324)	(0.066)	(7.822)
Observations	599	599	563	563
Cautious and well-organized (=1, if >=3)	0.015	0.634	0.006	2.627
	(0.044)	(1.906)	(0.047)	(9.762)
Observations	601	601	563	563
Curious and exploratory; enjoys new experiences (=1, if >=3)	-0.002	-4.609	-0.024	-8.003
	(0.039)	(9.905)	(0.040)	(35.356)
Observations	599	599	562	562
Will think before doing something; not impulsive (=1, if >=3)	0.060	1.426	0.058	3.989
	(0.053)	(3.210)	(0.057)	(20.276)
Observations	597	597	559	559
Gets along well with peers (=1, if >=3)	0.001	3.986	-0.004	7.678
	(0.043)	(9.218)	(0.043)	(39.164)
Observations	610	610	572	572
Tolerates peers' mistakes in games or other activities (=1, if >=3)	0.009	1.034	-0.021	2.186
	(0.059)	(4.409)	(0.059)	(27.502)
Observations	597	597	559	559
Enjoys helping others in games or other activities (=1, if >=3)	0.008	-1.750	-0.032	-6.695
	(0.045)	(3.389)	(0.045)	(51.855)
Observations	600	600	562	562
Usually follows parents' instructions (=1, if >=3)	0.015	0.691	0.025	4.867
	(0.047)	(2.752)	(0.046)	(24.056)
Observations	608	608	570	570
Can easily overcome irritability (=1, if >=3)	-0.080	0.101	-0.070	3.662
	(0.051)	(2.177)	(0.053)	(19.438)
Observations	607	607	570	570
Popular with peers (=1, if >=3)	-0.003	-0.845	-0.000	-1.984
	(0.026)	(1.671)	(0.028)	(9.284)
Observations	609	609	571	571
Tries to be independent (=1, if >=3)	0.024	-0.041	0.011	2.898
	(0.052)	(1.970)	(0.055)	(15.444)
Observations	607	607	569	569
Outcomes: parents' evaluation of their children's non-cognitive abilities (from 2014 and 2018 surveys, almost 4 years after)				
Studies very hard (=1, if >=3)	-0.007	0.761 * *	-0.006	0.966 * *
	(0.027)	(0.356)	(0.028)	(0.417)
Observations	1381	1381	1328	1328
Concentrates on tasks (=1, if >=3)	-0.005	0.446 *	-0.000	0.388
	(0.030)	(0.246)	(0.030)	(0.306)
Observations	1434	1434	1379	1379
Will check their schoolwork several times before finishing it (=1, if >=3)	-0.013	0.230	-0.003	0.455
	(0.034)	(0.358)	(0.034)	(0.450)
Observations	1379	1379	1327	1327
Disciplined (=1, if >=3)	0.021	0.205	0.024	0.158
	(0.023)	(0.233)	(0.023)	(0.287)
Observations	1434	1434	1379	1379
Like placing things in order (=1, if >=3)	-0.002	0.353	0.013	0.555
	(0.031)	(0.292)	(0.032)	(0.362)
Observations	1434	1434	1379	1379
Only plays after completing schoolwork (=1, if >=3)	0.041	0.338 *	0.047 *	0.376
	(0.027)	(0.200)	(0.027)	(0.238)
Observations	1380	1380	1327	1327
Finishes something once they have started it (=1, if >=3)	-0.011	0.493	-0.019	0.560
	(0.027)	(0.298)	(0.028)	(0.376)
Observations	1434	1434	1379	1379
Outcomes: parents' evaluation of their children's non-cognitive abilities (from 2012 and 2016 surveys, almost 2 years after)				
Studies very hard (=1, if >=3)	-0.014	-0.750 *	-0.024	-0.815 * *
	(0.031)	(0.401)	(0.032)	(0.365)
Observations	1196	1196	1148	1148
Concentrates on tasks (=1, if >=3)	0.011	-0.178	-0.002	-0.375
	(0.030)	(0.357)	(0.031)	(0.447)
Observations	1469	1469	1411	1411
Will check their schoolwork several times before finishing it (=1, if >=3)	0.021	-0.039	0.021	-0.165
	(0.033)	(0.438)	(0.034)	(0.414)
Observations	1190	1190	1143	1143
Disciplined (=1, if >=3)	0.001	-0.157	0.001	-0.183
	(0.021)	(0.206)	(0.021)	(0.262)
Observations	1463	1463	1405	1405
Like placing things in order (=1, if >=3)	-0.069 * *	-0.559	-0.067 * *	-0.354
	(0.031)	(0.437)	(0.032)	(0.483)
Observations	1464	1464	1406	1406
Only plays after completing schoolwork (=1, if >=3)	0.017	-0.408	0.018	-0.578 *
	(0.028)	(0.313)	(0.029)	(0.309)
Observations	1197	1197	1150	1150
Finishes something once they have started it (=1, if >=3)	0.044 *	-0.095	0.037	-0.105
	(0.024)	(0.283)	(0.024)	(0.359)
Observations	1459	1459	1401	1401

Note: This table reports OLS and IV-2SLS estimates of preschool attendance on non-cognitive skills. The control variables are used in all the 2SLS regressions.

this effect is substantial: In the fifth grade, students who attended an OVOP school had grades 0.445 standard deviations higher than those who attended other kindergarten types. Such an effect size would be very difficult to achieve with conventional education policy investments (e.g., higher teacher quality or salaries, school construction, online teaching aids). For example, the estimated class-size effect for primary and secondary schools in China is about 0.06 standard deviations; this means that class size would need to be reduced by eight students—requiring more teachers and the construction of more classrooms and other facilities—to keep the student-teacher ratio constant and achieve the same effect. At the same time, we show that the OVOP experiment has a positive effect on poverty alleviation for disadvantaged children, and that those students also largely benefited from attending OVOP schools.

7. Conclusion

Using nationally representative survey data, case study administrative data, and a set of causal inference methods, this paper examines the causal impacts of early childhood education between the ages of three and five on children's' longer-term development outcomes in rural China. We have focused on the period of rapid development in early childhood education for the low-income families with national and local policy experiments that aimed expanding both the quantity and quality of preschools. At the national level, the central government has implemented three waves of Three-year Action Plans for Preschool Education over the past decade, which facilitates both the provision of village preschools and student enrollments. We analyzed CFPS data using a DID-IV approach and found that building new kindergartens in impoverished rural areas (ITT effect) and encouraging students to attend kindergarten (TOT effect) had positive effects on student development (particularly cognitive skills) four years later.

Like many other developed and developing countries, the more critical policy challenge after reaching universal preschool access is how the quality of preschool education can be improved to ensure that all children (especially disadvantaged children) benefit from preschool education in the long run. In reevaluating the China Development

Table A7
Effect of Attending OVOP on First-grade Score Using Different Controls and Samples.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	First-grade exam results (standardized scores)						
Attended OVOP	0.048	0.045	0.061	0.070	0.080	0.082	0.091
	(0.053)	(0.063)	(0.067)	(0.066)	(0.069)	(0.075)	(0.092)
Girls		0.038					
		(0.054)					
Left-behind children		-0.105 *					
		(0.057)					
Children in poverty		-0.051					
		(0.070)					
Only child		-0.051					
		(0.054)					
Orphans		-0.149 *					
		(0.081)					
Mother's age		0.004	0.007	0.006	0.007	0.008	0.006
		(0.006)	(0.007)	(0.007)	(0.007)	(0.008)	(0.010)
Mother's occupation (housewife)		0.038					
		(0.136)					
Mother's occupation (employed)		-0.025					
		(0.074)					
Mother's occupation (unemployed)		-0.075					
		(0.103)					
Father's occupation (employed)		0.033					
		(0.063)					
Constant	-0.070 *	-0.103	-0.278	-0.251	-0.265	-0.259	-0.196
	(0.038)	(0.194)	(0.189)	(0.187)	(0.199)	(0.228)	(0.283)
Subgroup fixed effects	No	No	Yes	Yes	Yes	Yes	Yes
Numbers in group			No limit	> =4	> =10	> =20	> =40
Observations	1314	1314	1314	1195	1015	786	521
R-squared	0.001	0.008	0.128	0.074	0.052	0.033	0.023

Note: Subgroups are defined using all the controls listed in the table. The first-grade exam score includes the total scores in Chinese and Mathematics.

Research Foundation's OVOP project, we found that OVOP schools, compared with other types of kindergarten (i.e., township public or private, county private), had a positive impact on student achievement in grades 1, 3, and 5, especially among disadvantaged children. This local policy experiment, now spreading across the country, has built a model for high-quality early childhood provision in the poorest regions of China and many other low-income developing countries.

Early childhood education has a substantially positive impact on the long-term human capital development of low-income students and its cost-benefit substantially exceeds that of conventional education investment, making it one of the most effective ways to alleviate poverty with educational precision. However, existing literature on the causal effects of universal programs is still inconclusive (see a summary in van Huizen and Plantenga, 2018), which raises questions about the cost-effectiveness of preschool expansions at scale. Our results from China suggest that both the availability and quality of early childhood education schools' matter, as well as that universal preschool is an important policy tool to reduce the education and income inequalities. However, by comparing OVOP with the various other types of kindergartens already available in impoverished rural areas, we found that the quality of education varies greatly among institutions regardless of whether they are in the same area. Rather than simply expanding the supply of preschools, early childhood education policy should focus on building high-quality preschools in low-income areas as well as promoting students' non-cognitive skills. Because high-quality programs imply high costs, future work that comprehensively accounts for the long-term impacts of such programs are needed to better guide policymaking.

Furthermore, two different policy approaches can be considered in combination with local contexts: building new kindergartens and encouraging more students to use existing school resources (public and private schools). Policy choices need to be tailored to local conditions and precisely aligned. For example, in urban areas, the availability of kindergartens in the community does not have a significant impact on families' preschool education choices. As such, other approaches should be considered for targeted poverty alleviation in preschool education in urban areas. For families in low-income, rural areas, especially among disadvantaged families, price may be an important factor discouraging families from choosing preschool education—particularly early preschool education for three- to five-year-old children—or a factor leading these families to choose low-quality preschool education. Accordingly, increasing the precision of support for poor families will further enhance the positive impact of high-quality preschool programs.

CRediT authorship contribution statement

Shuangye Chen: Conceptualization, Supervision, Writing – original draft, Writing – review & editing. **Yanlin Liu:** Data curation, Formal analysis, Writing – original draft. **Jin Yang:** Methodology, Formal analysis, Writing – original draft, Writing – review & editing. **Yuchen Yang:** Methodology, Formal analysis, Project administration, Writing – original draft, Writing – review & editing. **Xiaoyang Ye:** Conceptualization, Data curation, Formal analysis, Writing – original draft, Writing – review & editing.

Appendix

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