Does One More Year of Rural Preschool Education Have More Dosage Effects?

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Abstract

Inadequate and unbalanced development of preschool education is a prominent problem of China's education. development. In poverty-stricken rural areas, the population of pre-school-aged children generally exceeds the local capacity to provide services, resulting in some pre-school-aged children, especially those aged 3 to 4, could not participate in kindergarten. Local governments and authorities often have to weigh the scale and quality of preschool service, whether to provide two-year or three-year preschool services in rural areas. The "One Village, One Preschool (OVOP) " program aims to ensure that all pre-school-aged children in China's poverty-stricken rural areas can receive fair and quality preschool education. This study followed 23,775 children from preschool (4 years old) to fourth grade (10 years old) in a poverty county in Guizhou Province. Multiple methods including linear model, discrete model and multiple propensity score weighted matching (MPSW) were used to analyze the relationship between variables, interventions and effects. The results showed that children of the 3-year OVOP group and the 2-year OVOP group had very similar scores at the beginning of the first grade, 0.14 SD behind the children of the public kindergarten group. However, by the third and fourth grades, children of the 3-year OVOP group had caught up with children of the public kindergarten group, compared to the children of the 2-year OVOP group had lagged behind by about 0.2 SD. The results concluded that in poverty-stricken rural areas, children received one more year preschool education can reduce the long-term fade-out effects.

Keywords: *poverty-stricken area, preschool education intervention, dose effect, fade out effect*

1. INTRODUCTION

Early education is closely related to a person's lifelong development, and early experience determines the quality of development in adolescence and adulthood [14]. The theory of early childhood development emphasizes that there are "optimal teaching period" and "zone of proximal development" in the development of early childhood potential[69]. If the "best teaching zone" is missed, the same intervention will be useless and children's potential will not reach the "zone of proximal development". The early development of children is affected by many factors, and poverty is one of the most important and basic factors. Poverty poses social, psychological, biological and security threats to children's development [66]. Children living in poverty for a long time will spend less time in school and have worse academic performance [2] [35]. Long-term

poverty pressure will reduce the stimulation and nutrients necessary for children's brain development. This leads to a gap in brain capacity development [24]. 43% (approximately 250 million) of children under 5 years of age in low social-economic status households in developing countries are at risk of not reaching their developmental potential [11].

Early education is the most effective and cost-effective intervention to address inequality caused by poverty [22] [54], preschool education intervention can not only increase the employment opportunities of individuals in adulthood and obtain a relatively high wage level, but also provide favorable conditions for the human capital accumulation of the next generation [29]. In studies of the effects of preschool education in the United States, it is found that of all children receiving early education, children from poor families benefit the

most in terms of school readiness and long-term academic achievement [10] [20] [43]. A long-term follow-up study of the Perry Preschool Education Program in the United States showed that by the age of 18-20, children who had participated in preschool had better school performance and employment, significantly fewer behavioral problems such as early pregnancy and crime than the control group, and better employment and income at the age of 27 when assessed [64]. There are few psychological studies on early intervention programs for poor children in Brazil. The measurement and evaluation of economic benefits and human capital benefits [4] show that early development intervention can effectively reduce the dropout rate and grade retention rate and save the cost of public education. One more year of pre-school education increases the number of years of schooling by half a year.

Many countries in the world have made efforts to help low-income groups gain access to early education opportunities. However, globally, children from poor families are only half as likely to participate in early development interventions as those from high-income families [63]. "Inequality in access to development opportunities" further exacerbates the solidification of social strata. To address the challenge of "access to development opportunities", many developing countries have invested money [24] [27], nutrition [31] and education [3] to improve access to early development for children living in poverty.

With the development of early education services, researchers and practitioners pay more and more attention to the effectiveness of preschool education quality and type [34][48]. Scholars have proposed to expand the coverage of early education resources for poor children to solve their development dilemma [21][42]. This proposal implies a core issue, namely, the "dose effect" of preschool education on children's development, increasing the value added of early childhood education hours on children's development results [53]. This core issue has attracted the attention of governments because it is related to the action strategy of government departments and the direction of financial investment. Studies have shown that the longer poor children participate in early education programs, the higher their level of cognitive development [7] [18]. A study of early Start programs in the United States found that children who were introduced to early Start programs at age 3 and entered kindergarten at age 4 had better reading skills than children who entered kindergarten directly from age 4 [34].

However, some researchers emphasize that prolonged early intervention in children will have a negative impact on children's development [17] [42] [64], the effect size produced by early intervention for less than 1 year was 0.2 sd, while the effect size of the program lasting 3 years was only 0.3 SD, lower than the expected 0.6 SD [48].

Many early childhood development intervention programs produce nearly maximum results in the first year [26], although increased intervention duration can produce better results than one-year programs [8] [13] [19] [58] [68] [69], but the effect size of income decreased year by year afterwards [1] [53] [61]. Therefore, additional years of early developmental intervention may be superfluous [53], as these times do not provide more effective learning and developmental increments. From a policy maker's perspective, previous dose-response studies have shown that investing in one year of early childhood education is the most cost-effective unless additional years of intervention have a more sustained and profound effect on the child's development process.

Does early education have a "fade out effect" in the long run? A large number of studies have found that early childhood education has an impact on the academic performance of children who benefit from it [12] [56], and their lifelong happiness had a long-lasting effect [4] [28]. In examining the impact of early intervention on primary school performance, a study in Argentina found that one year of early education was associated with an 8% increase in third-grade test scores [9]. A study in Uganda showed that children who participated in early development interventions achieved 6-12% higher math performance in sixth grade than those who did not [33]. In a Danish study, it was found that participation in high-quality pre-school education increased the test scores of grade 9 by 0.01 to 0.02 standard deviations [6].

Some studies have highlighted that the "fade out effect" may be widespread [2] [5] [40] [44]. The effects of most public early childhood services are still short-term and disappear by the end of kindergarten or early primary school [50] [67], at the end of preschool education, children who received it performed significantly better than those who did not, but at the end of second grade, children who received it performed as well as those who did not, and the latter even exceeded the former [40], Children who attend early childhood education tend to fall back to the population average by the third grade [41] [51]. In the research on how to weaken the "fading effect", it is suggested that the "fading effect" from kindergarten to grade one can be alleviated by constantly improving the professional ability of teachers [35].

Research on the mechanism of the "fade out effect" has been developing. Some studies have pointed out that disadvantaged factors, such as ethnic minorities [25], poverty, etc. [29], lead to the "fade out effect" and significant achievement gap in the third grade. Other studies have pointed out that the third grade of primary school is a stage of teaching transition, such as in English-speaking countries, from "learning to read" (simple decoding) to "reading to learn" (deep understanding) [23]. It is difficult for children to master

deep understanding skills. They not only need to learn a large number of words, but also need to understand realistic concepts, which is closely related to abundant environmental stimulation and parental input [60]. However, poor children are extremely lacking in this aspect. The "fade out effect" of preschool education is not predictive for the future, and the achievement gap after the third grade has a lasting impact on students' high school performance and college entrance ability [38].

In general, although there have been many studies on the dose effect, fade out effect and "compensate" effect of preschool education on the development of poor children, these studies are independent, lack of group coherence and integration, and do not fully explain what kind of intervention and what kind of characteristics of the population, what kind of short-term and long-term effects. More lack of mechanism analysis and extensive practical value of the discussion. Starting from the development reality of China, we pay more attention to the dose effect of preschool education intervention strategies on the development of poor children, whether there is a "fade out effect" in the long term, and the universal benefit value of extensive practice.

The Chinese government continues to pay attention to preschool education. From 1976 to 2021, the gross enrollment rate of preschool education in China increased by eight times (from 11% to 88%) [17]. Almost all urban children (over 99%) have access to preschool education [46], while only 30.1% of children from poor areas and rural areas (mainly located in central and western China) attend preschool education [70]. Unbalanced and inadequate development is the main contradiction facing China's development at the present stage. The significant gap between urban and rural areas, between regions and between the rich and the poor has been deeply demonstrated in contiguous poverty-stricken rural areas (hereinafter referred to as "poverty-stricken rural areas"). As mentioned above, although the quality of rural education resources in poor areas has been improving in recent years, these resources are mainly concentrated in county towns and townships, and preschool education resources at the village level are still lacking. Before 2012, there were mainly two types of preschool education services in state-designated poverty-stricken counties, namely public kindergartens and private kindergartens. Fully supported by financial funds, the public parks are mainly concentrated in the county seat and township centers, and can provide preschool education opportunities for about 35 percent of school-age children in the county. Private (private) kindergartens are operated at the expense of children's families and are concentrated in county and township centers. School buses can transport children from remote rural areas to kindergartens. These kindergartens can provide preschool education opportunities for more than 30-40% of children in the county. Public kindergartens have a better teaching environment, teacher compensation,

teacher strength and teaching quality, with a teacher-student ratio of about 1:10, while private kindergartens have a teacher-student ratio of about 1:25, which also dwarfs all indicators. The lack of preschool education service supply in rural areas, coupled with family economic conditions, living geographical location, left-behind, family labor time and other practical constraints, the problem of "difficult and expensive kindergarten" for rural children in poor areas is very prominent.

In 2009, the China Development Research Foundation (CDRF) launched the "One Village, One Preschool" program (OVOP), a large-scale preschool education intervention aimed at guaranteeing rural children in poverty-stricken areas access to preschool education services in villages. The implementation and results of this plan have promoted the deployment and implementation of preschool education policies in poor areas of China. Due to the complex environment and large differences in population distribution in poor areas, most counties in poor areas have large population and few resources. Therefore, the intervention strategy for rural areas is to build at least one village-level kindergarten in each village according to the number of school-age children. Employ volunteer teachers from the county (village) with high school or above education experience which related to early education. The employ process contains professional exam, interview and other qualification test. In some villages, due to the large number of children and the space limitation, children aged 4-6 are first included in preschool education services, and 2-year preschool education services are guaranteed first. For villages with a small number of children, children aged 3-6 are included in the scope of pre-school education services, providing three-year pre-school education services. OVOP is a village-level public welfare kindergarten free of charge, providing preschool education opportunities for 25-35% of the total county's children.

Previous research on the OVOP found that it had a consistently positive impact on the academic performance of children at the primary school level. Those who have no preschool education experience are with the lower test scores and rankings in the later stages of primary school, and those in rural private kindergartens. However, the scores and rankings of students from OVOP and students in public preschool both increased [15]. Based on different realistic conditions and intervention strategy, the core question of this study is that in the process of policy intervention transfer into the scaling-up policy, the standardization of interventions is critical. Compared of 2 years or 3 years of preschool education, what are the different effects, those effects are strongly related to the policy deployment and fiscal investment, more related to the policy effect and the satisfaction of the people.

This study aims to through long-term academic achievement (grade 4), try to answer,

1) In poverty-stricken areas of China, is there any long-term different effects between 2 or 3 years of preschool education intervention?

2) Is one more year preschool education valuable for children's long-term sustainable development?

3) Is there a more significant dose effect, and can effectively reduce the "fade out effect"?

The study hypothesized that the marginal gains in knowledge or skills that an additional year of intervention might produce were helpful in child development and could reduce or even offset the fading effect in third or fourth grade; An extra year of knowledge and skills gained in preschool does not disappear in third or fourth grade. This study will be an innovation, and the results and conclusions will supplement the deficiencies of international studies in related fields, and may also provide a new idea for future research and provide a basis for government and social actions in a larger range.

2. METHODS

2.1 Participants

This study cooperated with the local education bureau, included all fourth-grade primary school students in the county from 2015 to 2018 as a complete sample, total of 23,775 students. The sample information included scores of consecutive county-level exams since enrollment, preschool education experience and family background information. The dropout rate is less than 0.1%, there is no sample lost.

The sample could be divided into five groups according to their preschool education experiences, 1) 1,712 students had not attended a kindergarten, 2) 11,674 students had attended a public kindergarten, 3) 4,921 students had attended a private kindergarten, 4) 3,813 students had attended "one village and one Garden" for two years, and 5) 1,656 students had attended "one village and one Garden" for three years.

Table 1 describes the first year grades of the sample students and their background information. In general, students who attended public kindergartens had better academic performance and had relatively better family economic and social background. The family social-economic status of the students who have experience with private kindergartens is significantly better than that of the students who have not been to kindergartens. The students who attended OVOP for two or three years had similar family backgrounds and had the lowest economic and social status as those who did not attend kindergarten. There is a significant difference in the first grade scores of the three groups of students, students who have not been to kindergarten are the worst, and the scores of 2-years OVOP and 3-years OVOP groups are close to those of students of town private kindergartens.

Table 1. Descriptive statistics grouped by preschool education types.

	3-year-OVOP	2-year-OVOP	Town Private	Town Public	No ECE
Sample size	1656	3813	4921	11674	1712
Chinese-year-1 mean	76.80	76.60	68.00	78.80	60.80
(sd)	(16.80)	(16.20)	(16.60)	(15.60)	(14.90)
Math-year-1 mean	76.90	76.50	68.00	78.70	60.80
(sd)	(16.80)	(16.20)	(16.70)	(15.50)	(15.10)
English-year-1 mean	76.80	76.50	68.00	78.70	60.80
(sd)	(16.80)	(16.20)	(16.70)	(15.50)	(15.10)
Sum-score-year-1 mean	230.00	230.00	204.00	236.00	182.00
(sd)	(49.80)	(47.90)	(49.30)	(45.80)	(44.30)
Single child	44.60%	43.20%	47.80%	49.20%	42.00%
Left behind child	39.30%	38.60%	28.20%	17.10%	37.40%
Child w/ special need	6.76%	8.86%	4.57%	2.28%	8.05%

Poverty	12.70%	14.00%	2.23%	0.53%	14.10%
Mom w/ high school edu	23.30%	23.20%	39.70%	50.50%	24.80%
Mom township Hukou	11.40%	12.40%	26.30%	80.80%	14.30%
Dad township Hukou	7.25%	8.03%	22.70%	75.60%	6.52%
Han ethnicity	20.10%	18.10%	36.90%	39.30%	21.30%

2.2 Intervention

Intervention measures mainly include the construction of kindergartens in rural areas, the use of idle public facilities in villages (more than 90% of kindergartens are transformed from restricted public facilities, through renovation, expansion, decoration, etc., to build a basic environment for children to learn and play. Configure play AIDS in kindergarten. Develop and organize courses that meet national and local standards. Hire preschool teachers and carry out training.

Transportation time to kindergarten is one of the difficult challenges faced by rural children and their families in poor areas. Before the implementation of OVOP, there were few public free kindergartens. Long-time transportation or unsafe school buses prevent poor rural families from receiving preschool education. The implementation of OVOP has made the accessibility of preschool education to less than 30 minutes' walk. In addition to learning and activity conditions, 65% of OVOP kindergarten can provide lunch for children, and 32 percent have facilities and space for lunch break.

The recruitment and professional development of preschool teachers are mainly undertaken by local governments. Local governments organize the recruitment, selection, training and assessment of preschool teachers. OVOP teachers are mainly graduates from local vocational colleges or universities, who are familiar with the local language, culture, customs and local relationships. The average age of the OVOP teachers is 28 years old, 87.2% are from the county, and 42.8% have higher education background. Local education departments provide regular training, exchanges, visits, teaching and research opportunities for teachers of OVOP, to improve their professional abilities. Meanwhile, local education departments also encourage teachers of OVOP to participate in continuing education.

Due to the small scale of OVOP, the teacher-child ratio is about 1:16, which is lower than private kindergartens, but higher than public kindergartens. An important characteristic of OVOP is "mixed-age teaching". More than half of the OVOP schools have only one class, with children aged 3-6 studying and playing together. The curriculum content and textbook outline of OVOP is the same as that of public kindergartens.

Funds for the first phase of OVOP (the first three years of the project) is raised by CDRF from enterprises and other charitable organizations. All funds raised will be donated to the education department of the local government, which will allocate according to the teaching and operation needs of the kindergarten. After the first three years, the operating costs of OVOP was taken over by local governments. On average, the operating cost of each kindergarten of OVOP is about RMB 50,000 yuan per year, including the salary of preschool teachers about RMB 2,500-2,800 yuan per month. This salary level is lower than that of both public and private kindergartens, because teachers of OVOP adopt the strategy of "local people serving their hometown", they are filled with a sense of honor and responsibility which is more important than salary.

2.3 Methodology

2.3.1 Results

The study collected the county-level test scores of all students from first grade to the end of fourth grade, including academic achievements in Chinese, math and English. Within each grade level, students' standardized scores (Z-Score) and total scores are calculated, and the standardized scores are named Chinese, Math, English and total scores. In the different models, each score is considered as an outcome variable, and the internal reliability of the test is not considered in this study.

2.3.2 Prediction indicators

In the sample, the main predictor was the type of preschool educational experience. In every primary school students are recorded when they enrolled, percentage of five types of preschool education is as below, 3-years OVOP covers about 7% of the students, 2-years OVOP covers about 16%, the public kindergarten covers about 49%, private garden covers about 21%, no preschool education students accounted for about 7% of the sample.

2.3.3 Control variables

The national compulsory education registration system collects basic demographic variables and basic family information of students. Supplementary information collection forms were issued in this study, which collected variables such as students' left-behind status, special needs, family social economic status, and mother's education level. Based on child development theory, this study selected key control variables related to children's academic achievement that may influence families' choice of different typological pre-educational experiences. Relevant demographic variables and family background information were collected in September 2018.

Among the dummy variables, the gender of girl is encoded as "1" in this study. Code the one-child family as "1",the left-behind children is "1". There are generally three types of special situations, children with physical disabilities, children with intellectual disabilities/developmental delays, and orphans. One of these three situation is coded as "1". Code the poverty households as "1". Code children living with at least one parents as "1". The mothers' rural household residence code as "0", and the urban household registration code as "1". Different types of household registration are often closely related to employment, land ownership and different social welfare provision. The father has rural household registration code as "0", urban household registration code as "1".

2.3.4 Analysis approach

A key challenge of this study is the self-selection bias. Parents' choice of different types of preschool education will have different effects on children's development. If OLS regression is used directly, the "confounding effect" cannot be elucidated. Affected by extreme values, OLS analysis results may have greater deviations, especially when there are significant differences in sample population size and serious overlap between covariables [30]. Therefore, multiple propensity score weighted matching (MPSW) was used in this study to balance the differences between groups before intervention and minimize the bias. The MPSW estimation method reconstructs observed data to simulate experimental data and balances the possible effects of intervention on different group variables. By balancing pre-processing variables, MPSW can reduce selection bias in non-experimental studies.

In this study, MPSW was used to balance each covariable between groups, and the balance result was satisfactory (all P values > 0.05). The balance test showed that there were significant differences in several covariables between groups before the tradeoff, and the average difference P value or KS test P value was greater than 0.05 after the tradeoff. This study compares the models before and after weighted matching of multiple propensity scores, and each group has stable consistency. This study mainly reports the weighted results.

In this study, primary education is a post-intervention variable (i.e. students enrolled in primary school after pre-school education). When the variable is part of the intervention variable, control cannot be exercised in estimating causal effects [30] [55]. Controlling for the outcome of causal variables could cause seriously bias inference. Such "post-treatment bias" is common in social science research [37]. Therefore, it is not recommended to control for weighted or matched post-intervention variables, either as control variables or multinomial clustering [15] [47], because this again causes post-treatment bias. In the estimates of this study, the above factors would affect the bias reduction effect of inverse probability exponential weighting (IPW) (see Rosenbaum, 1984 for a detailed statistical explanation). In order to make conservative estimates in nest data structures without using multi-level modeling, robust standard deviations are reported to guard against type I error inflation.

3. RESULTS

This study not only studied the students first grades scores (the intercept), but also the paired slopes of their longitudinal trajectory. This study adopted a longitudinal growth model [57] to estimate of the effects value of preschool education for the Z-score of the total score and rank. This study begins by assuming that the effect of time is linear. In the substitution model, we took the intervening years as a discrete dummy variable. The details of the two models are shown in Table 2, where L represents the linear relationship of time and D represents the discretization of time. The comparison was with students who had not received pre-school education. When time is used as a discrete dummy variable, the control year is the first year. According to the relationship between different types of preschool education and intervention time, this study added the interaction effect between time and preschool education type into the model.

First of all, by analyzing of the intercept and main effect of preschool education, it is found that public kindergarten students have the highest scores in all subjects in the first grade, followed by the 3-year OVOP, then by the 2-year OVOP and the private kindergarten group, the students who have not received preschool education were the bottom group. There was no statistically significant difference between the 3-year and 2-year OVOP of the first grade score. The first grade scores of the students from the private kindergarten group were significantly lower than those from the public kindergarten and the two groups of students from OVOP group, but significantly higher than those who did not

receive preschool education. Detailed results are shown in Figures 1 and 2.

Second, the slope of growth is complicated by the significant effect of time and the significant interaction effect of time and preschool education type. Linear growth of figure 1 and discrete growth of figure 2 summarized this result. This result shows a nearly consistency with intercept and growth trend across all scores. This study only illustrates the total scores in Figures 1 and 2 as results.
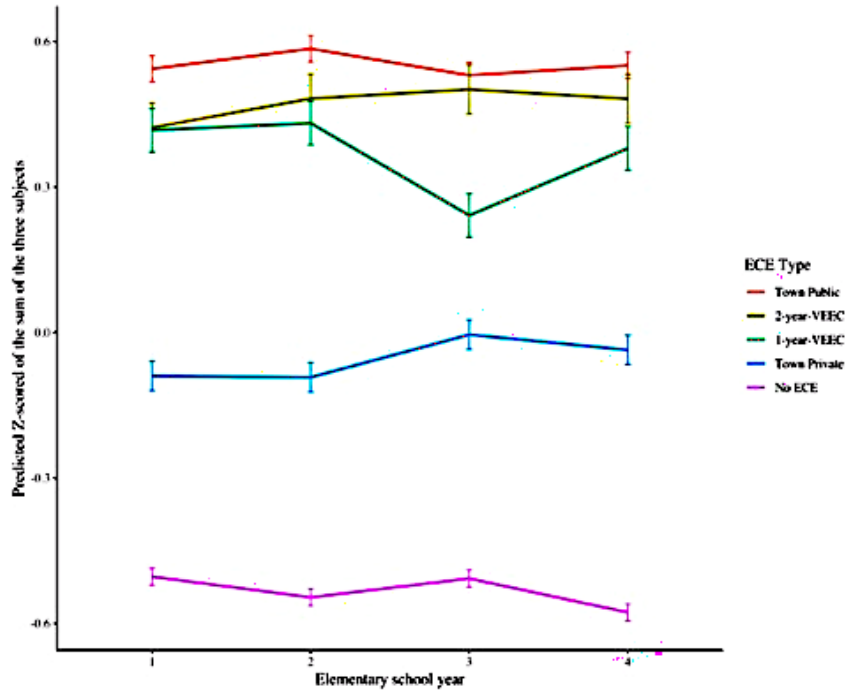

Figure 1. A 95% confidence interval was used to predict a linear relationship between total SCORE Z-score and grade level and type of preschool education.
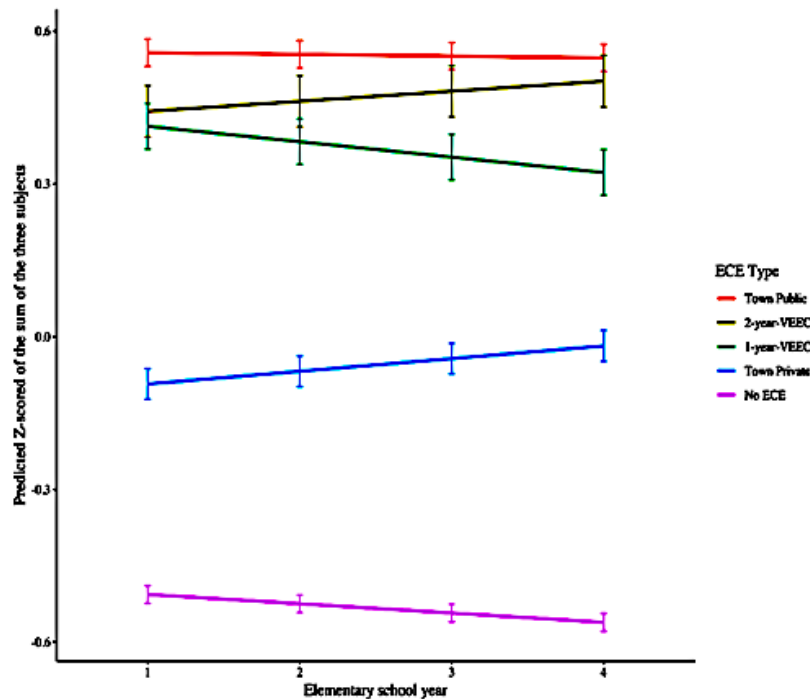

Figure 2. A 95% confidence interval was used to predict total SCORE z-score as a function of discontinuity between outcomes and different preschool types.

Table 2. Predicting elementary grades using multinomial propensity score weighted growth models

	M(Total_L)		M(Total_D)		M(Chinese_L)		M(Chinese_D)		M(Math_L)		M(Math_D)		M(English_L)		M(English_D)	
Fixed effects:																
	Estimate	se	Estimate	se	Estimate	se	Estimate	se	Estimate	se	Estimate	se	Estimate	se	Estimate	se
Intercept	-0.491	0.017 ***	-0.507	0.017 ***	-0.481	0.017 ***	-0.501	0.016 ***	-0.492	0.017 ***	-0.505	0.016 ***	-0.481	0.017 ***	-0.495	0.016 ***
year	-0.018	0.001 ***			-0.019	0.002 ***			-0.016	0.002 ***			-0.019	0.002 ***		
year2			-0.043	0.004 ***			-0.033	0.005 ***			-0.043	0.005 ***			-0.051	0.005 ***
year3			-0.004	0.004			-0.003	0.005			-0.003	0.005			-0.005	0.005
year4			-0.074	0.004 ***			-0.073	0.005 ***			-0.068	0.005 ***			-0.078	0.005 ***
TownPublic	1.049	0.031 ***	1.047	0.031 ***	1.042	0.031 ***	1.038	0.030 ***	1.032	0.031 ***	1.035	0.030 ***	1.030	0.031 ***	1.025	0.030 ***
3-Year-OVOP	0.910	0.026 ***	0.926	0.026 ***	0.911	0.026 ***	0.927	0.026 ***	0.904	0.026 ***	0.910	0.026 ***	0.880	0.026 ***	0.903	0.026 ***
2-Year-OVOP	0.931	0.020 ***	0.921	0.020 ***	0.918	0.020 ***	0.915	0.020 ***	0.922	0.020 ***	0.905	0.020 ***	0.916	0.020 ***	0.905	0.020 ***
TownPrivate	0.370	0.017 ***	0.414	0.017 ***	0.368	0.017 ***	0.416	0.017 ***	0.366	0.017 ***	0.407	0.017 ***	0.362	0.017 ***	0.402	0.017 ***
gender	0.011	0.012	0.011	0.012	0.008	0.012	0.008	0.012	0.013	0.012	0.013	0.012	0.012	0.012	0.012	0.012
race	-0.014	0.013	-0.014	0.013	-0.014	0.013	-0.014	0.013	-0.013	0.013	-0.013	0.013	-0.013	0.013	-0.013	0.013
momedu	-0.001	0.013	-0.001	0.013	-0.001	0.013	-0.001	0.013	-0.001	0.013	-0.001	0.013	-0.001	0.013	-0.001	0.013
dadhukou	-0.007	0.017	-0.007	0.017	-0.007	0.016	-0.007	0.016	-0.006	0.016	-0.006	0.016	-0.007	0.016	-0.007	0.016
momhukou	0.005	0.015	0.005	0.015	0.002	0.015	0.002	0.015	0.008	0.015	0.008	0.015	0.004	0.015	0.004	0.015
poverty	-0.009	0.024	-0.009	0.024	-0.009	0.023	-0.009	0.023	-0.008	0.023	-0.008	0.023	-0.009	0.023	-0.009	0.023
singlechild	0.001	0.012	0.001	0.012	0.001	0.012	0.001	0.012	0.002	0.012	0.002	0.012	-0.002	0.012	-0.002	0.012
specialneed	0.038	0.025	0.038	0.025	0.040	0.025	0.040	0.025	0.037	0.025	0.037	0.025	0.038	0.025	0.038	0.025
yearxTownPublic	0.015	0.002 ***			0.014	0.002 ***			0.015	0.002 ***			0.015	0.002 ***		
yearx3-Year-OVOP	0.038	0.002 ***			0.032	0.002 ***			0.038	0.002 ***			0.043	0.002 ***		
yearx2-Year-OVOP	-0.012	0.002 ***			-0.012	0.002 ***			-0.012	0.002 ***			-0.012	0.002 ***		
yearxTownPrivate	0.043	0.002 ***			0.041	0.002 ***			0.042	0.002 ***			0.044	0.002 ***		
year2xTownPublic			0.084	0.006 ***			0.086	0.008 ***			0.066	0.007 ***			0.098	0.007 ***
year3xTownPublic			-0.010	0.006 ~			-0.015	0.008 *			-0.001	0.007			-0.013	0.007 ~
year4xTownPublic			0.081	0.006 ***			0.079	0.008 ***			0.072	0.007 ***			0.088	0.007 ***
year2x3-Year-OVOP			0.102	0.005 ***			0.079	0.007 ***			0.119	0.007 ***			0.106	0.007 ***
year3x3-Year-OVOP			0.082	0.005 ***			0.061	0.007 ***			0.099	0.007 ***			0.083	0.007 ***
year4x3-Year-OVOP			0.133	0.005 ***			0.112	0.007 ***			0.132	0.007 ***			0.150	0.007 ***
year2x2-Year-OVOP			0.057	0.005 ***			0.041	0.007 ***			0.069	0.007 ***			0.059	0.007 ***
year3x2-Year-OVOP			-0.172	0.005 ***			-0.181	0.007 ***			-0.155	0.007 ***			-0.173	0.007 ***
year4x2-Year-OVOP			0.036	0.005 ***			0.035	0.007 ***			0.034	0.007 ***			0.039	0.007 ***
year2:TownPrivate			0.040	0.005 ***			0.020	0.007 **			0.046	0.007 ***			0.052	0.007 ***
year3:TownPrivate			0.089	0.005 ***			0.086	0.007 ***			0.085	0.007 ***			0.091	0.007 ***
year4:TownPrivate			0.127	0.005 ***			0.116	0.007 ***			0.128	0.007 ***			0.132	0.007 ***
Random effects:																
	Variance		Variance		Variance		Variance		Variance		Variance		Variance		Variance	
Intercept	0.825		0.826		0.797		0.798		0.797		0.7982		0.797		0.7974	
Residual	0.148		0.141		0.2550		0.2473		0.250		0.2435		0.251		0.2438	

Notes: *** p < 0.001, ** p < 0.01, * p < 0.05, ~ p < 0.08 after FDR adjustment

According to the time linear situation in Figure 1, the group of students from public kindergartens showed a flat growth, and the group ranked first in grade 4. The students' scores from the 3-year OVOP group showed a positive growth slope, and the total z-score increased by 0.02 standard deviations every year. By grade 4, the gap between the 3-year OVOP group and the public kindergarten group was significantly narrowed, from 0.14 standard deviations to 0.05 standard deviations. On the contrary, the scores of the students in the group of 2-year OVOP showed a negative growth slope, and the overall z-score decreased by 0.03 standard deviations year by year. Although the results of the 3-year and 2-year OVOP groups were almost the same in the first grade (0.02 standard deviation), the 2-year one-village-one-garden group lagged behind the 3-year OVOP group by 0.18 standard deviation by grade 4. The growth slope of the private kindergarten group was similar to that of the 3-year one-village-one-park group, and the total z-score increased by 0.02 standard deviations per year. Although the private kindergarten group lagged behind the 2-year one-village-one-park group by 0.28 standard deviation, the average total score of the students in this group was only 0.01 standard deviation lower than the overall average score. The group without kindergarten showed a negative growth slope, decreasing by 0.02 standard deviations per year.

From the time discrete paradigm shown in FIG. 2, the third grade was a turning point. The 3-year OVOP group catched up the public kindergarten group in grade 3, but fell behind again in grade 4. The z-score of grade 3 in the 2-year OVOP decreased by 0.23 standard deviations compared with grade 2. The gap between the 2-year OVOP group and the 3-year OVOP group also enlarged during time, widening from 0.05 to 0.26 SD. The score of the town private kindergarten group increased by 0.05 standard deviations from grade 2 to grade 3. The z-score of grade 3 of group without preschool education did not change from that of grade 1, but the scores of grade 2 and 4 decreased significantly by 0.04 and 0.07 standard deviations. See Figure 2 and Table 2 for details.

Overall, the z-score of the public kindergarten group was consistently the highest and remained stable. The results of the 3-year OVOP group and the 2-year OVOP group were similar in grade 1, but the 3-year OVOP group maintained a steady increase, while the 2-year OVOP group declined. In grade 3, the results of the 2-year OVOP group showed a significant decline. The growth rate of the private kindergarten group was similar to that of the 3-year OVOP group, and the growth was most significant in grade 3. The z-score of the students without pre-school education was consistently in the bottom and falling. The relative intercepts and trends of the five groups were almost consistent.

Although the 3-year OVOP group and the 2-year OVOP group had similar low family socio-economic background as the group that have not receive preschool education, the academic performance of the first two groups was 0.95 and 0.92 standard deviations higher than that of the no preschool education group respectively. By grade 4, the first two groups were 1.06 and 0.88 standard deviations higher, respectively. Although the family social-economic background of the students from the private kindergarten group and the public kindergarten group is relatively better, the scores of the students in the private kindergarten group are always inferior to OVOP groups. This result was confirmed by several data analysis methods.

4. DISCUSSION

The Chinese government always attaches great importance to children's development, and strives to provide fair, inclusive and high-quality preschool education opportunities for rural children. This study focuses on evaluating the cumulative effect of one more year of preschool education on children's academic performance during school, aiming to provide basic evidence for future policy formulation. For the first time studies the relationship between the duration of preschool education experience and the long-term "fade-out effect". This study evaluated the long-term effects of different preschool experiences on student achievement by using multiple propensity weighting scoring methods on a large sample of grade 4 in a poverty-stricken county.

According to the results of this study, an additional year of preschool experience attenuates the "fade out effect" and helps students maintain good academic performance growth trends over grade 3. The main research results are discussed in the following aspects:

4.1 Effects

As short term effects, this study, to some extent, were consistent with other studies, i.e. preschool education had a positive effect and the dose effect was negligible, if only the results of the first year after admission were concerned. Regardless of 2-years OVOP experience or 3-years OVOP experience, the average score of the OVOP group students was 0.3 standard deviation higher than the overall mean, 0.7 standard deviation higher than the students who had no preschool experience, and 0.4 standard deviation higher than the students from private kindergartens. Since OVOP was built in the rural areas that lack of resources, with poor conditions and lack of talent teachers, there was a significant gap between OVOP and those public kindergartens which was guaranteed by fiscal input. Therefore, the scores of the OVOP students were always behind those from public kindergartens. On the other hand, the background of students in the public kindergarten group usually have

better social-economic status, they have ability and willingness to enroll their children in extracurricular and interest classes.

Compared with town private kindergartens, OVOP has some positive factors. First, OVOP is built in villages, some children who used to have long time transportation can "backflow" to this nearby kindergartens. Daily tiring transportion will make children feel negative pressure, which will have a negative impact on children's development [65]. Second, the salary of teachers in OVOP is relatively close to that of teachers in private kindergartens. Moreover, teachers in OVOP serve their hometown as volunteers and are full of sense of honor and respect. As a result, teachers in OVOP have a longer working duration, compared with teachers in private kindergartens, who have relative higher mobility. Many OVOP teachers said that they were afraid of parents' criticism and conflicts when they worked as kindergarten teachers in cities, but they were recognized and respected in village. Third, OVOP has lower student teacher ratio than that of town private kindergartens, teachers have more energy to organize teaching, pay more attention to each child's emotion, development needs, and interact and help children more actively.

4.2 Dose effect

Existing dose-effect studies indicate that, in most cases, an extra year of preschool intervention has little effect on dose-effect and is an unnecessary evaluation [55]. In the first grade, the performance of the 3-year OVOP group was almost the same as that of the 2-year OVOP group, this finding is consistent with recent studies on the dose-effect that increased years of preschool education do not increase returns [1] [52] [61]. However, the goal of early intervention is not to improve children's basic academic abilities, and the extra year is not aiming to help children to learn more academic knowledge and skills [34]. The longer term performance study found that the 3-year OVOP group maintained its performance growth at a rate of 0.02 standard deviation per year, while the 2-year OVOP group had a negative slope of -0.03 standard deviation per year. By grade 4, the 3-year OVOP group almost caught up with the public garden group, while the 2-year OVOP group fell behind 0.18 standard deviations.

In order to further analyze the different developmental trajectory between the 3-year and 2-year OVOP groups, the discrete model was used to find that the 2-year OVOP group showed a large fade-out effect (0.2 standard deviation) in grade 3, while the 3-year OVOP group did not show a fade-out effect, but their grades still improved. The fade-out effect observed in the 2-year OVOP group is consistent with many previous studies, that is, in the long term, the effect of 2-year preschool education intervention tends to gradually

disappear. With the deepening of academic learning, the fade-out effect appears, and is most obvious in grade 3.

Sustained improvement in academic performance often depends on the accumulation of extra-curricular knowledge and the building of basic cognitive skills what cannot be reflected by test scores. One more year of preschool education allows children to enter the kindergarten between 3 and 4 years old, which is more in line with the early rich stimulating environment emphasized by the theory of early childhood development, and is conducive to the development and formation of children's general knowledge, language ability, mathematical perception, self-control, etc. [63]. General knowledge and vocabulary are core predictors of reading and comprehension ability [59], mathematical perception is a key predictor of mathematical ability [36], and self-control is the basis of long-term learning habits and mental resilience [49]. Child development is structural, and there is an "optimal teaching period" for the formation of some abilities [72], which cannot be made up for if missed, such as language ability. Full interaction, play and help between adults and children during the "best teaching period" can expand children's "zone of proximal development", that is, human potential [73]. To some extent, the above theories explain that an extra year of preschool education may be more in line with the "optimal teaching period" of children's development and expand their "zone of proximal development", whereas if children start preschool education at age 5, it may already be too late. The education level of the primary caregivers of rural children in poor areas is generally low, which is more unfavorable to the learning and development of children at home. More than a year the development of preschool education can make children have accumulated more basic ability, good teacher interaction more expanded their potential, and is not a simple subject knowledge accumulation, the basic ability and potential in a first grade exam does not show, but by the end of third grade, need more independent ability to learn and understand, This potential often shows the advantages of sustainable development.

4.3 Limitations and prospects

This study focuses on the school performance of rural children in poverty-stricken areas, and explores the dose-effect, fade-out effect and possible influencing mechanism of preschool education experience on school performance. On the basis of this study, some research directions are worthy of attention and further development. One is to study the social emotion and intelligence of children. An independent person can evaluate his development level and potential from biological, social and intellectual aspects (Shi, 2003; Shi, 2010), this study did not conduct research and evaluation on the basic abilities and characteristics of children, nor

did it conduct in-depth analysis on the "hidden skills" that led to the ability differentiation of students in the 3-years OVOP group and 2-years OVOP group.

The second is the relationship between preschool education quality and individual development level. There have been some international studies on factors that may influence children's development in preschool education, such as whether playing materials are abundant and suitable for children's development needs, teachers' sense of efficacy, teachers' way and content of questioning, and emotional communication in teacher-student interaction [67]. This study does not directly analyze the classroom teaching practice of one village and one garden, but only analyzes the possible influence on children's development and early learning from the basic characteristics of teachers. In future studies, the heterogeneity of education quality on the population can be further analyzed.

The third is the universal value of this research. This study is based on a full-sample study in a County from Guizhou Province. For this county, the effect of preschool education is universal, and this study also promotes the standardized development of preschool education in county level. But could this study and results be extrapolated to other poor rural areas across the country? Some basic factors of preschool education are inspiring and worthy of reference, such as basing a preschool education into the village, recruiting teachers locally, carrying out rigorous assessment and training, and providing preschool education intervention for children from the age of 3, ensuring appropriate teaching resources and salaries. If the basic conditions and quality of education can be guaranteed, the intervention and effect are of promotion value.

Fourth, the impact of the quality of primary education. In this study, primary education is a post-intervention event compared with preschool education, and many studies have pointed out that controlling post-intervention events will have a bias on the estimation of intervention effect, so this study did not deal with it too much. However, the analysis of the characteristics of primary schools can be interpreted from another perspective, to what extent students' academic abilities and achievements can be attributed to preschool education, and to what extent they can be attributed to the heterogeneity of primary schools. With the integration of schools and the deepening of urbanization in China, the teaching quality of compulsory education schools in poor counties tends to be more and more balanced. At the same time, teachers in poor areas adopt the post rotation and exchange system, that is, teachers, especially excellent teachers, should teach in different schools and organize teaching and research. As a result, differences in the quality of education in schools are narrowing.

OVOP is an inclusive intervention service and a natural control was formed during the process of

intervention, not a randomized controlled trial. Compared with the randomized controlled trial, the universal benefit intervention lacks scientific rigor, but it is more consistent with the universal value in terms of ethics and morality, and more in line with the development needs of the country and society. In this study, statistical analysis method is used to make up for this problem to some extent. Is worth discussing, based on real extensive social living environment of the intervention experiment, often influenced by various realistic situation, including the people and the flow of information and communication, administration of convergence, and the merit of parents, etc., therefore, randomized controlled trial of the realistic social environment scientific rigor will face challenges.

5. CONCLUSION

The conclusion of this study is that providing 3-year preschool education for rural children in poverty-stricken areas is more in line with the principle and needs of children's development, and can better stimulate children's potential and ensure the long-term effect of preschool education. Governments at all levels should strive to extend the length of preschool education from one or two years to three years, rather than merely providing preschool education services with limited effects from the perspective of cost and management complexity. The effect of one more year of preschool education is fully evident in the later stage of primary school, affecting the long-term development trajectory of children. The dose-effect of preschool education can reduce or even eliminate the "fading effect" and help children maintain their learning advantage in the long term.

In recent years, the model and experience of OVOP has been absorbed and promoted by the national education policy. Preschool education in the countryside of the central government and local government pays great attention to quality, especially in preschool education as part of the education service system, the education quality for the effect of the whole education system, therefore, the state education department around pre-school education supply, starting from the top design specification will be three years gross enrollment rate of preschool education as statistics and evaluation indicators

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