

## Analysis of the Efficiency and Influencing Factors of Fiscal Expenditure on Compulsory Education

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### [Abstract]

Using the panel data of 31 regions in China from 2006 to 2021, this paper analyzes the efficiency and influencing factors of the fiscal expenditure on compulsory education in China. Through the analysis found that the efficiency of some economically developed regional is lower, but the efficiency of economically backward regional is higher. In order to further analyze the influencing factors of the efficiency of fiscal expenditures on compulsory education, using Tobit model is analyzed. It is found that regional per capita GDP and fiscal self-sufficiency rate have a negative impact on the efficiency of fiscal expenditure on compulsory education. Age structure, percentage of fiscal expenditure on compulsory education and level of teachers have a positive impact on the efficiency of fiscal expenditure on compulsory education. Fiscal decentralization has no significant effect on the efficiency of fiscal expenditure on compulsory education.

▶ **Key words:** China, Compulsory Education, Fiscal Expenditure, Efficiency, Tobit Model, DEA Model

### [요 약]

본 연구는 의무교육에 대한 재정지출의 효율성에 미치는 영향 요인을 분석하고 있다. 중국의 의무교육도 다른 국가와 마찬가지로 주로 재정지출에 의존하고 있다. 본 연구는 우선 2006-2021년 기간 동안 중국의 31개 지역을 대상으로 의무교육에 대한 재정지출의 효율성을 추계한다. 의무교육에 대한 재정지출의 효율성은 지역경제발전 수준이 상대적으로 높은 지역이 오히려 낮게 나타나고 있으며, 지역경제발전 수준이 상대적으로 낮은 지역의 효율성이 높게 나타나고 있다. 그리고 효율성을 종속변수로 설정하고 1인당 GDP, 재정자립도, 연령구조, 재정지출의 비중, 교사의 수준을 설명변수로 설정하여 Tobit모형을 이용하여 효율성의 영향요인을 분석하였다. 분석 결과에 의하면 1인당 GDP와 재정자립도는 효율성에 통계적 유의성이 나타나지 않으며, 연령구조, 재정지출의 비중 그리고 교사의 수준은 정(+)의 통계적 유의성이 나타나고 있다.

▶ **주제어:** 중국, 의무교육, 재정지출, 효율성, Tobit Model, DEA Model

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## I. Introduction

Compulsory education is the foundation of education, and the government has always attached great importance to the development of compulsory education. Due to the free, compulsory and universal characteristics of compulsory education, there will be some problems when the government uniformly implements relevant education policies and provides education guarantees for compulsory education. Zhang & Chen(2023) argued that in the stage of compulsory education, equity and efficiency are important goals for the development of compulsory education. So this paper mainly analyses the efficiency of fiscal expenditures on compulsory education and its influencing factors[1]. According to statistics from the Ministry of Education of the People's Republic of China, in 2021, China's general public budget for education is 3,746.34 billion yuan, increased by 5.17% over 2020. In 2021, the proportion of education expenditure in the general public budget to the general public budget expenditure is 15.25%, an increase of 0.47% over 2020. The proportion of education expenditure in the general public budget is the highest in Guangdong (20.79%), and the lowest in Heilongjiang (11.90%). It can be seen that the proportion of education expenditure in the general public budget is different in different regions. It shows that there is a big gap in the investment of education in different regions. This has led to the uneven development of compulsory education. In order to improve the uneven development of compulsory education, the government has formulated a series of policies. For example, the urban-rural integration policy aims to improve the uneven development of compulsory education between urban and rural areas. For example, the policy of two exemptions and one subsidy is aimed at providing some financial assistance to students from poor families. Because of China's large geographic area and population, there are many factors that influence the efficiency

of fiscal expenditures on compulsory education. For example, the differences in geographical location, natural environment and economic development level of each region will have an impact on the efficiency of fiscal expenditure on compulsory education. What causes the uneven development of compulsory education? In order to clearly understand the reasons for the uneven development of compulsory education, Therefore, this paper uses Tobit model to analyze the efficiency factors of fiscal expenditure influencing compulsory education.

As the most basic education, compulsory education is the education of people's quality and the starting point of social fairness. The research on the influencing factors of the efficiency of the fiscal expenditure on compulsory education is helpful to compare the disparities in the development of compulsory education in 31 regions(excluding Hong Kong, Macao, Taiwan region). It helps to find out what factors can promote the efficiency of compulsory education fiscal expenditures, and provides some corresponding suggestions based on the results of the analyses, and finally lead to a more efficient development of compulsory education.

## II. Literature Reviews

Robst(2001) argued that limiting funding to higher education to control the cost of higher education does not achieve efficient outputs[2]. Rong(2008) argued that uneven distribution of expenditure will increase the burden of compulsory education in rural regions, which is not beneficial to the development of compulsory education in rural regions[3]. Aristovnik & Obadić(2014) argued that the technological efficiency of education can be improved through, for example, consolidating schools and reducing costs[4]. Queiroz, et al.(2020) argued that economic level and infrastructure can promote the development of primary education[5].

Luo & Ma(2015) used the Malmquist-OLS analysis method to analyze the efficiency of fiscal expenditure on basic education in 12 prefecture-level cities of Hubei[6]. Li(2015) used the DEA-BCC model to analyze the efficiency of fiscal expenditure on compulsory education in Guangxi from 2002 to 2013[7]. Qi, et al.(2016) used the partial frontier approaches, order- $m$  efficiency and order- $\alpha$  efficiency methods to analyze the fiscal expenditure efficiency of basic education in 30 regions in China[8]. Jia(2017) used DEA-CCR model and Malmquist index to analyze the efficiency of resource allocation in basic education in 30 regions in China[9]. Ji(2020) used the DEA-CCR model to analyze the efficiency of higher education fiscal expenditure in six regions in central China[10]. Hu & Liu(2022) used the DEA-Malmquist index and the Tobit model to analyze the efficiency of higher education fiscal expenditure in eight ethnic minority regions in China and the factors affecting the efficiency[11].

In this paper, the calculation method of efficiency evaluation refers to the research of Jia(2017) and Ji(2020), and uses the DEA-CCR model to evaluate the efficiency of fiscal expenditure on compulsory education in 31 regions. The difference is that after evaluating efficiency, this paper further analyzes the influencing factors of efficiency. The advantage of such analysis is that it can clearly understand the reasons for the efficiency differences in different regions, and can provide some suggestions based on the research results. The research methods of influencing factors refer to the research of Hu & Liu(2022), and the Tobit model is used to analyze the efficiency factors influencing the fiscal expenditure of compulsory education. The difference is that the main analysis object of this paper is compulsory education, while Hu & Liu(2022) mainly analyzed the higher education of eight ethnic minority regions in China.

### III. Empirical Analysis of DEA Model

#### 1. Construction of DEA model

DEA-CCR model is based on input-output data, from which the most efficient input-output variables are selected as the optimal production frontier, and the curve of data envelope is constructed by linear programming[12]. Points on the data envelope curve indicate that the input-output structure is efficient, with an efficiency value of 1. Points outside the curve indicate that the input-output structure is not optimal, and the efficiency value is greater than zero and less than 1.

#### 2. Selection of variables for the DEA model

This paper refers to the research of Yue & Wang(2010), Sun, et al.(2023). The input variable are selected to be the per capita general public budget expenditure on education for compulsory education[14], number of full-time teachers [15]. The output variables are selected to be the consolidation rate of compulsory education and the junior high school graduates[6][9][13]. The data mainly come from China Statistical Yearbook and the Ministry of Education of China.

#### 3. Analysis results of DEA model

This paper uses data from 2006 to 2021 to evaluate the efficiency of China's fiscal expenditure on compulsory education. Table 1 shows the average value of efficiency in the 16 years from 2006 to 2021.

As can be seen in table 1, there are significant differences in the efficiency of financial expenditures on compulsory education among the 31 regions. It is worth noting that the efficiency of some economically developed regions with sufficient educational resources is very low, while the efficiency of some economically backward regions is very high. For example, Beijing and Shanghai, two economically developed regions, have the lowest efficiencies, 0.629 and 0.621

respectively. It shows that the structure of inputs and outputs of financial expenditures for compulsory education in Beijing and Shanghai needs to be improved, and educational resources are not reasonably allocated, so they are less efficient. The three economically backward regions, Henan, Xizang and Ningxia, are very efficient, with an average value of 1.

Table 1. Average efficiency for 2006-2021

Region	Mean	Region	Mean
Beijing	0.629	Hubei	0.874
Tianjin	0.795	Hunan	0.928
Hebei	0.906	Guangdong	0.899
Shanxi	0.837	Guangxi	0.941
Inner Mongolia	0.735	Hainan	0.933
Liaoning	0.818	Chongqing	0.977
Jilin	0.740	Sichuan	0.903
Heilongjiang	0.741	Guizhou	0.979
Shanghai	0.621	Yunnan	0.887
Jiangsu	0.776	Xizang	1.000
Zhejiang	0.780	Shaanxi	0.820
Anhui	0.915	Gansu	0.841
Fujian	0.855	Qinghai	0.979
Jiangxi	0.938	Ningxia	1.000
Shandong	0.791	Xinjiang	0.743
Henan	1.000		

This indicates that the structure of inputs and outputs of financial expenditures for compulsory education in these three regions is relatively favourable, and that the allocation of resources and the mode of management of education is the appropriate and efficient. So what are the reasons for the differences in different regions? so the next part of this paper will further analyze the influencing factors of the efficiency of the fiscal expenditures on compulsory education.

## IV. Empirical Analysis of Tobit Model

### 1. Construction of Tobit model

The efficiency value calculated by DEA model in this paper is between 0 and 1. Therefore, the Tobit model is used to analyze the influencing factors of the efficiency of the fiscal expenditure of compulsory education. A Tobit model is a model in

which the value of the dependent variable is subject to some limitation. This model is also known as limited dependent variable model[11][16][17]. The standard Tobit model is as follows (1).

$$y_i^* = \beta_i x_i + u_i \quad (1)$$

Since the value of the dependent variable in this paper is double truncated data from 0 to 1, the model is (2).

$$\begin{cases} y_i^* = y_i, & \text{if } 0 < y_i^* \leq 1 \\ y_i^* = 0, & \text{if } y_i^* \leq 0 \\ y_i^* = 1, & \text{if } y_i^* > 1 \end{cases} \quad (2)$$

Where  $y_i^*$  in formula (2) is the dependent variable. The dependent variable of this paper is efficiency value in DEA model. When the dependent variable is  $0 < y_i^* \leq 1$ , the value of the dependent variable is  $y_i^*$ . When the dependent variable is  $y_i^* \leq 0$ , the value of the dependent variable is 0. When the dependent variable is  $y_i^* > 1$ , the value of the dependent variable is 1.  $x_i$  is an independent variable, which is a factor influencing the efficiency of fiscal expenditure on compulsory education.  $i$  is the type of independent variables, which in this paper are selected as regional per capita GDP(RPCGDP), fiscal self-sufficiency rate(FSSR), age structure(AS), fiscal decentralization(FD), percentage of fiscal expenditure on compulsory education(CEFEP), teachers level (TL).  $\beta_i$  is the coefficient,  $u_i$  is the error term,  $u_i$  is independent and follows a normal distribution,  $u_i \sim N(0, \sigma^2)$ .

### 2. Selection of variables for the Tobit model

In this paper, regional per capita GDP is selected as the independent variable. Regional per capita GDP reflects the level of living of the population and the level of economic development of the region. This is because the higher the level of economic development of a region means that the government of that region has more financial resources, and the more adequate the financial investment in education, so it will influence the efficiency of the fiscal expenditure on compulsory

education[18]. The fiscal self-sufficiency rate is selected as the independent variable. This is because the fiscal self-sufficiency rate indicates a region's ability to take care of itself financially. When the fiscal self-sufficiency rate of a region is higher, it means that the region's fiscal self-sufficiency is stronger. The more adequate the financial resources of local governments, the more adequate the financial resources in the field of education will be. So the fiscal self-sufficiency rate will influence the efficiency of the fiscal expenditure on compulsory education[6]. Age structure is selected as the independent variable. The age structure is the proportion of the population aged 0-14 to the total population. The more students are subject to compulsory education, the greater the demand for compulsory education in the region, due to the increased demand for compulsory education, it will raise the importance of the local government to compulsory education, and then the local government will increase the fiscal expenditure on compulsory education, so the age structure will influence the efficiency of the fiscal expenditure on compulsory education[19]. Fiscal decentralization is selected as the independent variable. Fiscal decentralization means that the central government gives certain autonomy to local governments. Because local governments, compared with the central government, have a better understanding of the needs of the local population, and also needs of compulsory education. Local governments can allocate resources more appropriately, and finance public services more appropriately, and can implement policy in accordance with the preferences of the local population. Favorable to the development of compulsory education, it may influence the efficiency of fiscal expenditures on compulsory education[8][20]. Percentage of fiscal expenditure on compulsory education is selected as the independent variable. Because in the stage of compulsory education, the main source of expenditure is the government's public finance, the development of compulsory education depends to a

large extent on the government's financial education expenditure, the higher the percentage of fiscal expenditure on compulsory education, the more adequate financial expenditure for compulsory education, so percentage of fiscal expenditure on compulsory education will influence the efficiency of the financial expenditure on compulsory education[11]. Teacher level is selected as the independent variable. Teacher level is the proportion of full-time teachers with bachelor's degree or above in compulsory education, which can reflect the improvement of teachers' academic qualifications and help improve the quality of education. Therefore, teacher level will influence the efficiency of fiscal expenditure on compulsory education[14].

### 3. Analysis results of Tobit model

This paper selects panel data of 31 regions in China from 2006 to 2021. The data mainly come from China Statistical Yearbook and the Ministry of Education of China. Table 2 is descriptive statistics of the factors influencing the efficiency of fiscal expenditure on compulsory education. In the table 2, N is the number of samples, mean is the average, sd is the standard deviation, min is the minimum and max is the maximum.

Table 2. Descriptive statistics of independent variable

Variables	N	Mean	Sd	Min	Max
RPCGDP	496	47,78	29,41	6,34	183,98
FSSR	496	0.49	0.20	0.06	0.95
AS	496	0.17	0.04	0.08	0.27
FD	496	1.06	0.57	0.50	3.58
CEFEP	496	0.09	0.13	0.02	0.68
TL	496	0.54	0.21	0.10	0.97

As can be seen from table 2, the standard deviation of RPCGDP is large, so it may influence the regression results of the Tobit model, so it is important to standardize the data before doing the regression analysis.

From the results of descriptive statistics, it can be seen that the standard deviation of RPCGDP is large, which may influence the results of the

regression, as well as in order to eliminate the differences in the dimension of the different independent variables, so it is necessary to standardize the independent variables in the Tobit model with Zscore.

Since different independent variables may have the problem of multicollinearity, the independent variables are tested for multicollinearity before doing the regression analysis. In this paper, the method of VIF(variance inflation factor) test is selected.

$$VIF = \frac{1}{1 - R^2} \quad (3)$$

In formula (3),  $R^2$  indicates the degree of correlation of the independent variables, the higher the  $R^2$ , the higher the correlation of the independent variables, and the value of  $R^2$  is between 0 and 1. The maximum value of  $R^2$  is 1. If the  $R^2$  is closer to 1, the higher the value of VIF, it means the stronger the correlation of the independent variables, that is, the independent variables have the problem of multicollinearity. On the contrary, the minimum value of  $R^2$  is 0. If the value of VIF is closer to 1 when  $R^2$  is closer to 0, it means that the correlation of the independent variables is low, that is, there is not a serious multicollinearity of the independent variables. In the table 3,  $1/VIF$  indicates the tolerance, which can be expressed as  $T(=1-R^2)$ . It can be seen that VIF and T are inverse of each other. So to determine whether there is multicollinearity among the independent variables, it can be judged by the two tests of VIF and T. It is usually considered that when the value of VIF is less than 10, or when the value of T is higher than 0.1, there is not a serious multicollinearity in the independent variables[21]. The results calculated are shown in table 3.

Table 3. Multicollinearity test

Variables	VIF	T(1/VIF)
Z_RPCGDP	6.520	0.153
Z_FSSR	5.020	0.199
Z_AS	2.600	0.384
Z_FD	1.970	0.508
Z_CEFEP	1.210	0.829
Z_TL	1.200	0.830
Mean VIF	3.090	

From Table 3, it can be seen that the VIF value of each independent variable is less than 10 and the average VIF value of the independent variables is 3.090, which is less than 5. The value of  $T(1/VIF)$  for each independent variable is higher than 0.1, from which it can be concluded that there is not a serious problem of multicollinearity among the independent variables.

Table 4 shows the results of the Tobit regression. Z\_RPCGDP, Z\_FSSR, Z\_AS, Z\_FD, Z\_CEFEP, Z\_TL indicates the value after standardization by Zscore.

Table 4. Regression results of Tobit model

Variables	Coef	Se	T-value	P-value	Sig
Z_RPCGDP	-0.080	0.010	-7.650	0.000	***
Z_FSSR	-0.031	0.015	-2.160	0.031	**
Z_AS	0.034	0.014	2.400	0.016	**
Z_FD	0.021	0.014	1.520	0.129	-
Z_CEFEP	0.008	0.004	1.940	0.052	*
Z_TL	0.045	0.010	4.540	0.000	***
Cons.	0.879	0.018	8.470	0.000	***

Note: \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$

From table 4, it can be seen that the regression coefficient of regional per capita GDP is -0.080, which has a negative influence on the efficiency of fiscal expenditure on compulsory education at the significant level of 0.01. The regression coefficient of fiscal self-sufficiency is -0.031, which has a negative influence on the efficiency of fiscal expenditure on compulsory education at the significant level of 0.05. The regression coefficient of age structure is 0.034, which has a positive influence on the efficiency of the fiscal expenditure of compulsory education at the significant level of 0.05. Fiscal decentralization has no significant influence on the efficiency of fiscal expenditure on

compulsory education. The regression coefficient of percentage of fiscal expenditure on compulsory education is 0.008, which has a positive influence on the efficiency of fiscal expenditure on compulsory education at the significant level of 0.1. The regression coefficient of teacher's level is 0.045, which has a positive influence on the efficiency of fiscal expenditure on compulsory education at the significant level of 0.01.

Regional per capita GDP has a negative effect on the efficiency of fiscal expenditure on compulsory education, as shown in table 1, Beijing, Shanghai are economically developed regions, but the efficiency of these 2 regions is not high, 0.629 and 0.621 respectively. The more economically developed regions have sufficient financial resources and per capita education expenditure, but their efficiency is not high. This suggests that economically developed regions may be over-investing in compulsory education and not allocating resources reasonably. On the contrary, for example, Henan, Xizang, and Ningxia are economically backward regions, and all three of these regions are highly efficient with an efficiency value of 1. Although the financial resources of economically backward regions are lower than those of economically developed regions, their efficiency is high, which indicates that economically backward regions allocate resources more reasonably. It can be seen that the level of economic development does not contribute to the efficiency of fiscal expenditure on compulsory education. This is the same conclusion as Li & Deng(2016)[18]. Fiscal self-sufficiency rate has a negative effect on the efficiency of fiscal expenditure on compulsory education, consistent with the conclusion of Luo & Ma(2015)[6]. Luo & Ma(2015) argued that local governments pay more attention to investment in areas that can promote economic growth in a short period of time, and do not pay enough attention to basic education, which has a long cycle of efficiency growth, thus leading

to a decrease in the efficiency of education[6]. Combining the views of the existing literature, this paper argues that it may be due to the fact that regions with better financial resources pay more attention to economic growth, focusing on high-production areas so that they can get greater revenues to increase the fiscal self-sufficiency rate of the local government, and thus pay less attention to the public services, and therefore do not improve the efficiency of the fiscal expenditures on compulsory education. The age structure can increase the demand for compulsory education, promote the financial investment of local governments in compulsory education, and then improve the efficiency of fiscal expenditure on compulsory education. This is the same conclusion as Cao(2020)[19]. The higher percentage of fiscal expenditure on compulsory education, the more importance the government attaches to compulsory education and the more adequate the fiscal resources for compulsory education, thus promoting the efficiency of fiscal expenditure on compulsory education. This is the same conclusion as Hu & Liu(2022)[11]. The higher the level of teachers, the higher the number of highly educated teachers, which contributes to the quality of compulsory education and thus to the efficiency of fiscal expenditures on compulsory education. Fiscal decentralization has no influence on the efficiency of fiscal expenditure on compulsory education. Although fiscal decentralization can improve the autonomy of local governments, the higher degree of fiscal decentralization can only show that local governments have more autonomy, but it does not mean that local governments have higher financial investment in compulsory education.

## V. Conclusion

This paper first evaluates the efficiency of fiscal expenditures on compulsory education in China,

and finds that the efficiency of fiscal expenditures on compulsory education differs greatly among the 31 regions. Economically developed regions such as Beijing and Shanghai are relatively less efficient, while economically backward regions such as Henan, Xizang, and Ningxia are relatively efficient. It can be seen that not the more developed the economy, the more efficient the fiscal expenditure on compulsory education will be. Therefore, this paper analyzes the factors influencing the efficiency of fiscal expenditures on compulsory education. Regional per capita GDP and fiscal self-sufficiency rate are found to have a negative influence on the efficiency of fiscal expenditures on compulsory education. The age structure, percentage of fiscal expenditure on compulsory education and the teachers level of have a positive influence on the efficiency of fiscal expenditure on compulsory education. Fiscal decentralization has no significant influence on the efficiency of fiscal expenditure on compulsory education. It can be seen that in order to improve the efficiency of fiscal expenditures on compulsory education, we should not only focus on economic development, as the economic growth of a region does not mean that the proportion of investment in education has increased. Therefore, compared with economic development, we should pay more attention to the proportion of fiscal expenditure on compulsory education, which can better reflect the local government's investment in education and the degree of importance. It is also possible to improve the quality of compulsory education by raising the qualifications of teachers, thereby increasing the efficiency of fiscal expenditure on compulsory education.

Finally, the research of this paper adds the analysis of factors influencing the efficiency of fiscal expenditures on compulsory education compared with the previous ones. But there are some shortcomings, because compulsory education includes primary education and junior high school education, and there are differences in efficiency

between primary education and junior high school education, this paper does not analyze the efficiency comparison of primary education and junior high school education separately, so the efficiency comparison of primary education and junior high school education will be further analyzed in the future research.

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