Combining Micro Data to Study the Impact of Financing System on Compulsory Education Quality

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Abstract.
Based on the micro data of China Education Panel Survey, this study first uses the factor analysis method with the SPSS software to construct a comprehensive index of compulsory education quality that more comprehensively reflects students' moral, intellectual, physical, aesthetic and social development. Then it mainly uses the instrumental variables method with the Stata software to empirically test the impact of financing system on compulsory education quality. The results show that fiscal appropriation has a significantly positive effect on compulsory education quality, and increasing the percentage of county/district level fiscal appropriations in compulsory education can significantly promote the positive effect of fiscal appropriation on compulsory education quality in China.

Keywords: *micro data; instrumental variables method; software; compulsory education quality; financing system*

1. Introduction

"Developing equity and quality education" is the policy orientation of compulsory education reform and development in China at present and in the future. Fiscal appropriation is an important material basis for the equity assurance and quality improvement of compulsory education development. The financing system of compulsory education has a deep institutional impact on fiscal appropriation and compulsory education quality. Under the background of the new normal of economic and the rapid development of urbanization, how to improve the current financing system of compulsory education furtherly in order to better ensure compulsory education equity and improve compulsory education quality is an important and practical problem.

The research on the impact of financing system on compulsory education quality is essentially from the efficiency dimension of compulsory education resource allocation. It mainly focuses on the relationship between the input and output of compulsory education resources. However, a large number of empirical studies abroad show that there is still a great debate whether fiscal appropriation in education can positively promote the improvement of education quality [1]. Most foreign empirical studies based on education financing system reform and fiscal decentralization system conclude that centralized education financing system reform is conducive to motivating local governments to increase fiscal appropriation in compulsory education and improve compulsory education quality [2]. Chinese scholars pay more attention to the effects of centralized financing system reform on fiscal allocation of compulsory education and less on compulsory education quality [3]. However, the official and publicly available database of student academic achievement that is widely tracked nationwide hasn't been established in China. Chinese scholars usually use the quantitative indicators such as fiscal appropriation, the number of students in school, the rate of advancement to higher education or student's test scores to measure compulsory education quality, thus neglecting the quantitative study on other aspects of student's development.

In view of this, using the micro data of China Education Panel Survey, this study aims to comprehensively measure compulsory education quality and empirically analyse the impact of financing system on compulsory education quality.

2. Data, model and variables

2.1. Data

The study uses the micro data of China Education Panel Survey (CEPS) covered a successful follow-up sample of eighth-grade students in 112 schools of 28 counties (cities and districts) across China in the 2014-2015 academic year. CEPS strictly adopts a hierarchical, multi-stage, probability-proportional-to-size sampling (PPS) method to conduct the questionnaire survey. The project has started the baseline survey in the 2013-2014 academic year, and successfully completed the first follow-up survey in the 2014-2015 academic year. The number of students successfully followed up is 9 449, and the total follow-up rate is 95.86%.

The two rounds of questionnaires include student questionnaire, parent questionnaire, homeroom teacher questionnaire, subject teacher questionnaire and school administrator questionnaire. Some questions are set up to be interrelated and have a certain logical relationship, so we can verify and supplement with each other to fill the missing values of some variables in the study.

2.2. Model

The educational production function reflects the combined relationship between various educational input and output in the educational production process at a given technical level. Based on the previous research model [4], this study incorporates fiscal appropriation and financing system of compulsory education into the educational production function, constructs the following regression models. Model (1) is the baseline regression model. Model (2) is the extended regression model considering the interaction term. To eliminate the effect of multicollinearity, the study first centralizes the mean value of fiscal appropriation and financing system of compulsory education separately, and then interacts them.

$$Y_{ij} = \alpha_0 + \beta X_{ij} + \lambda Z_{ij} + \alpha_1 I_{ij} + \alpha_2 F_{ij} + \alpha_3 S_{ij} + \varepsilon_{ij} \quad (1)$$

$$Y_{ij} = \alpha_0 + \beta X_{ij} + \lambda Z_{ij} + \theta X_{ij}Z_{ij} + \alpha_1 I_{ij} + \alpha_2 F_{ij} + \alpha_3 S_{ij} + \varepsilon_{ij} \quad (2)$$

In the equations, the subscript i denotes the individual student, and j denotes the student's school. Y_{ij} represents student's compulsory education quality. X_{ij} represents fiscal appropriation of compulsory education. Z_{ij} represents financing system of compulsory education. $X_{ij}Z_{ij}$ is the interaction term of fiscal appropriation and financing system of compulsory education. I_{ij}, F_{ij} and S_{ij} respectively represent the student's individual characteristic variables, family characteristic variables and school characteristic variables. α_0, β, λ, θ, α_1, α_2, α_3 are parameters of the regression model. ε_{ij} is the random error term.

2.3. Variables

2.3.1. Explained variable (Y_{ij})

Student's compulsory education quality (STQ): Under the concept of comprehensive development of moral, intellectual, physical, aesthetic and social development, five indicators are selected from the aspects of student's cognitive development, school behaviour performance, social behaviour performance, hobbies and self-efficacy (see Table 1). And the factor analysis method is used to measure the comprehensive index score of student's compulsory education quality with the SPSS software [5].

TABLE 1. Evaluation index system of compulsory education quality

Dimension	Indicators	Questionnaire option settings
Cognitive development	Standardized score of cognitive ability test (using 3PL model)	-
School behaviour performance	How much do you agree with each of the following statements about your school life? -My homeroom teacher always praises me. -I often take part in school/class activities. -I feel close to people in this school.	1 Strongly disagree 2 Somewhat disagree 3 Somewhat agree 4 Strongly agree
Social behaviour performance	How often did you do the following things in the past year? -Helping elders -Following orders and lining up -Being nice and honest	1 Never 2 Seldom 3 Sometimes 4 Often 5 Always
Hobbies	What hobbies do you have? None; Playing musical instruments, vocal practices/singing/ dancing/acting; Calligraphy; Painting or drawing/animation; Chess; Sports; Other	1 Yes 0 No

Self-efficacy	Are you confident in your future?	1 Not confident at all
		2 Not so confident
		3 Somewhat confident
		4 Very confident

For consistency, the variable of student's social behaviour performance is reset into four categories according to the questionnaire options, namely "1 never/seldom, 2 sometimes, 3 often, 4 always"; the variable of student's hobbies is reset into four categories according to the number of student's hobbies, namely "1 no hobbies, 2 only one hobby, 3 two hobbies, 4 more than three hobbies".

On the specific measurement, the SPSS software first automatically standardizes the selected variables by default. The p-value of Bartlett's sphericity test is 0.000, indicating that the correlation coefficient matrix of each variable cannot be the unit matrix. The value of Kaiser Meyer Olkin test is 0.762, which reaches a middling level and is suitable for the factor analysis. After selecting the analysis method of principal components and the maximum variance method in orthogonal rotation to rotate the factor-loading matrix, combined with the requirements of eigenvalues and cumulative variance contribution rate, it extracts five common factors. Their cumulative variance contribution rate reaches 74.73%, indicating that these five common factors can explain more than 70% information of the original variables. Finally, according to the scores of each common factor, the comprehensive factor score is calculated with the respective variance contribution rate as the weight. For ease of understanding and elimination of negative values, it is standardized with the value of [0, 10]. Then, we obtain the score value of each student's comprehensive index of compulsory education quality. The reliability test of the questionnaire shows the coefficient value of Cronbach's α is 0.702, indicating that the reliability and consistency of the measurement results of the comprehensive index of compulsory education quality in the questionnaire are acceptable.

2.3.2. Explanatory variables (X_{ij}, Z_{ij})

Fiscal appropriation of compulsory education (LNSTF): expressed by the logarithm of fiscal appropriation per student.

Financing system of compulsory education (FS): expressed by the percentage of county/district-level fiscal appropriations.

The interaction term of fiscal appropriation and financing system of compulsory education is represented by I_LNSTF_FS.

2.3.3. Control variables (I_{ij}, F_{ij}, S_{ij})

Student characteristic variables (I_{ij}): include SEX (male=1, female=0); HK (1 if the type of student's houkou is agriculture, and 0 otherwise); HEALTH (a continuous variable assigned a value of 1-5 according to student's self-assessed health status).

Family characteristic variables (F_{ij}): include ONLY (1 if the student is an only child, and 0 otherwise); ETCLASS (1 if the student attends cram school or extracurricular courses, and 0 otherwise); PARLIV (1 if only one or neither parent lives at home, and 0 otherwise); PAREDU (the highest educational level of parents is replaced by the years of education); PARJOB (1 if parent with management or professional-technical occupations background, and 0 otherwise); FAMECO (a continuous variable assigned a value of 1-3 according to student's self-assessed family financial conditions).

School characteristic variables (S_{ij}): include FACI (a continuous variable added up after assigned a value of 1-3 according to each of the ten types of self-assessed hardware facilities status); HTEAR (expressed by the percentage of teachers with senior title); TEATR (expressed by the number of teacher training); STRA (expressed by the student-teacher ratio); STYP (1 if the school type is public school, and 0 otherwise); SRAN (a continuous variable assigned a value of 1-5 according to the school's local ranking); PEDU (a continuous variable assigned a value of 1-5 according to the ranking of parents' educational level in the county); CEDU (expressed by the average years of education in the city).

Table 2 reports the descriptive statistics of the main variables.

TABLE 2. Descriptive statistics

Variable	Mean	Std. Dev.	Min	Max
STQ	6.083	1.587	0	10
LNSTF	6.813	1.049	0	8.380
FS	53.939	46.073	0	100
SEX	0.522	0.500	0	1
HK	0.540	0.498	0	1
HEALTH	3.864	0.937	1	5
ONLY	0.442	0.497	0	1
ETCLASS	0.502	0.500	0	1

PARLIV	0.184	0.387	0	1
PAREDU	10.948	3.094	0	19
PARJOB	0.205	0.403	0	1
FAMECO	1.852	0.508	1	3
FACI	21.499	4.370	12	30
HTEAR	0.212	0.151	0	0.820
TEATR	15.479	17.762	1	90
STRA	13.064	4.363	3	30.800
STYP	0.936	0.244	0	1
SRAN	3.976	0.844	1	5
PEDU	2.805	0.828	1	5
CEDU	9.546	1.435	6.800	12.190

3. Empirical analysis

3.1. Baseline regression result

For model (1) and (2), the study first estimates the parameters based on the traditional ordinary least squares method (OLS) to explore the effect of fiscal appropriation and financing system on compulsory education quality with the Stata software [6].

The regression results in column (1) and (2) of Table 3 show that after controlling the variables of individual student characteristics, family characteristics and school characteristics, the logarithm of fiscal appropriation per student has a significantly positive effect on the comprehensive index score of student's compulsory education quality. The coefficient of the variable "the percentage of county/district-level fiscal appropriations" is also positive at the significance level of 10%, and the interaction term is positive at the significance level of 1%. This suggests that increasing fiscal appropriation and increasing the percentage of county/district-level fiscal appropriations in compulsory education can significantly improve compulsory education quality, and increasing the percentage of county/district-level fiscal appropriations in compulsory education can indirectly promote the positive effect of fiscal appropriation on compulsory education quality.

Table 3. Regression results

Variable	(1)OLS	(2)OLS	(3)2SLS	(4)IGMM	(5)Replace variable
LNSTF	0.110***	0.118***	0.108***	0.108***	0.128***
	(0.030)	(0.030)	(0.041)	(0.041)	(0.040)
FS	0.065*	0.067*	0.070*	0.070*	
	(0.037)	(0.037)	(0.038)	(0.038)	
I_LNSTF_FS			0.214***	0.212***	0.212***
			(0.063)	(0.063)	(0.063)
DFS					0.070**
					(0.036)
I_LNSTF_ DFS					0.151**
					(0.062)
Student characteristic variables	YES	YES	YES	YES	YES
Family characteristic variables	YES	YES	YES	YES	YES
School characteristic variables	YES	YES	YES	YES	YES
P-value for over-identification test	-	-	0.974	0.974	0.694
Observations	9209	9209	9209	9209	9382
R-squared	0.197	0.198	0.198	0.198	0.203

Note: Robust standard errors in parentheses; * $p<0.10$, ** $p<0.05$, *** $p<0.01$.

3.2. Robustness test

3.2.1. Robustness test using instrumental variables method

Considering the potential omitted variables and mutual causality may bring about endogeneity between compulsory education quality and fiscal appropriation of compulsory education, this study uses two instrumental variables for robustness testing. One instrumental variable is the logarithm of fiscal appropriation per student in the base period and the other one is the logarithm of fiscal appropriation per student weighted by the number of students in the surveyed schools except the local county/district. The two-stage least squares regression method (2SLS) and the iterative generalized moment estimation method (IGMM) are used respectively.

It can be seen from the columns (3) and (4) of table 3, the regression results of 2SLS estimation and IGMM estimation remain consistent, compared with the baseline OLS regression results. The coefficient of the

logarithm of fiscal appropriation per student remains significantly positive. The coefficient of the variable "the percentage of county/district-level fiscal appropriations" is significantly positive at the significance level of 10%, and the interaction term is significantly positive at the significance level of 1%.

In terms of the validity of the instrumental variables, the Kleibergen-Paap rk Wald F statistic based on the weak instrumental variable test with the Stata software is much larger than the critical value at the significance level of 10%, which rejects the hypothesis of weak instrumental variables. The p-value of Hansen J statistic based on the over-identification test also exceeds 0.10, which means that the two selected instrumental variables do not have the problem of weak instrumental variables and are reasonably valid. This indicates that the estimation results are still robust after considering the endogenous problem.

3.2.2. Robustness test for replacing the variable of financing system of compulsory education

In order to further support the reliability of the previous findings, this study resets the variable financing system of compulsory education as a dummy variable (DFS). It is defined as "1 if the percentage of county/district-level fiscal appropriations is more than 50%, and 0 otherwise". The regression results are shown in column (5) of table 3.

The coefficient of the logarithm of fiscal appropriation per student remains significantly positive. The redefined variable financing system of compulsory education and its interaction term with the logarithm of fiscal appropriation per student (I_LNSTF_DFS) are significantly positive at the significance level of 5%, which implies that the aforementioned empirical results are reliable.

4. Conclusion

Based on the micro data of China Education Panel Survey, the study constructs a comprehensive index of compulsory education quality and empirically analyses the impact of financing system on compulsory education quality. The regression results show that fiscal appropriation has a significantly positive impact on the comprehensive index score of student's compulsory education quality, and increasing the percentage of county/district-level fiscal appropriations in compulsory education can not only directly and significantly improve compulsory education quality, but also indirectly promote the positive effect of fiscal appropriation on compulsory education quality. Therefore, the study suggests that it is very necessary to innovate the evaluation system of compulsory education quality and deepen the financing system reform of compulsory education.

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