Effectiveness of Shadow Education for College Students: Focusing on College Students of Art Majors in Shanxi Province, China

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Abstract

This study mainly aimed to examine the effectiveness of shadow education on college students' cognitive ability by taking junior and senior students of art majors in Shanxi Province as the survey sample. To achieve this, OLS regression and PSM (Propensity Score Matching) methods were used to identify the effectiveness of shadow education on students' cognitive ability. Quantile regression was employed to analyze the heterogeneous effectiveness of shadow education on students at different quantiles of cognitive ability. The results indicated that shadow education can improve the cognitive ability of art majors. Especially for students who have not participated in shadow education at present, if they take part in shadow education, their cognitive ability will be improved better. Students with lower and higher levels of cognitive ability appeared to benefit more from shadow education than those with moderate levels.
Keywords: Shadow education, College students, Cognitive ability, China

Introduction

Shadow education has become a universal phenomenon in the world, especially in East Asia. The past thirty years have seen increasingly rapid advances in field of the research on shadow education for K12 students. Although the Chinese government has taken steps to slow the growth of the shadow education industry for K12, shadow education for college students has not been harmed at all and has instead been steadily expanding. However, shadow education research concerned with college students is extremely rare. It can be seen that the research on shadow education for college students in China is not consistent with the booming development of this industry. When defining the scope of shadow education, it was mentioned in particular by Bray (1999) that shadow education does not only exist in primary school, junior, and senior high school. He suggested that researchers should consider the specific conditions of different regions when determining the research object. Therefore, this study took college students as the research object.

The terms "shadow education," "extracurricular training," and "Private Supplemental Tutoring (PST)" are frequently used interchangeably in the literature. In

international literature, the metaphor “shadow education” is widely used, and “extracurricular training” is adopted more often in China. “Shadow education,” “private supplemental tutoring,” and “extracurricular training” are all equated in this article. There is no definite, accepted definition of shadow education, so researchers should define “shadow education” reasonably according to the research objectives (Bary & Liu, 2015). In this study, shadow education is described as academic tutoring for economic profit selected by students in the market to improve personal human capital and pass examinations or obtain qualification certificates, as well as non-academic tutoring for personal interests.

Research Objective

The two most crucial roles in the entire process of shadow education are played by the demand side and the provider. In the research on the demand side of shadow education, few researches has examined whether students benefit from shadow education, despite the fact that many studies on the influencing factors of shadow education demand have been conducted in the past. As a result, the main objective of this study is to examine the effectiveness of shadow education for college students.

Literature Review

Depending on the research method and object, studies on the effectiveness of shadow education frequently come to various results. This section mainly summarized the research characteristics of the effectiveness of shadow education from two aspects: research conclusion and analytical method.

In terms of research conclusion, many researchers concluded that shadow education could considerably raise students’ academic achievement like Hu, Fan, and Ding (2015). However, other researchers, such as Wang, Hao, and Li (2014) demonstrated that the effect of shadow schooling on students’ academic performance is uncertain. Several scholars, including Li and Pan, believed that students would receive little or even no benefit from shadow education (2020).

In terms of analysis methods, Li (2017) used the stratification-multilevel technique to study the average impact and heterogeneous effectiveness of two different types of shadow education; Zhang and Zhang (2017) employed the data of CEPS in 2010 and the method of tool variables; Liu and Yao (2018) adopted the Logistic regression model; Byun (2014), Xu (2020) used the propensity score matching method based on the observable variable selection hypothesis; Q-methodology was utilized by Cayubit et al. (2014).

In summary, it can be seen that the majority of the published research examined the effectiveness of students’ participation in shadow education using exam results as the

outcome variables. Yet, the standards for evaluating certain educational accomplishments should take into account students' cognitive abilities in addition to their exam scores. Additionally, the majority of earlier studies' findings have proven that shadow education has a positive and notable impact on students' academic progress. The key issues, however, are endogeneity and sample selection bias brought on by unobservable elements like natural ability, motivation, and parental expectations. Besides, a single analytical method was used by the majority of researchers, and only a small number of studies used multiple analytical methods to confirm the effectiveness of shadow education. Finally, most scholars estimated the average effect of shadow education on all students instead of considering more specific situations.

To compensate for some limitations of previous studies, this article (this study) used the test results of students' cognitive ability as the dependent variable and employed two analytical methods respectively to examine the effectiveness of shadow education for college students. At last, the heterogeneous effectiveness of tutoring on students at different quantiles of cognitive ability was identified. The analysis approach and research framework used to examine the effectiveness of shadow education in this empirical study are expected to serve as a reference for shadow education researchers performing related research in the future, and it is hoped that the conclusions can give some implications for policy-makers.

Methodology

Research Design

Quantitative approach was used in this research, the data was collected by questionnaire and analyzed respectively with OLS (Ordinary Least Squares) regression, PSM (Propensity Score Matching) and quantile regression. First, OLS regression was adopted to analyze the average effectiveness of shadow education participation on students' cognitive ability. But so far, there are some deficiencies in OLS. OLS regression can't distinguish the influence of getting involved in shadow education on students' test results of cognitive ability from other factors that affect students' cognitive ability. Some examples of factors that may have varied degrees of influence on a student's cognitive ability test results include personal level characteristics, family level characteristics, and university level characteristics. This makes it difficult to determine whether students' increased cognitive ability was a result of their involvement in shadow education, which can produce biased results. On the other hand, the correlation between shadow education participation and the model's error term will result in endogenous issues, which can also lead to biased estimates. Thus, second, in order to overcome the drawbacks of OLS, PSM was utilized to further verify the results and more precisely pinpoint the role of shadow

education participation in improving students' cognitive ability. At last, quantile regression was used to analyze the heterogeneous effectiveness of tutoring on students with different quantiles of cognitive ability.

Sample

The previous research showed that the results of shadow education research are greatly affected by cultural, regional, and other factors. The smaller the research scope and the more targeted the research object, the more accurate and constructive the results are. Additionally, facing turning points in life, more junior and senior students participate in shadow education in preparation for continuing their education or finding a job. Consequently, junior and senior college students of art majors respectively enrolled in 2019 and 2018 in Shanxi Province were selected as survey samples for the part of the questionnaire. The population is 12,933(N). The sample size was determined by Yamane's (1973) calculation formula: $n=N/(1+Ne^2)$. Setting the error rate "e"as 5%, the minimum sample size should be 388 in this study. Next, using the stratified sampling method, according to the stratified sampling formula: $n_x=(n)\ Ni/N$, a total of 388 people should be selected from 17 schools offering art majors in Shanxi Province. In order to avoid invalid questionnaire, the survey increased the number of questionnaires that should be distributed in each school by 50% in practice. Thus, after distributing 582 surveys questionnaires in all, 400 valid questionnaires were ultimately gathered (68.73%).

Variable Description

The following is a description of variables and their symbols:

Dependent variable: $Score_i$ is the symbol of test results of students' cognitive ability. The standardized score data of cognitive ability was obtained after cognitive ability test. Cognitive ability refers to the ability of human beings to extract, store and use information from the objective world, that is, the ability of human brain to process information, which is manifested in grasping the laws of things' movement, change and development direction, mainly involving human's abstract thinking, logical deduction and memory. The cognitive ability test was used to measure students' cognitive ability. It includes language common sense, logical thinking, numerical reasoning, graphical reasoning, quantitative relationship and category reasoning, logical judgment and other aspects of the test questions. At present, cognitive ability test is widely used in enterprise recruitment to evaluate the comprehensive quality and potential of candidates and screen the best talents for enterprises. Through cognitive ability assessment, the basic abilities of job seekers such as common sense, reasoning and understanding can be estimated.

Core variable: T_i represents whether students have participated in shadow education. $T_i=0$ means no participation in shadow education, and $T_i=1$ means participation in shadow education.

Control variable: Z_i. In order to more accurately estimate the net effectiveness of participating in shadow education, this paper used the research of Zhou Ying (2018) for reference to control relevant factors that may affect cognitive ability from three aspects: students' individual level characteristics, family level characteristics and university level characteristics. Specifically:

Variables of students' individual level characteristics: gender ($gender_i$); registered permanent residence (rpr_i); income expectation ($inco\_me_i$); whether it is an only child ($child_i$).

Variables of family level characteristics: parents' expectation of children's income ($inco\_parent_i$); highest academic degree among parents (edu_i); frequency of parents' caring about learning ($study_i$); family economic condition ($econ_i$); Variables of university level characteristics: school rank ($schrank_i$).

The detailed variables are described as Table 1.

Table 1 Variable Description and Descriptive Statistics

Variables	Variable description	Mean	SD
$Score_i$	Continuous variable	-4.49e-0.6	0.85
T_i	0=No participation in shadow education 1=Participation in shadow education	0.41	0.50
$gender_i$	0=female, 1=male	0.52	0.50
rpr_i	0=non rural area, 1=rural area	0.54	0.50
$child_i$	0=not an only child, 1=an only child	0.44	0.50
$inco\_me_i$	1=less then 2,000 yuan 2=2,001~5,000 yuan 3=5,001~8,000 yuan 4=8,001~11,000 yuan 5=11,001~14,000 yuan 6=14,001~17,000 yuan 7=17,001~20,000 yuan 8=20,001~23,000 yuan 9=more than 23,001 yuan	6.81	1.71
$inco\_parent_i$	1=less then 2,000 yuan 2=2,001~5,000 yuan 3=5,001~8,000 yuan 4=8,001~11,000 yuan 5=11,001~14,000 yuan 6=14,001~17,000 yuan 7=17,001~20,000 yuan 8=20,001~23,000 yuan 9=more than 23,001 yuan	6.95	1.56
$study_i$	1=never; 2=three to four weeks; 3=one to two weeks 4=almost every week	2.40	1.17

Variables	Variable description	Mean	SD
edu_i	1=no education; 2=primary school; 3=junior high school; 4=technical secondary school or technical school; 5=vocational high school; 6=ordinary high school; 7=associate degree; 8= bachelor degree, 9=master degree or above	4.48	2.02
$econ_i$	1=very difficult; 2=relatively difficult; 3=medium; 4=relatively rich; 5=very rich	2.83	0.60
$schrank_i$	1=worst, 2=lower middle, 3=medium, 4-upper middle, 5=best	3.95	0.82

Findings

OLS Estimation Results

In order to estimate the effectiveness of participating in shadow education on students' cognitive ability, the following model was set: $Score_i=\alpha_0+\alpha_1 T_i+yZ_i+\varepsilon_i$.
OLS regression results were displayed in Table 2.

Table 2 OLS Regression Results

Independent variable	$Score_i$	
	Coefficient	SE
T_i	0.0553***	0.0136
$gender_i$	-0.0277**	0.0123
rpr_i	-0.0116	0.0146
$child_i$	0.1736***	0.1412
$inco\_me_i$	0.0217***	0.0044
$inco\_parent_i$	0.0130**	0.0047
$study_i$	0.0147**	0.0053
edu_i	0.0239***	0.0036
$econ_i$	0.0599***	0.0107
$schrank_i$	0.0835***	0.0082
Constant	-1.0668***	0.0617
F	52.832	
P	0.0000	
R^2	0.1374	

***p＜0.01， **p＜0.05， *p＜0.1

From a statistical point of view, Prob>F=0.000 implies that the model is meaningful. In detail, first, for the core variable, T_i is positive at a significance level of 1%, which can be concluded that taking part in shadow education could enhance students' cognitive ability. Second, for the students' individual level characteristics, coefficient of $gender_i$ is significantly negative, which shows a disparity in the cognitive abilities of male and female art majors, with male generally having poorer cognitive abilities than female. The coefficient of rpr_i is not significant, indicating that the cognitive ability of students has no significant relationship with whether they are from rural areas or non-rural areas. The coefficient of $child_i$ is significantly positive, indicating that only children and non-only children had different levels of cognitive capacity. The average cognitive ability of only

children was higher than that of non only children. The coefficient of $inco\_me_i$ is significantly positive, which suggests that students' income expectation is in direct proportion to their cognitive ability. Third, for family-level variables, the coefficient of parents' income expectation for children ($inco\_parent_i$) is significantly positive, which indicates that parents' income expectation for children is in direct proportion to their children's cognitive ability. The coefficient of frequency of parents' concern about the study ($study_i$) is significantly positive, which indicates that the more families care about children's learning, the more the cognitive ability of college students will be improved. Therefore, for college students, the more their family members care about their learning, the higher their cognitive ability will be; The coefficient of highest education among parents (edu_i) is significantly positive, suggesting that parents' educational background is positively related to student's cognitive ability, which also indicates the importance of parental guidance for college students. The coefficient of family economic status ($econ_i$) is significantly positive, implying that learners' cognitive abilities rise with family economic status. Fourth, for the university level variable, the coefficient of the school rank ($schrank_i$) is significantly positive, which shows that the higher the school ranking is, the higher the cognitive ability test results of its students are.

However, OLS may not be able to accurately evaluate the effectiveness of shadow education on students' cognitive ability, because there may be endogenous problems caused by sample selection bias. Hence, PSM was employed in the next section to avoid these deficiencies, and to validate the OLS regression results again.

PSM Estimation Results

Propensity Score Matching (PSM) is a commonly used matching analysis method, which controls possible research bias by matching units with similar propensity. It can more accurately assess the impact of training on students' cognitive ability by eliminating the difference between students who have participated in training and students who didn't take part in training.

In this paper, T_i is a binary selection variable that divided the students into two groups, one is the treatment group, which refers to students who have participated in shadow education, and the other is the control group, which refers to students who have not participated in shadow education.

The first step of PSM is to select a covariate. The key to the success of PSM is the selection of covariate X. The significance of covariates is that after controlling covariate X, the cognitive ability test results (Score) of students who joined in shadow education and students who did not engage in are solely attributed to shadow education. This paper selected the control variables at the individual level, family level, and university level that

affect students' cognitive abilities mentioned above as covariate X.

In the second step, the Logit regression model is used to estimate the propensity score P, which is the conditional probability for each student to participate in shadow education given the covariate X.

The third step is propensity score matching. There are three main methods of propensity score matching. The first method is k-nearest neighbor matching, which finds k individuals in different groups with the closest propensity score. The second method is radius matching, which limits the propensity score's absolute distance. The third method is kernel matching: the matching result of each individual is all individuals of different groups, but different weights are given according to different individual distances, that is, the weight of the near is large, the weight of the far is small, and the weight beyond a certain range can be 0.

The fourth step is to check the matching quality. A covariate balancing test was performed to detect the difference between the treatment group and the control group after matching to test the matching quality.

The last step of PSM is to calculate the average treatment effect on students who have taken part in shadow education (ATT=Average Treatment Effects on Treated Group) according to the matched samples.

Table 3 showed the Estimation Results of ATT through PSM with different matching method. Nearest neighbor matching (k=1 and k=4), radius matching [Caliper (0.01)], and kernel matching were used to estimate the ATT.

Table 3 Estimation Results of ATT with Different Matching Method

Matching method	Explained variable: students' cognitive ability test results (Score)		
	ATT	SE	OLS
One to one matching	-0.0236	0.0264	0.0551***
One to four matching	0.0142	0.0192	0.0551***
Caliper(0.01)	0.0322**	0.0164	0.0551***
Kernel	0.0350***	0.0161	0.0551***

$p < 0.05$,*$p < 0.01$

According to the results of the nearest neighbor matching method using one-to-one matching and one-to-four matching, it is shown that for students who have participated in shadow education, the effectiveness of shadow education on their cognitive ability test results is not significant. And the result of the radius matching method with the

radius being set as 0.01 indicates that for students who have participated in shadow education, the effectiveness of shadow education on their cognitive ability test results is 0.0322. From the result of kernel matching method, it can be seen that for students who have participated in shadow education, the effectiveness of shadow education on their cognitive ability test results is 0.0350. The main reason for this difference may be that different matching algorithms generated different common support areas, which resulted in different degrees of damage to the matching samples. As a result, students who have participated in shadow education choose different students who did not participated in shadow education to match under different matching algorithms. Radius matching results are similar to kernel matching and OLS results, revealing that students' cognitive capacities can be enhanced by taking part in shadow education. As a result of using information from all samples, kernel matching is more trustworthy.

The benefits of shadow education for the cognitive growth of learners may be seen in the estimation results of the radius matching and kernel matching techniques, which are comparable to OLS regression results. Nevertheless, their value is less than the OLS regression results. The reason can be considered that the result estimated by OLS regression refers to the average effect of shadow education on the cognitive ability of students who have participated in shadow education compared with students who have not participated in shadow education. On the other hand, the ATT estimated by PSM refers to the average effect of shadow education on the cognitive ability of students who have participated in shadow education compared with "themselves" before they did not participate in shadow education. Therefore, it is also necessary to estimate the average treatment effect on students who haven't taken part in shadow education (ATU=Average Treatment Effects on Untreated Group) as well as the average treatment effect on the entire sample (ATE=Average Treatment Effect on population). Since the estimation results of the radius matching method and the kernel matching method were similar, Table 4 presented the estimation results of the kernel matching method, and based on the Bootstrap Method, the statistical significance and standard deviation of the estimated effect were tested 50 times.

Table 4 Estimation Results Based on Kernel Matching

	Average treatment effect	SE
ATT	0.0350***	0.0151
ATU	0.0608***	0.0271
ATE	0.0479***	0.0135

Based on the estimation results of kernel matching, for non-participants of shadow education, the average effect (ATU) of their participation in shadow education is 0.0608, and it is significant at the significance level of 1%. For participants of shadow education, the average effect (ATT) of their participation in shadow education is 0.0350, and it is significant at the significance level of 1%. For all students, the average effect (ATE) of their participation in shadow education is 0.0479. Therefore, it can be inferred that participating in shadow education will significantly improve the results of students' cognitive ability. At the same time, for students who did not participate in shadow education at present, if they participate in shadow education, their cognitive ability will be improved better.

Analysis on the Heterogeneity of the Effectiveness of Shadow Education

The average effectiveness described by OLS cannot answer whether shadow education has heterogeneous effectiveness on students' cognitive ability. Therefore, the quantile regression was used in this section to respectively conduct 10%, 50%, and 90% quantile regression on the model: $Score_i=\alpha_0+\alpha_1 T_i+yZ_i+\varepsilon_i$. They respectively represented the performance of students' cognitive ability on low, median, and high scores. The estimated results are presented in Table 5.

Table 5 Quantile Regression Results

	Quantile		
	10%	50%	90%
T_i	0.0867***(0.0243)	0.0481***(0.0114)	0.0710***(0.0264)
$gender_i$	-0.0334(0.0256)	-0.0398**(0.0188)	-0.0078(0.0211)
rpr_i	-0.0066(0.0301)	-0.0243(0.0195)	-0.0216(0.0278)
$child_i$	0.1596***(0.0272)	0.2147***(0.0221)	0.1624***(0.0240)
edu_me_i	0.0244***(0.0064)	0.0241***(0.0067)	0.0249***(0.0078)
edu_parent_i	0.0057(0.0068)	0.0182***(0.0067)	0.0182*(0.0094)
$study_i$	0.0270***(0.0082)	0.0077(0.0051)	0.0029(0.0093)
edu_i	0.0171***(0.0066)	0.0262***(0.0068)	0.0172***(0.0045)
$econ_i$	0.0310***(0.0181)	0.0702***(0.0158)	0.0456***(0.0143)
$schrank_i$	0.0603***(0.0118)	0.0949***(0.0123)	0.0748***(0.0136)
Constant	-2.0250***(0.1132)	-1.2248***(0.1156)	0.1177(0.0750)
Quasi R^2	0.0425	0.071	0.0597

***p<0.01, **p<0.0.05, * p<0.1; The values in parentheses are the standard errors of regression coefficients.

It can be seen from Table 5 that, from left to right, with the increase of quantile (10% ⟶ 50% ⟶ 90%), the regression coefficient of whether students have participated in shadow education (T_i) is positive at the significant level of 1%, with the coefficients of 0.0867, 0.0481 and 0.0710 respectively, showing a trend of decreasing first and then increasing. This illustrates that participating in shadow education has a stronger impact on students with lower and higher cognitive capacities than it does on learners in the middle position. In short, art majors' participation in shadow education can improve their cognitive ability. At the same time, for students at different cognitive ability quantiles, participation in shadow education have different effect. Students with weak cognitive capacity and excellent cognitive ability benefit from shadow education more than students with medium level.

Conclusions

This article analyzed the effectiveness of shadow education for college students by evaluating how it affected students' cognitive abilities. The results indicated that shadow education for college students can enhance the cognitive abilities of students majoring in art. Especially for students who have not participated in shadow education at

present, if they participate in shadow education, their cognitive ability will be more positively affected. Additionally, the effectiveness of participating in shadow education on students with relatively poor cognitive ability and relatively good cognitive ability is greater than that on students in the middle, which can be concluded that shadow education is more inclined to serve learners with superior, and poor cognitive ability.

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