Can Higher Household Education Expenditure Improve the National College Entrance Exam Performance? Empirical Evidence from Jinan, China

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The purpose of this study was to examine the effect of household education expenditure on National College Entrance Exam (NCEE) performance in China. Using a comprehensive dataset with a sample size of 5840 students collected in Jinan, China, this study found that the average effect of household education expenditure on NCEE performance is not significant, but it may have a significant and positive effect on those with higher test scores. There is a significantly positive effect on Chinese scores for students at the 0.75th quantile and on English scores for those at the 0.5th quantile.

Introduction

Among all types of educational inputs available for research, educational expenditure is one of the most important (Zhou & Zhang (authors, 2015)). It plays an important role in the accumulation of human capital and the economic growth of one country (Kaganovich & Zilcha, 1999; Shi, 2006). Evaluating the effects of educational expenditure on student achievement is, therefore, a crucial issue for both researchers and stakeholders in education systems. Although public expenditure has been extensively researched in the context of debates on school effectiveness and government accountability (Tsang 1994; Tsang and Ding 2005), very limited data for household education expenditure has been provided, primarily due to data constraints. A better understanding of household education expenditure is very important, for it would play an important role in family, school and policy decisions towards resource allocation in China. For one thing, it can help to improve educational quality. Household education expenditures are private resources that augment public resources to education. It can be used as interventions to

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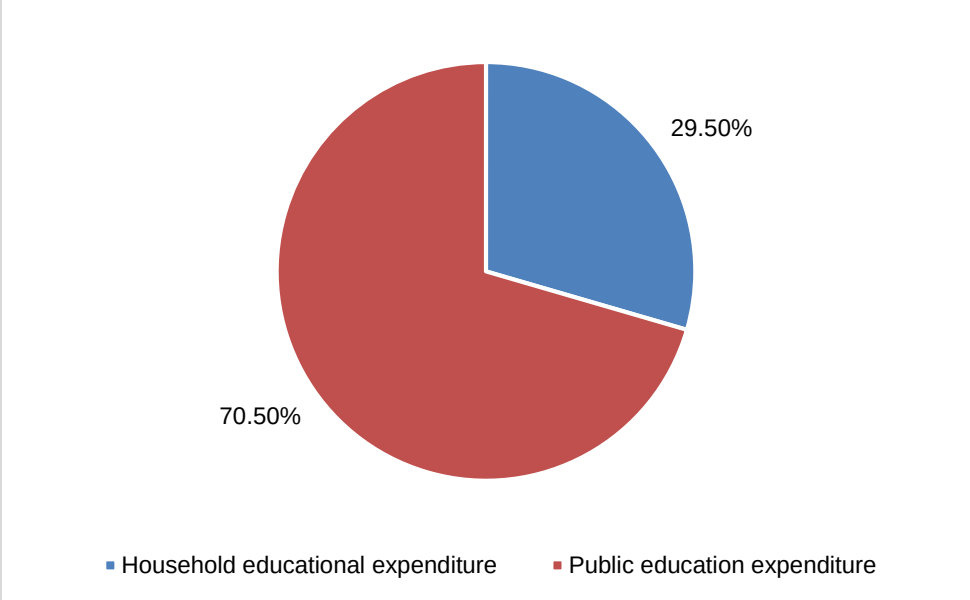
enhance education quality. Furthermore, household education expenditure can also help to address the educational inequality issues. Disparities in household education expenditure among social groups may exacerbate educational inequalities among social groups. It may help policymakers to design policies to mitigate educational inequality if there is a good understanding of variation in household investment to education (Tsang & Kidchanapanish, 1992; Shi, 2006).

Household educational expenditure, or monetary spending, contributed by families for their children's education, constitutes an important part of total education expenditures (Li & Tsang, 2003; Tsang, 2002). According to national statistics in China, the scale of household educational expenditure was 8959.05 billion RMB (1298.41 billion US$) in 2013, accounting for 29.5% of total education spending (public education expenditure totaled 21405.67 billion RMB, or 3102.27 billion US$) (Figure 1).

Figure 1. The scale of household and public education expenditure.



Source: Yearbook of China Education Statistics (2013)

Household educational expenditure constitutes a significant proportion of household spending. In urban families, household educational expenditure accounted for 35.1% of total household expenditure, and it accounted for 30.1% of total family income in 2013.[1] In addition, household educational expenditure is strongly correlated with household income and wealth; high household income often predicts high household education

[1] Statistic Report on National Education Expenditure in 2013, published by the Ministry of Education, National Statistics Bureau, and the Ministry of Public Finance.

expenditure (West, 1995; Foko, Tiyab & Husson, 2012; Zhou & Zhang (authors, 2015)). With the increasing attention on improving student achievement, a growing number of parents spend more on education with the hope that it will help their children get better grades and scores relatively than their peers on exams. Examining the effectiveness of household education expenditure would help families make optimal decisions towards investment on education.

One of the most serious difficulties in China's development of economy and society is the dualistic structure system of urban and rural. Getting access to higher education is the best way for the students from poor or rural families flow from lower class to higher class in society (Zhou, 2001; Xu & Yi, 2014). Therefore, exam-oriented education (the fairest competition mechanism so far in China) is powerful for narrowing the urban-rural gap, and rich-poor gap. In China, senior high school is not only the first stage of non-compulsory education but also the most crucial stage connecting basic education to higher education. If household education expenditure can significantly improve student achievement as far as the National College Entrance Exam (NCEE), and, therefore, college admission probability, it may enhance the role of the education system in stratifying social classes ensuring social equity, and maintaining social stability of Chinese society. Thus, it is crucial to evaluate the influence of household educational expenditure on student achievement using solid empirical evidence.

Among the first ones to investigate the impact of household education expenditure on student NCEE performance in China, this study sheds light on household education investment and also on education policy reforms. The findings are helpful for parents to decide how much they will invest education expenditure on their children. According to the different effects across groups, policy makers can decide how much they will invest public education expenditure on students with different backgrounds, which could help to mitigate educational inequality.

Literature Review

Although many prior studies have examined the determinants of household educational expenditure (e.g., Tsang & Kidchanapanish, 1992; Tansel, 2002; Glick & Sahn, 2000; Brown & Park, 2002; Lokshin & Sawada, 1999; Zhou & Zhang (authors, 2015)), relatively few studies have attempted to evaluate the effect of household educational expenditure on student academic achievement. None of them have focused specifically on China. Tansel (2002) used an ordered probit model and a well-designed dataset that covered 26256 families in Turkey to find household education expenditure has a positive correlation with school enrolment at primary, middle, and high school levels. This was not a causal

inference, however, and the study did not use test scores as an education outcome. Using ordinary least square (OLS) regression and data from the National Education Longitudinal Survey (NELS), Israel, Beaulieu & Hartless (2001) found a positive effect of household education expenditure on math test scores, reading scores, and staying in school. However, the sample used only included 8th-grade students, and may not apply to students at all levels. On the contrary, Liu & Xie (2015) use the 2010 China Family Panel Studies (CFPS) data and OLS regression, and find that family education expenses have no effect on students' verbal ability in China. Using data from more than 2000 families in five areas in China, Liang (2012) found household education investment, especially the out-of-school investment, has a significant positive impact on the changes in student test scores. However, this study used the 2010 fall semester test scores as the post-test scores and 2010 spring semester test scores as the pre-test scores. The tests are not standardized which cannot reflect student academic performance. The time between the two tests was short and the results might be biased.

The existing results are mixed, and only two studies are in China. This study aims to identify the effects of household educational expenditure on NCEE achievement using individual-level data in China. The significance of this study lies in four aspects. First, this study is among the first to evaluate the achievement effect of household education expenditure on NCEE performance in China, and this study is the first to report detailed information of household education expenditure in China. Second, this study employed the NCEE score as a measure of student achievement, i.e. the outcome variable. High School Entrance Exam (HSEE) as prior test scores are also included. NCEE and HSEE are the most representative exams in China, and it can truly reflect student academic achievement. Third, this study took subject difference into consideration. Fourth, this study estimated the heterogeneous effects of household education expenditure among female and male students, urban and rural students, and students with different academic achievement levels.

According to theories and previous study, household education expenditure is determined by student academic achievement (Tansel, 2002; Israel, Beaulieu & Hartless, 2001), such as High School Entrance Exam (HSEE) scores for high school students, annual family income, academic track, gender, urban-rural status, and socioeconomic status (SES) (Tsang & Kidchanapanish, 1992; Zhou & Zhang (authors, 2015)), some of which might also affect student NCEE scores (Zhang, 2013). If this kind of mutual determinants of NCEE score and household educational spending were omitted in the Education Production Function regression, the estimated coefficient for household educational

spending would be biased. Therefore, this study collected data on all the major factors, and they are all controlled in the regression.

The above section discussed the motivation behind this research and reviewed literature on the achievement effect of household education expenditure. The remainder of the paper is organized as follows: Section 2 discusses methodology, Section 3 describes the data collection and descriptive statistics related to this study, Section 4 reports the empirical results, and Section 5 provides a brief summary and conclusions.

Methodology

Model Setup The empirical model and data collection are based on Education Production Function. An Education Production Function is a mathematical relation showing the maximum education outputs that can be produced with the given educational resources under a given education technology (Cohn & Geske, 1990). According to the Education Production Function, the formation of academic achievement as the educational output will be affected by the personal and school inputs. As a kind of educational input, household education expenditure is regarded as the key variable affecting educational output here; several other variables are controlled in the regression. The regression model used in this study can be expressed as follows:

$$NCEE = \alpha + \beta \cdot household\ education\ spending + \delta \cdot X + \varepsilon$$

where NCEE refers to a student's comprehensive NCEE score, which includes Chinese, English, and mathematics scores. In Shandong Province, there are five subjects in NCEE: all students must take Chinese, English, math, and comprehensive capability exams and the tests for science track and humanity track students are different. Science track students must take comprehensive science tests (physics, chemistry, and biology), and humanity track students must take comprehensive humanities tests (politics, history, and geography).

Household education spending is the key variable of interest in this study. Monthly household education expenditure data was obtained through a multiple-choice questionnaire used in the survey (to be explained later), with spending level choices including fifteen categories.[2] We converted this categorical variable into a continuous

[2] i.e. below 200 RMB, 201-500 RMB, 501-800 RMB, 801-1000 RMB, 1001-1500 RMB, 1501-2000 RMB, 2001-3000 RMB, 3001-5000 RMB, 5001-7000 RMB, 7001-9000 RMB, 9001-11000 RMB, 11001-13000 RMB, 13001-15000 RMB, 15001-20000 RMB, and above 20000 RMB.

variable, and the upper limit of each level was used as the real value of self-reported expenditure. In fact, the empirical results are consistent using the lower limit value, median value, or the upper limit of each category as the real value (see Appendix Table A4). X is a vector of control variables including annual family income, gender, urban-rural status, socioeconomic status (SES), academic track, corresponding High School Entrance Exam (HSEE) score, and high school admission line (which measures the general school quality). Table 1 details how each control variable was measured. ε is the error term.

Table 1: Measurement of control variables.

Variables	Variable types	Measurement or comments
Annual Family Income	Continuous variable	Converted from categorical variable using the upper limit of each option as the real value.
Female	Dummy variable	Female=1 if the student is female; =0 if male
Rural	Dummy variable	Rural=1 if the student comes from a rural family; =0 if from an urban family.
SES	Continuous variable	Index constructed through principal component analysis using four variables: father and mother's respective education level, and father and mother's respective occupation (which relates to social status).
Science track	Dummy variable	Science track =1 if the student is in science track; =0 if humanity track.
HSEE admission line	Discrete variable	HSEE score of admission line for high schools.
HSEE	Continuous variable	Standardized scores with mean of zero and standard deviation of one.

According to Zhou & Zhang (authors, 2015), the factors that can influence household education spending include annual family income, gender, urban-rural status, SES, and HSEE score. All these factors were controlled carefully, resulting in estimated effects of household education spending that are demonstrably unbiased.

Measurement of Household Education Expenditures In empirical social science studies, exact measurement of the variables of interest is often difficult to secure and can consequently cause bias in the regression. Special focus was placed on this concern to ensure accurate results; information for household income or household education expenditure collected through survey methods may not be precise due to respondents'

difficulty in recalling exact figures, for example. The potential bias generated by measurement error can be interpreted by the following equations:

$$y_t = \alpha + \beta x_t^* + \varepsilon_t$$
$$x_t = x_t^* + \eta_t$$

where x* denotes the true but unobserved value, which can be called a latent variable. x is observed value of x*. ε and η are model errors and measurement errors respectively, and measurement error η is assumed to be independent from the true value x*. If y is simply regressed on x, the coefficient of the slope is as follows:

$$\hat{\beta} = \frac{\sum_{t=1}^{n}(x_t - \bar{x})(y_t - \bar{y})}{\sum_{t=1}^{n}(x_t - \bar{x})^2}$$

$$\hat{\beta} \to \frac{Cov[x_t, y_t]}{Var[x_t]} = \frac{\beta\sigma_{x^*}^2}{\sigma_{x^*}^2 + \sigma_\eta^2} = \frac{\beta}{1 + \sigma_\eta^2/\sigma_{x^*}^2}$$

where $\hat{\beta}$ is smaller than the true value of β, and it biases toward zero. That is to say, the regression coefficient is diluted by the measurement error. We did take this potential bias into account.

Endogeneity and Omitted Variable Bias (OVB) In any statistical model, endogeneity is a problem that occurs when the independent variable is correlated with the error term in a regression. Omitted variables are one of the common sources of endogeneity. If an independent variable is correlated with the key variable of interest and is omitted in the regression (i.e., left in the residual term,) the key variable of interest will be correlated with the residual and the OLS estimation will be biased. This problem is called "omitted variable bias" (OVB).

In this study, the potential for OVB was avoided by including the most likely major control variables in the regression according to theories and previous research. According to Zhou & Zhang (2015), the factors that can influence household education spending include annual family income, gender, urban-rural status, SES, and HSEE score. All these factors were controlled carefully to prevent OVB, resulting in estimated effects of household education spending that are demonstrably unbiased.

Data Collection and Descriptive Statistics

Data Collection The data used in this study was collected from Jinan, the capital of Shandong Province in China. A non-proportional, stratified cluster sampling strategy was utilized. Twenty-five senior high schools were randomly selected out of 34 public regular high schools from 9 districts in Jinan, including 15 urban schools, 8 county schools, and two rural schools. Within each high school, 3-5 classes in Grade 12 were randomly chosen and all students in the selected classes were sampled. The sample size in this study was 5840 students in total.

There was a large proportion of missing data in the financial variables, around 44%. It is common because financial data is difficult to recall. It is assumed that the data is missing at random. Table 2 reports the disparities of NCEE scores and HSEE scores between students in the missing subsample and non-missing subsample. The missing subsample is the subsample containing a large proportion of missing data in the financial variables. The differences of these scores between the two subsamples are not significant. Therefore, it is reasonable to rely on this data.

Table 2. Descriptive Statistics for missing and non-missing subsamples

Variables	Missing subsample	Non-missing subsample
NCEE total score	468.71	472.28
NCEE Chinese score	98.64	98.86
NCEE Math score	94.84	94.01
NCEE English score	92.00	92.56
HSEE total score	552.23	551.43
HSEE Chinese score	88.47	87.90
HSEE Math score	104.47	104.17
HSEE English score	101.90	101.14

Note: *p<0.05, ** p<0.01.

In order to make full use of all the data gathered and improve its statistical power, the multiple imputation (MI) method was applied. MI is a flexible, simulation-based statistical technique for handling missing data which consists of three steps:[3]

[3] Stata multiple-imputation reference manual. Release 13. http://www.stata.com/manuals13/mi.pdf. Table A1 shows the procedure of multiple imputation.

(1) Introduce random variation into the imputation process, and generate several data sets, each with slightly different imputed values.
(2) Perform an analysis on each of the data sets.
(3) Combine the results into a single set of parameter estimates, standard errors, and test statistics.

Descriptive Statistics

Table 3 shows the mean values of education spending on various items. Self-reported education spending is the spending reported by parents, and it is an average expenditure for each year across Grade 10-12. Calculated education spending is the spending calculated by the authors according to detailed expenditure items, including school choice fee (1 year), tuition fee, boarding fee, private tutoring expenditure, computer purchases, and other education-related expenditures. Spending on school related items includes a school choice fee, a tuition fee, and a boarding fee. The "school choice fee" is paid by parents who choose to enroll their child in high-performing schools if the child's HSEE score is a few points lower than that school's HSEE admission line. The school choice fee is a one-time donation that covers the child's entire high school education, so one-third of the school choice fee is considered annual household spending.[4]

The mean of self-reported education spending is 6875 RMB (996.38 US$), while calculated education spending has a mean of 5817 (843.04 US$). Due to the potential omitted items in the calculated education expenditure, this study took self-reported education spending as an independent variable (Private tutoring fee, computer purchases, and other education-related expenditures are the average expenditures for each year across Grade 10-12.).

[4] This policy was supervised by the local education authority, but was abolished from 2015.

Table 3. Mean values of various education expenditures.

Variables		Mean
Self-reported education spending		6875.19 (996.40 US$)
Calculated education spending		5817.05 (843.05 US$)
Spending on school-related items	Tuition fee	1485.75 (215.33 US$)
	Boarding fee	298.00 (43.19 US$)
	School choice fee (3 years)	2931.00 (424.78 US$)
Expenditure on academic-oriented private tutoring		630.81 (91.42 US$)
Expenditure on art/music/sport tutoring		222.92 (32.31 US$)
Computer purchases		1529.85 (221.72 US$)
Other education-related expenditures		687.06 (99.57 US$)

Note: Units in RMB.

According to Zhou & Zhang (authors, 2015), family income, socioeconomic status, high school entrance exam score, and gender are the main influencing factors of household education expenditure. Annual family income has a positive effect on household education expenditure, but the impact of household income on school-related spending is not significant. This is mainly due to little variation in tuition or boarding fees. SES has a significant positive impact on household education expenditure, and the higher a student's HSEE scores, the lower their household's education expenditure. The household education expenditure of female students is significantly higher than that of male students, and the household education burden on rural students is higher than that on urban students; therefore, we selected these variables as covariates.

Table 4. Covariates on NCEE achievement.

Variables	Observations	Mean	Std. Dev.	Min	Max
Annual family income	4470	47428.38 (6873.68 US$)	39729.47	6000	240000
Female	5839	.53	.50	0	1
Rural	5839	.49	.50	0	1
Science track	5722	.57	.50	0	1

The covariates in the analyses include yearly household income, HSEE score, gender composition, percentage of rural students, SES, academic track (science or humanities), and high school admission line. As Table 4 shows, average annual family income is 47428 RMB (6873.62 US$). The proportion of female students is 53.3%, 48.6% of the students come from rural families, and 57.2% of the students are on the science track. SES and HSEE scores are standardized, with a mean of zero and standard deviation of one.

In China, the *hukou* registration system divides the student population by residence into "rural" and "urban" categories. Students who come from rural families have lower education expenditure and lower education quality than their urban counterparts. Rural students can attend urban high schools if they show high academic performance. Table 5 compares the mean of household education expenditures on various items for both urban and rural students. There is not much difference between the two categories as far as tuition and boarding fees. Concerning school choice fee, urban students spend about two times as much as rural students. The total expenditure on private tutoring for urban students is 2489.384 RMB (360.780 US$) on average, while the private tutoring expenditure for rural students is only 319.034 RMB (46.237 US$). Computer purchases and other education-related expenditures for urban students are much greater than those for rural students.

Table 5. Household education expenditures on various items.

Main components of household education expenditure	**Mean**	
	Rural students	**Urban students**
Tuition	1364.55 (197.76 US$)	1645.33 (238.45 US$)
School choice fee	2406.09 (348.71 US$)	4140.86 (600.12 US$)
Boarding	315.44 (45.72 US$)	261.22 (37.86 US$)
Expenditure on academic-oriented private tutoring	160.76 (23.30 US$)	1635.25 (236.99 US$)
Expenditure on art/music/sport private tutoring	158.27 (22.94 US$)	854.13 (123.79 US$)
Computer purchases	903.21 (130.90 US$)	2126.41 (308.18 US$)
Other education-related expenditures	538.81 (78.09 US$)	1145.71 (166.04 US$)

Note: Units in RMB.

Figure 2 compares the total NCEE scores of urban and rural students. In the top 50%, the total proportion of rural students is higher than urban students. This result is consistent

with the fact that only outstanding rural students are accepted by high schools, currently at only a 10% proportion of the total high school student population. Technically, 80% of urban students can be accepted to urban high schools, but between 2007 and 2010 the proportion reached as high as 90% (Figure 3).

Figure 2. NCEE distribution of urban and rural students.

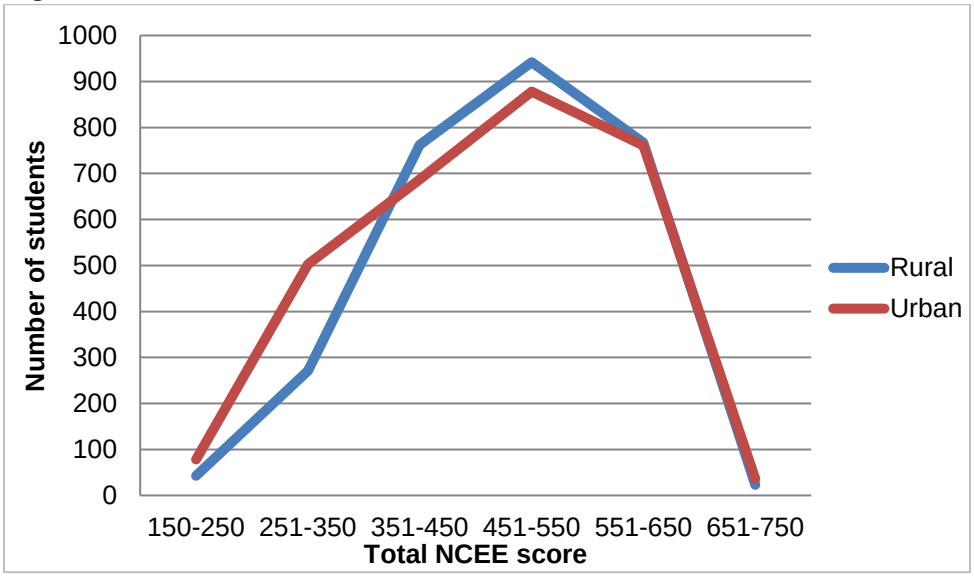
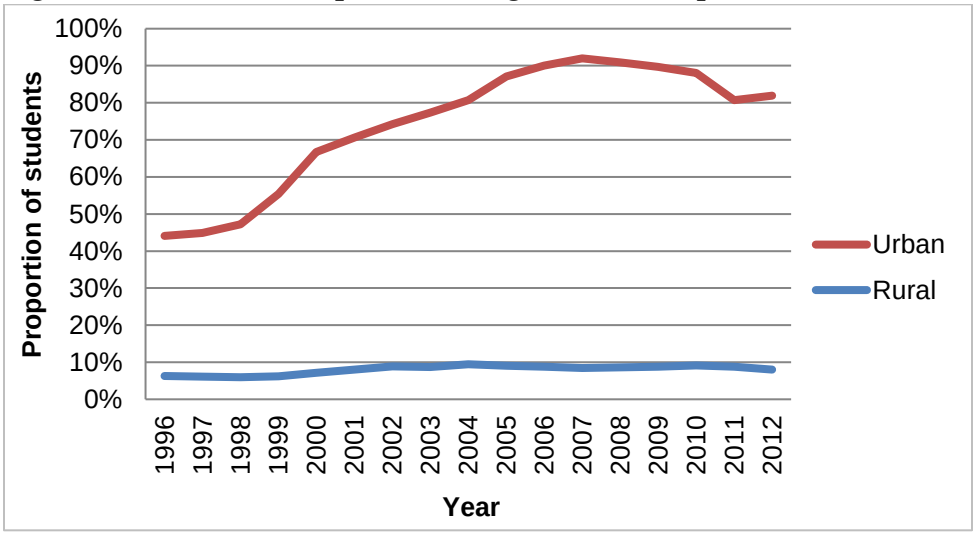


Figure 3. Urban-rural disparities in high school acceptance rate.



Source: Yearbooks of China Education Statistics (2000-2013)

Empirical Results

This section discusses the effects of household education expenditure on student NCEE achievement by subject. Table 6 lists the effects of household education expenditure on

NCEE achievement for urban and rural students, female and male students according to the total score, Chinese score, math score, and English score. There is no effect of household education expenditure on NCEE score for the whole sample or subsamples. For robustness check, Table A2 shows the effect of calculated household education expenditure in the appendix. The results reported in Table A2 are consistent with those in Table 6.

Table 6. Effects of household education expenditure on NCEE achievement.

Sample	Total score	Chinese	Math	English
All	0.018	0.003	0.010	0.021
	(0.015)	(0.021)	(0.017)	(0.019)
Female	0.002	-0.015	-0.004	0.018
	(0.015)	(0.025)	(0.021)	(0.023)
Male	0.033	0.020	0.023	0.025
	(0.020)	(0.025)	(0.023)	(0.019)
Urban	0.014	0.008	-0.021	0.011
	(0.023)	(0.027)	(0.026)	(0.026)
Rural	0.012	-0.007	0.036	0.025
	(0.019)	(0.030)	(0.021)	(0.025)

Note: Standard errors in parentheses. * $p<0.05$, ** $p<0.01$.

This study also examines the effect of specific types of expenditure, i.e. spending on school-related items, private tutoring fees, and computer purchases on student NCEE performance. Table 7 reports the effects of each specific household education expenditure on student NCEE achievement. For school-related expenditure, it has no impact on student total score, but it has a significantly negative impact on student Chinese, Math and English achievement respectively. With regard to academic-oriented private tutoring expenditure, it has no effect on student total score, Chinese score or English score, while it has a significantly negative effect on Math score. Art/music/sports tutoring expenditure and computer purchases have no impact on student NCEE achievement according to the total score, Chinese score, math score, or English score.

Table 7. Achievement effects of specific household education expenditure.

Specific expenditures	Total	Chinese	Math	English
	(1)	(2)	(3)	(4)
Spending on school-related items	-0.034	-0.090	-0.083	-0.086*
	(0.042)	(0.055)	(0.049)	(0.034)
Expenditure on academic-oriented private tutoring	-0.042	-0.058	-0.031*	-0.026
	(0.024)	(0.032)	(0.019)	(0.014)
Expenditure on art/music/sport tutoring	-0.042	-0.048	-0.039	-0.058*
	(0.021)	(0.026)	(0.023)	(0.017)
Computer purchases	-0.019	-0.016	-0.029	-0.009
	(0.023)	(0.028)	(0.031)	(0.025)

Note: Standard errors in parentheses. * $p<0.05$, ** $p<0.01$.

The model found that the average effect of household education expenditure on NCEE performance is not significant. However, the reasons for the results are not clear. To get more detailed information, we also used quantile regression to more closely examine the heterogeneous effect of household expenditure on students with different levels of academic achievement. Quantile regression aims at estimating either the median or other quantiles of the dependent variable. Relative to the ordinary least squares regression, the quantile regression estimates are more robust (Koenker & Bassett, 1978).

Column (1) of Table 8 shows the effect of household education expenditure on total NCEE score, and Columns (2), (3), and (4) show the results for Chinese, math, and English, respectively. Regarding total NCEE score, household education expenditure has a significantly positive effect on the students whose NCEE total score is at 0.9^{th} quantile, while there is no effect on those whose scores are at the 0.75^{th}, 0.5^{th}, 0.25^{th}, or 0.1^{st} quantiles. For Chinese scores, household education expenditure has a significant and positive effect on students whose scores are at the 0.75^{th} quantile. There is no effect of household education expenditure on math scores at any quantile. In terms of English scores, there is a significantly positive correlation at the 0.5^{th} quantile of the distribution. For the robustness check, the results reported in Table A3 shows there is no effect of calculated household education expenditure on the students with different levels of academic achievement.

Table 8: Achievement effects of household education expenditure, by quantile.

Quantile	Total score	Chinese	Math	English
	(1)	(2)	(3)	(4)
0.9	0.040**	0.023	0.024	0.006
	(0.014)	(0.023)	(0.017)	(0.011)
0.75	0.016	0.044*	0.009	0.004
	(0.014)	(0.020)	(0.019)	(0.015)
0.5	-0.004	-0.000	0.004	0.040**
	(0.014)	(0.021)	(0.015)	(0.015)
0.25	-0.013	0.014	-0.006	0.015
	(0.013)	(0.025)	(0.019)	(0.017)
0.1	0.014	0.017	-0.004	0.038
	(0.019)	(0.026)	(0.026)	(0.020)

Note: Standard errors in parentheses. * $p<0.05$, ** $p<0.01$.

Figure 4 presents the heterogeneous effects of household education expenditure on NCEE score by subject. The solid lines represent the estimated coefficient of household education expenditure, and the gray areas are 95% confidence intervals. There is no significant effect at any quantile for math score, but a significantly positive effect on Chinese scores for students at the 0.75th quantile and on English scores for those at the 0.5th quantile. There is a significant and positive effect on total NCEE score for higher-achieving students.

Table 9 reports the effects of all the control variables. Annual family income has no effect on total NCEE score or scores in any of the three subjects. HSEE score is, however, a significant and positive determinant of the NCEE score across all subjects. There is no gender disparity in total NCEE score, Chinese score, or math score, but a gap favoring girls in English score. Rural students perform better than urban students on the NCEE across all subjects. SES has a positive effect on total NCEE score as well as math and English, but no effect on Chinese score. Because NCEE tests are different for science and humanity track students, NCEE achievements between these two groups differ significantly.

Figure 4. Heterogeneous effects of household education expenditure on NCEE scores

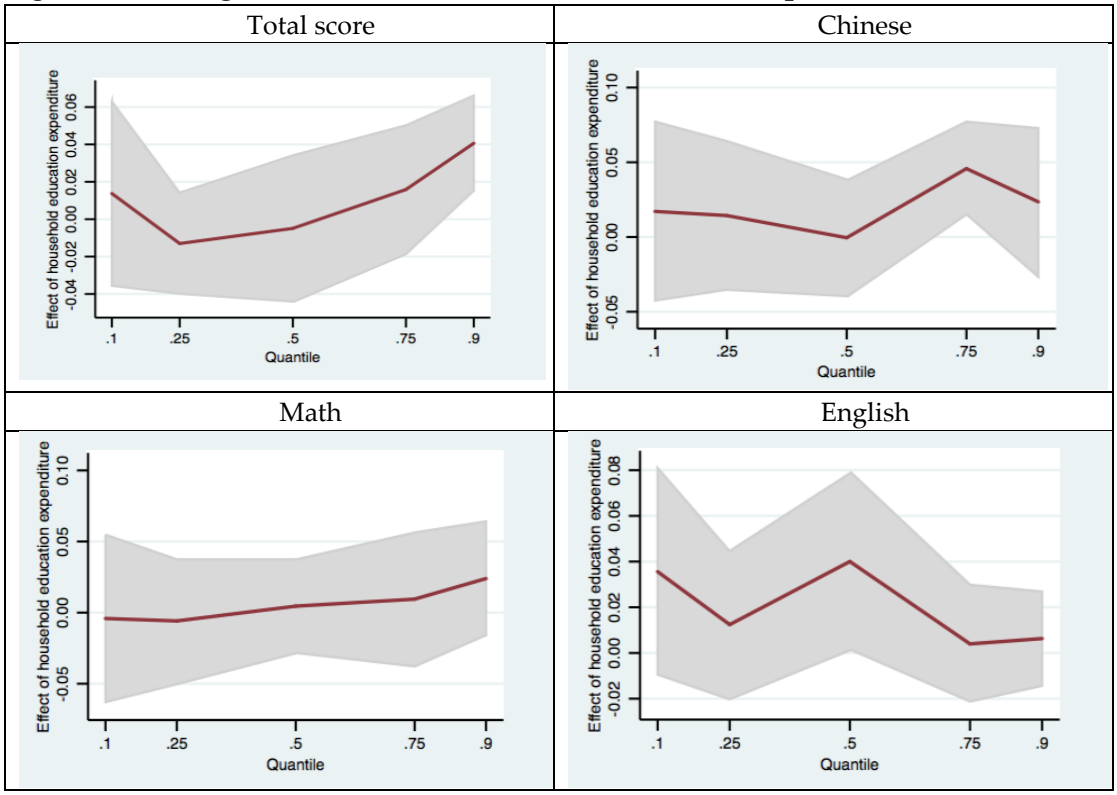


Table 9. Estimated coefficients of control variables.

	Total score	Chinese	Math	English
Annual family income	-0.019	-0.029	-0.028	-0.011
	(0.016)	(0.022)	(0.022)	(0.018)
HSEE	0.687**	0.460**	0.590**	0.600**
	(0.045)	(0.035)	(0.044)	(0.046)
Female	-0.010	0.068	0.001	0.012**
	(0.026)	(0.033)	(0.033)	(0.022)
Rural	0.205**	0.227**	0.238**	0.014*
	(0.056)	(0.045)	(0.055)	(0.054)
SES	0.014	0.004	0.016	0.037**
	(0.011)	(0.014)	(0.013)	(0.010)
Science track	-0.340**	0.049	-0.321**	0.118*
	(0.052)	(0.044)	(0.049)	(0.045)

HSEE admission line	0.246**	0.030**	0.265**	0.280**
	(0.047)	(0.062)	(0.064)	(0.049)
N	4335	4343	4343	4343
F	103.72	85.14	101.74	153.52
Prob>F	0.000	0.000	0.000	0.000

Note: Standard errors in parentheses. * p<0.05, ** p<0.01.

In summary, the average achievement effect of household education expenditure is not significant overall but may have some positive effect on high achievers. More specifically, household education expenditure may be effective for students whose Chinese scores are at the 0.75th quantile and for those with English scores at the 0.5th quantile.

Conclusions and Discussion

Generally speaking, the average effect of household education expenditure on student NCEE achievement is not significant. This result is consistent with Liu & Xie (2015)'s finding on verbal test. There are several plausible reasons for this observation. Household education expenditure includes tuition fee, boarding fee, school choice fee, private tutoring spending, and other expenditures; among these, tuition fee is a cost that every student's family must pay except for those well below the poverty line. The range of tuition cost was 1100-2000 RMB (159.42-289.86 US$) for one year in 2013 in Shandong province.[5] There is not much difference in student boarding fees, either. Therefore, neither variable contributes significantly to variations in NCEE performance.

School choice fee is another portion of household education expenditure. The empirical results show that school-related expenditures have no impact on student total scores. However, it has a significantly negative impact on student Chinese, Math and English scores. Since there are not much variation in the tuition fee and boarding fee, the negative effect may all come from school choice fee. According to Chen, Ding, and Ye (2014), Zhang, Chen & Wang (2014) and Zhang, Liu & Li (2015), high-performing schools may not effectively improve test scores for students who are already high performing through physical inputs, teacher effect, or peer effect. Therefore, those who have high scores but are just below the admission line for high-performing schools pay school choice fee to enroll, but may not benefit from this investment. The "key & non-key school system" has resulted in a severe competition in terms of school choice in China. Thus causing parents to pay a large number of household expenditures for their children to get into key schools

[5] See Yearbook of China Education Statistics (2013).

(Zhang, 2013; Zhang, Chen & Wang, 2014). Since school choice cannot improve student academic performance, parents should invest less money on school choice. Governments should also make efforts to forbid school choice and to achieve educational equity and quality by reducing the achievement gap between high performing schools and low performing schools.

Private tutoring fees are also included in total household education expenditure. According to Zhang (2013), the average effect of private tutoring on NCEE score is not significant; therefore, this portion of household expenditure is also not significant. Furthermore, the effect of computer purchases is also not significant.
In summary, because the majority of the individual portions of household spending on education are not effective, it is reasonable to assume that the average effect of total household spending is not significant. It may be effective on certain subgroups, however, according to the quantile regression results.

This study is among the first to evaluate the achievement effect of household education expenditure on NCEE performance in China. Besides estimating the average effect of household education expenditure on student academic performance for the whole sample, urban subsample and rural subsample, female subsample and male subsample, this study also examined the heterogeneous effect of household expenditure on students with different levels of academic achievement. According to the different effect across groups, families could make better decisions on the educational investment according to the empirical results.

There are several limitations of this study. First, this study only estimates the effect on Grade 12 student performance in Jinan, China, which may undermine the external validity of the results. In order to improve the external validity of the results, it is necessary to collect data from different regions in China or worldwide and at different educational levels. Secondly, the exact measurement of the variables is often difficult to obtain and consequently causes bias in the regression. The information of students collected through survey might not be accurate because of the difficulty in recalling memory and so on. Finally, although the potential for endogeneity was avoided by including most possible major control variables in the regression, better identification strategies should be employed in the future.

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Appendix

Table A1. The Procedure of Multiple Imputation

Variables	Observation	Proportion of data missing	Filled-in	Total
Self-reported education spending	4479	23.30%	1361	5840
Calculated education spending	3305	43.41%	2535	5840
Spending on school-related items	4514	22.71%	1326	5840
Tuition fee	4843	17.07%	997	5840
Boarding fee	4521	22.59%	1319	5840
Expenditure on academic-oriented private tutoring	5256	10.00%	584	5840
Expenditure on art/music/sport tutoring	5163	11.59%	677	5840
School choice fee (3 years)	5055	13.44%	785	5840
Computer purchases	5212	10.75%	628	5840
Other education-related expenditures	4360	25.34%	1480	5840

Note: Observations + Filled-in observations = Total.

Table A2. Effects of calculated household education expenditure on NCEE

Sample	Total score	Chinese	Math	English
All	-0.021	-0.024	-0.023	-0.021
	(0.011)	(0.013)	(0.012)	(0.011)
Female	-0.013	-0.018	-0.007	-0.011
	(0.013)	(0.015)	(0.015)	(0.012)
Male	-0.033	-0.031	-0.043	-0.034
	(0.018)	(0.017)	(0.024)	(0.028)
Urban	-0.030	-0.032	-0.032	-0.025
	(0.019)	(0.019)	(0.017)	(0.013)
Rural	-0.015	-0.015	-0.015	-0.017
	(0.013)	(0.012)	(0.013)	(0.011)

Note: Standard errors in parentheses. * $p<0.05$, ** $p<0.01$.

Table A3. Effects of calculated household education expenditure by quantile

Quantile	Total score	Chinese	Math	English
0.9	0.009	-0.008	-0.014	-0.014
	(0.010)	(0.015)	(0.010)	(0.008)
0.75	0.014	-0.020	-0.017	-0.015
	(0.009)	(0.012)	(0.010)	(0.010)
0.5	-0.026	-0.022	-0.017	0.023
	(0.015)	(0.013)	(0.010)	(0.014)
0.25	-0.032	-0.031	-0.032	-0.026
	(0.017)	(0.018)	(0.017)	(0.012)
0.1	-0.022	-0.034	-0.037	-0.023
	(0.013)	(0.018)	(0.019)	(0.016)

Note: Standard errors in parentheses. * $p<0.05$, ** $p<0.01$.

Table A4. Effects of household education expenditure on NCEE achievement.

		Total score			Chinese			Math			English		
	Sample	Upper limit	Lower limit	Median	Upper limit	Lower limit	Median	Upper limit	Lower limit	Median	Upper limit	Lower limit	Median
Self-reported education spending	All	0.018	0.019	0.016	0.003	0.004	0.003	0.010	0012	0.010	0.021	0.022	0.019
		(0.015)	(0.015)	(0.014)	(0.021)	(0.022)	(0.020)	(0.017)	(0.017)	(0.016)	(0.019)	(0.019)	(0.018)
	Female	0.002	0.004	0.001	-0.015	-0.014	-0.016	-0.004	-0.002	-0.005	0.018	0.021	0.015
		(0.015)	(0.015)	(0.014)	(0.025)	(0.025)	(0.023)	(0.021)	(0.021)	(0.020)	(0.023)	(0.023)	(0.022)
	Male	0.033	0.035	0.031	0.020	0.021	0.020	0.023	0.025	0.023	0.025	0.026	0.024
		(0.020)	(0.020)	(0.018)	(0.025)	(0.025)	(0.023)	(0.023)	(0.023)	(0.022)	(0.019)	(0.019)	(0.018)
	Urban	0.014	0.014	0.012	0.008	-0.009	0.009	-0.021	0.039	-0.019	0.011	0.026	0.010
		(0.023)	(0.019)	(0.021)	(0.027)	(0.030)	(0.025)	(0.026)	(0.021)	(0.024)	(0.026)	(0.025)	(0.024)
	Rural	0.012	0.014	0.011	-0.007	-0.009	-0.008	0.036	0.039	0.034	0.025	0.026	0.022
		(0.019)	(0.019)	(0.018)	(0.030)	(0.030)	(0.028)	(0.021)	(0.020)	(0.020)	(0.025)	(0.025)	(0.024)

Note: Standard errors in parentheses. * p<0.05, ** p<0.01.