

Wu, Yongqiu; Huang, Yi; Zhao, Jing; Pu, Yanping

**Article**

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# Transfer payment structure and local government fiscal efficiency: evidence from China

Yongqiu Wu<sup>1\*</sup> , Yi Huang<sup>1</sup>, Jing Zhao<sup>1</sup> and Yanping Pu<sup>2</sup>

\* Correspondence:

wuyongqiu@cqu.edu.cn.com

<sup>1</sup>School of Economics and Business  
Administration of Chongqing  
University, Chongqing, China

Full list of author information is  
available at the end of the article

## Abstract

**Background:** After revenue-sharing system reform, the proportion of tax refund in fiscal transfer payments continued to decline, and the proportion of categorical grant and condition grant is increased. The paper studies how transfer payment structure effect fiscal efficiency from the perspective of local financial revenue structure.

**Methods:** This paper use the SE-DEA model to measures the financial efficiency, and studies how transfer payment structure effect fiscal efficiency by the quantile regression method.

**Results:** The theoretical and empirical studies indicate that the tax refund is the most effective policy and the categorical grant is more efficient than condition grant.

**Conclusions:** The China's central government should decrease the condition grant and increases the tax refund or categorical grant in transfer payment.

**Keywords:** Transfer payment, Fiscal efficiency, Quantile regression

## Background

The vertical imbalance between central and local finance and lateral imbalance between regional finance contributes to the system of transfer payment. It is a policy tool universally used by central government to narrow the regional differences in economic development and to promote universal public service equal. Since China's reform of tax system in 1994, the system of tax refund and transfer payment is introduced. At present, the transfer payment from central government to local government concludes tax refund, categorical grant<sup>1</sup> and condition grant (An, 2007). Among the constitution of local government revenue, central fiscal transfer payment is the most important revenue of local government. The local government fiscal revenue is 298.6 billion CNY in 1995 and the local financial subsidies from central to local is 253.3 billion CNY, which accounts for 45.9% of local government revenue. By 2015, the tax refund and transfer payment from central to local government is 5509.8 billion CNY, which accounts for 42.6% of local government revenue. Although the scale of financial subsidies from central to local government is expanding since 1995, with an average annual growth rate of 16.6%, the proportion of central transfer payment in local fiscal revenue has maintained the level of 40 to 50%. Table 1 shows the change of payment structure from central financial to local government. The total scale of central

**Table 1** the change of transfer payment structure from 1995 to 2012 in China

Year	Scale of transfer payment (Billion CNY)	Tax refund		Categorical grant (Financial transfer payment)		Condition grant	
		Amount (Billion CNY)	Proportion (%)	Amount (Billion CNY)	Proportion (%)	Amount (Billion CNY)	Proportion (%)
1995	253.3	186.7	73.7	29.1	11.5	37.5	14.8
1996	267.2	194.9	72.9	23.5	8.8	48.9	18.3
1997	280.1	201.2	71.8	27.3	9.7	51.6	18.4
1998	328.5	208.3	63.4	31.3	9.5	88.9	27.1
1999	399.2	212.1	53.1	51.1	12.8	136.0	34.1
2000	474.8	220.7	46.5	89.3	18.8	164.8	34.7
2001	611.7	230.9	37.7	160.5	26.2	220.4	36.0
2002	735.3	300.7	40.9	194.4	26.4	240.2	32.7
2003	805.8	342.5	42.5	224.1	27.8	239.2	29.7
2004	1037.9	360.9	34.7	335.2	32.3	342.3	33.0
2005	1147.4	375.8	32.8	417.7	36.4	352.9	30.8
2006	1349.1	393.0	29.1	516.0	38.3	441.2	32.7
2007	1811.2	409.6	22.6	709.3	39.2	689.2	38.1
2008	2294.6	428.2	18.7	869.6	37.9	996.7	43.4
2009	2888.9	493.4	17.1	1137.5	39.4	1258.0	43.5
2010	3234.1	499.3	15.4	1323.6	40.9	1411.2	43.6
2011	3992.1	504.0	12.6	1831.1	45.9	1657.0	41.5
2012	45,362	5128	11.3	21,430	47.2	18,804	41.5
2013	48,020	5045	10.5	24,363	50.7	18,610	38.8
2014	51,591	5082	9.9	27,568	53.4	18,941	36.7
2015	55,098	5019	9.1	28,455	51.7	21,624	39.2

Note: the data is from "China Financial Yearbook" and "Summary of Financial Statistics"; the categorical transfer payment is called financial transfer payment before 2009

government financial subsidies in 1995 is 253.3 billion CNY. Among them, the tax refund is 186.7 billion CNY, which accounts for 73.7%, the categorical grant is 29.1 billion CNY, which accounts for 11.5 and the condition grant is 37.5 billion CNY, which accounts for 14.8%. By 2015, the total size of central transfer payment is 5509.8 billion CNY. Among them, the tax refund is 501.9 billion CNY, which accounts for 9.1%, the categorical grant is 2845.5 billion CNY, which accounts for 51.7%, and the condition grant is 2162.4 billion CNY, which accounts for 39.2%. The changing trend of transfer payment structure is that proportion of tax refund is declining while that of categorical grant and condition grant is increasing.

On the relationship between transfer payment and financial efficiency, the early public financial theory considers the central transfer payments and local tax are treated as equal by local government, and the revenue structure of local government does not affect arrangement of local financial expenditure, as well as fiscal expenditure efficiency (Wilde, 1968; Bradford and Oates, 1971;). The "flypaper effect" found at the end of 1970 shows that higher the proportion of transfer payment in revenue structure of local government, the larger the scale in financial expenditure (Hines and Thaler, 1995; Brennan and Pincus, 1996). Although the "flypaper effect" has no direct relationship with financial efficiency of local government, it has been proved that the financial

revenue structure has effect on expenditure behavior of local government. Since the 1990s, foreign studies focus on the issue of fairness and efficiency of transfer payment: whether the transfer payment can make the local government provide public service more fairly and efficiently (Gamkhar and Shah, 2007). In the literature of transfer payment and financial efficiency, the recent empirical studies generally think the transfer payment efficiency is lower than the local tax. Oates (1994) suggests that local government pay more attention to the transfer payment from higher level of government than local tax revenue, and the transfer payment efficiency is lower than that of local revenue. Baker et al. (1999) studied the Canadian's subsidies system changed from unlimited amount to limited amount and found that this changing can improve capital efficiency and conserve spending of local government. Borck and Owings (2003) consider that it is the political reason not the efficiency that plays an important role that contributes the lower efficiency of transfer payment of central government. Albouy (2010) evaluated the efficiency and fairness of federal government fiscal equalization in USA, and suggested that the federal fiscal transfer policy is neither fair nor efficiency, and on the contrary, the problem of inefficiency and lacking of assistance to minority nationalities are aggravated. Bhatt and Scaramozzino (2013) empirically evaluated the relationship between transfer payment and financial deficit in India and suggested that the fiscal transfer payment system distorts the incentive status and has a significant positive correlation with government's fiscal deficit. The domestic studies mainly concern about the equalization effect of transfer payments (Liu and Jiao, 2002; Ma and Yu, 2003; Guo et al., 2009; Jia et al., 2010). The literature of transfer payment efficiency is little. An (2007) suggested that it was due to unstandardized allocation of payment allocation, lacking of effective supervision and opaque operation that contributes to the low efficiency of financial transfer payment. Qiao et al. (2006) suggested both the categorical grant and condition grant have the moral risk, which reduces local government fiscal effort. Fan and Zhang (2010) study the relationship between transfer payment and economic growth and suggested the transfer payment policy is inefficient, which may reduce the potential of economic growth. However, Tang and Wang (2012) suggested that the higher local government depends on central financial transfer payment, the more capital invests to the strong rigidity area of science, education and agriculture, which improves the efficiency of local government finance. The view explains the efficiency of transfer payment is higher than that of revenue from another perspective.

The existing literatures mainly focus on the effect of transfer payment on local financial efficiency. This paper studies the different efficiencies of three kinds of transfer payment systems. In China's current financial transfer payment system, there are three kinds of transfer payments: tax refund, categorical transfer payment, and condition payment. The proportion of tax refund since the tax reform in 1994 is continually declining while the other two kinds of payment are increasing. It is of great significance to study the effect of structural changes in transfer payment on financial efficiency in order to optimize the form of transfer payment and improve the financial funds efficiency. The following structure of this paper is as follows: based on the present literature research, the second part measures the financial efficiency with the SE-DEA model and analyzes the change trend of overall efficiency of fiscal funds. The third part constructs the theory model of transfer payment structure's effect on local government's expenditure behavior and analyzes how

the change of transfer payment structure affect local government fiscal efficiency in the condition of unchanged amount of central transfer payment. The fourth part uses the quantile regression method to empirically test the relationship between transfer payment structure and local financial efficiency. The fifth part summarizes the conclusions and briefly describes the significance of this study.

## Methods

### The measurement of financial efficiency

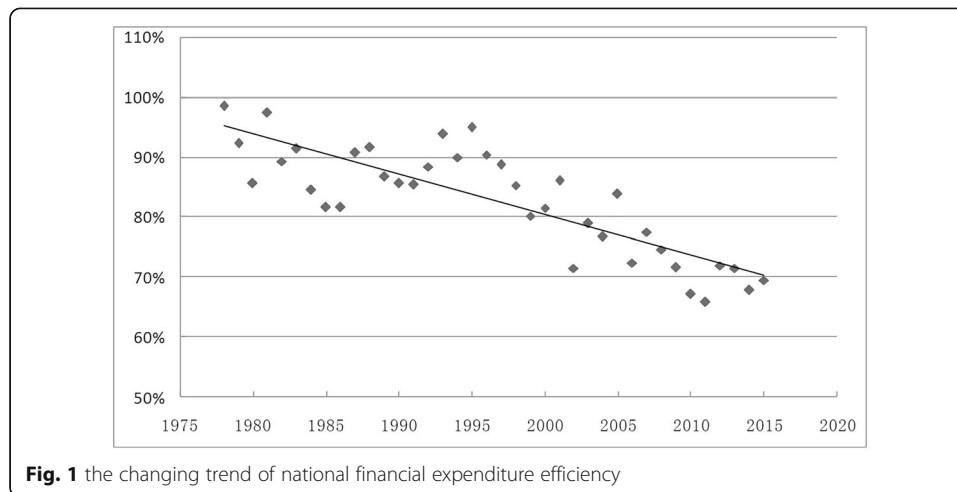
Financial efficiency is the embodiment of efficiency in the field of finance, and it includes the efficiency of fiscal expenditure, the efficiency of financial management and the efficiency of the financial system and so on. This paper mainly studies the fiscal expenditure efficiency, namely the efficiency of financial funds, which indicates rational options about different spending plans and specific ways and methods of using funds, and more output from less input in the case of certain financial funds.

We use the stochastic frontier function model and data envelopment analysis (DEA) to study the financial efficiency. Taking into the optimal input-output scheme of decision unit, the DEA method can better reflect the information and characteristics of evaluation object. In compared with stochastic frontier function and other parameter method, the method of DEA is more applicable to solve the efficiency evaluation of complex system of input and output. Therefore, this paper used DEA to evaluate the financial expenditure efficiency of local government. The existing literature used the traditional CCR-DEA to evaluate the financial efficiency, but this model cannot further evaluate the effective decision unit (Seiford and Zhu, 1998). The super DEA method (SE-DEA) proposed by Andersen and Peteren (1993) makes the comparison between effective decision units. The basic expression of the model is as follows:

$$\begin{aligned}
 & \text{Min } \theta \\
 & \text{s.t. } \sum_{i=1}^n \lambda_i X_i - \theta X_0 \leq 0 \\
 & \quad \sum_{i=1}^n \lambda_i Y_i - X_0 \geq 0 \\
 & \quad \lambda_i \geq 0 \quad i = 1, 2, \dots, n
 \end{aligned} \tag{1}$$

For the index of input and output, in reference to studies of Chen and Zhang (2008), Tang and Wang (2012), the nine representative financial output indexes such as education, health, science, technology are selected: GDP, number of full-time teachers, number of patents, total energy consumption of residents, number of health institutions, per capita social security expenditure, supply capacity of city water (increment), railway mileage (increment); the financial expenditure is selected as input index. Since there is no effective data in the calculation of military expenditure, the military spending does not include military index. And the relative military index is not concluded in the output index. It is taken into account that government funding support public officials that office number is not regarded as the input indicators.

The SE-DEA method is used to calculate the national financial expenditure efficiency (central and local government finance are concluded). All the input and output data are from "Compilation of statistics of sixty years in China" and "Chinese Statistical Yearbook". In order to eliminate the impact of price factors, the scale of fiscal



expenditure, GDP processed with CPI index. Figure 1 shows the historical trend of national fiscal SE-DEA efficiency calculated by software of EMS. It can be seen from the figure that the overall efficiency of China's fiscal expenditure obviously decreased from 1978 to 2015. The efficiency value is 0.986 in 1978, and declined to 0.695 in 2015. Chinese financial funds efficiency is related to financial system reform, especially the 1994 tax sharing reform. Before the reform of tax system in 1994 Chinese financial funds efficiency was relatively stable, while after it the financial funds efficiency started to decrease. The underlying cause for this change is that the reform brings tax refund, thus the central government may not use financial funds most efficiently because of information asymmetry. After 1998, the fiscal expenditure efficiency increased because the government has regulated procurement model and increased transparency in the use of government funds by reformation. But the financial funds efficiency decreased significantly during 2007–2011, related to the fiscal expansion policy. Local government improves investment scale through debt financing. Fiscal expenditure efficiency rise somewhat after 2011, due to the budget management system reformation, in which the central government required that the financial revenue and expenditure shall be included in budget management.

### The theoretical model

Among these three types of transfer payments, since the tax refund is relevant with growth of local government revenue and central government has no restriction on the capital, the inaccurate budget cannot contribute to the “flypaper effect”. Therefore, it is generally considered that efficiency of tax refund has no different with revenue of local government. However, the large scale of transfer payment contributes to the financial not matching with the responsibility. The categorical transfer payment and condition payment would reduce the effort of local government, which brings the loss of efficiency (Qiao et al., 2006). Especially the condition transfer payment, since the fixed fund is for specified purpose, local government must execute with clear regulations made by the central government. It is due to the inaccuracy of capital demand, lag of disbursement of funds, as well as dispersion of supervision and management that the “flypaper effect” appears. From the perspective of practical experience, at the beginning

of tax reform in the 90s of last century, transfer payment from central financial to different local government is quite equal. Along with the strategy of western development (1999), revitalizing Northeast (2003), and rise of central China (2005), the proportion of tax refund is decreasing year by year, and the transfer payment to the backward regions is increasing in order to promote fair. However, the policy effect is not satisfactory, the public expenditure in the backward regions has not been improved significantly, supply of public goods is still insufficient and regional gap of public service is still widening (An and Ren, 2008). Fan and Zhang (2010) found that each 1% increasing in the proportion of transfer payment would decrease the long-term growth rate by 0.03%. In addition, in order to improve the efficiency of transfer payment, central government begins to cleanup the condition transfer payment. In 2014, the item of condition transfer payment is compressed from 220 to 150, which is for the purpose of solve the arbitrary of condition transfer payment, abuse of power, corruption and other issues.

With the theory of consumer behavior, this paper analyzes the effect of transfer payment on fiscal expenditure efficiency. Public goods (services) that local government needs to buy are divided into two types:  $z_1$  and  $z_2$ . the local government to accept higher transfer income, including three areas: tax refund  $s_1$ , categorical grant  $s_2$  and condition grant  $s_3$ . The condition grant can be only used for purchasing  $z_2$ . Since this paper focuses on the internal structure of transfer payment, the local government's tax revenue is not taken into consideration. The goal of local government is to provide public goods as much as possible in the constraint of limited fiscal revenue. The logarithmic utility function is used to set the local government objective function:

$$\text{Max}\{U\} = \beta_1 \ln z_1 + \beta_2 \ln z_2 \tag{2}$$

The logarithmic utility function reflects the marginal utility diminishing law of public goods provided by local governments. The exogenous parameters  $\beta_1$  and  $\beta_2$  reflects the relative importance of the two public goods. Since the condition grant revenue  $s_3$  can be only used to buy the public goods  $z_2$ , the budget constraint that local government faces is:

$$p_1 z_1 + \max(p_2 z_2 - s_3, 0) = s_1 + s_2 \tag{3}$$

$p_1$  and  $p_2$  is the function is the price of public goods  $z_1$  and  $z_2$  respectively. The lagrange multiplier is introduced in the constraint of function 3, the function 2 can be expressed as follows:

$$U = \begin{cases} \beta_1 \ln \frac{\beta_1(s_1 + s_2 + s_3)}{p_1(\beta_1 + \beta_2)} + \beta_2 \ln \frac{\beta_2(s_1 + s_2 + s_3)}{p_2(\beta_1 + \beta_2)} & s_3 \leq \frac{\beta_2(s_1 + s_2)}{\beta_1} \\ \beta_1 \ln \frac{s_1 + s_2}{p_1} + \beta_2 \ln \frac{s_3}{p_2} & s_3 > \frac{\beta_2(s_1 + s_2)}{\beta_1} \end{cases} \tag{4}$$

The function 4 has the economic meaning: if  $s_3 > \frac{\beta_2(s_1 + s_2)}{\beta_1}$ , local government would use the condition grant  $s_3$  in purchasing  $z_2$ , and use the condition grant  $s_1$  and  $s_2$  in purchasing  $z_1$ . If  $s_3 < \frac{\beta_2(s_1 + s_2)}{\beta_1}$ , local government would use the capital of  $\frac{\beta_1(s_1 + s_2 + s_3)}{p_1(\beta_1 + \beta_2)}$  in purchasing  $z_1$ , and use the  $\frac{\beta_2(s_1 + s_2 + s_3)}{p_2(\beta_1 + \beta_2)}$  in purchasing  $z_2$ .  $s_3 \frac{\beta_2(s_1 + s_2)}{\beta_1}$  means that in the

condition that the optimal allocation of state government utility is in the maximization, the marginal utility acquired when condition grant  $s_3$  is used to purchase public goods  $z_2$  is equal to that acquired when tax refund and categorical transfer payment  $(s_1 + s_2)$  is used to purchase public good  $z_1$ .

On the basis of previous analysis, this paper focuses on how the changes in the transfer payment structure affect the behavior of local governments. First is to analyze the efficiency difference between condition grant and the categorical grant. In the case of transfer payment from central to local government  $(s_1 + s_2 + s_3)$  and the tax refund are fixed, if central government reduces the condition grant, the categorical grant would be equally increased  $(ds_2 = -ds_3)$ .

In the condition that total amount of central financial subsidy and tax refund are fixed, the unconditional financial subsidy would be transferred into the conditional transfer subsidy:

$$\left. \frac{dU}{ds_2} \right|_{ds_2 = -ds_3} = \begin{cases} \frac{\beta_1 + \beta_2}{s_1 + s_2 + s_3} (ds_2 + ds_3) & s_3 \leq \frac{\beta_2(s_1 + s_2)}{\beta_1} \\ \frac{\beta_1}{s_1 + s_2} ds_2 + \frac{\beta_2}{s_3} ds_3 & s_3 > \frac{\beta_2(s_1 + s_2)}{\beta_1} \end{cases} \quad (5)$$

When  $ds_2 = -ds_3$ , the function (5) would be:

$$\left. \frac{dU}{ds_2} \right|_{ds_2 = -ds_3} = \begin{cases} 0 & s_3 \leq \frac{\beta_2(s_1 + s_2)}{\beta_1} \\ \frac{\beta_1}{s_1 + s_2} - \frac{\beta_2}{s_3} > 0 & s_3 > \frac{\beta_2(s_1 + s_2)}{\beta_1} \end{cases} \quad (6)$$

The function 6 indicates that due to the use of condition grant is limited, when the size of condition grant  $s_3 \leq \frac{\beta_2(s_1 + s_2)}{\beta_1}$  is limited, that reducing the condition grant while increasing the categorical grant equally would not affect the financial efficiency; If the size of condition grant is high  $(s_3 > \frac{\beta_2(s_1 + s_2)}{\beta_1})$ , since the condition grant is limited, that reducing the condition grant while increasing the categorical grant equally would improve the overall efficiency of financial funds. The above analysis can get the first proposition about the transfer payment structure and financial efficiency: in the condition that the size of transfer payment and tax refund is fixed, that increasing the categorical grant while decreasing the condition grant would make the efficiency of fiscal funds not lower than the original level.

The effect of tax refund structure on financial efficiency is analyzed below. It due to the information asymmetry, rent-seeking behavior and other factors that local government needs to spend extra cost when in fight for the categorical grant and condition grant. Therefore, in the condition that the size of transfer payment is fixed, if the tax refund is transferred into the categorical grant or condition grant, then the constraint would be required:  $ds_1 = -d(s_2 + s_3)$ . The function 4 is differentiated as follows:



$$\frac{dU}{ds_1} \Big|_{ds_1 = -d(s_2+s_3)+c} = \begin{cases} \frac{\beta_1 + \beta_2}{s_1 + s_2 + s_3} d(s_1 + s_2 + s_3) & s_3 \leq \frac{\beta_2(s_1 + s_2)}{\beta_1} \\ \frac{\beta_2}{s_1 + s_2} d(s_1 + s_2) + \frac{\beta_1}{s_3} ds_3 & s_3 > \frac{\beta_2(s_1 + s_2)}{\beta_1} \end{cases} \quad (7)$$

With the constraint condition of  $s_3 > \frac{\beta_2(s_1+s_2)}{\beta_1}$ , the function 7 can be changed to the follows:

$$\frac{dU}{ds_1} \Big|_{ds_1 = -d(s_2+s_3)+c} \begin{cases} = \frac{\beta_1 + \beta_2}{s_1 + s_2 + s_3} d(s_1 + s_2 + s_3) & s_3 \leq \frac{\beta_2(s_1 + s_2)}{\beta_1} \\ > \frac{\beta_2}{s_3} d(s_1 + s_2) + \frac{\beta_1}{s_3} ds_3 & s_3 > \frac{\beta_2(s_1 + s_2)}{\beta_1} \end{cases} \quad (8)$$

With  $ds_1 = -d(s_2 + s_3)$  replaced in the function 8, the function 9 can be acquired:

$$\frac{dU}{ds_1} \Big|_{ds_1 = -d(s_2+s_3)+c} \begin{cases} = \frac{(\beta_1 + \beta_2) \times c}{s_1 + s_2 + s_3} & s_3 \leq \frac{\beta_2(s_1 + s_2)}{\beta_1} \\ > \frac{\beta_2}{s_3} \times c & s_3 > \frac{\beta_2(s_1 + s_2)}{\beta_1} \end{cases} \quad (9)$$

In the function 9, since the parameter and variables  $\beta_1, \beta_2, s_1, s_2, s_3,$  and  $c$  are greater than 0, then  $\frac{dU}{ds_1} \Big|_{ds_1 = -d(s_2+s_3)+c} > 0$ . The second proposition about the tax refund and financial efficiency can be acquired in the condition that the size of transfer payment is fixed, since local government needs extra cost and raise the tax refund when local government fighting for the central subsidy, the categorical grant and condition grant could be reduced, which can improve the financial efficiency of local governments.<sup>2</sup>

**Data and variables**

Under the background of tax system reform, China has formulated the “methods of transfer payment in transitional period” in 1999. But this transfer payment system, as an incomplete transfer payment system, cannot really reflect the impact of subsidy structure from central to local on the local financial efficiency. Therefore, the empirical research sample is the data after 2000. While after 2012 the local government transfer payments did not disclose, the empirical research using 2000~2011 provincial panel data.

**Dependent variable**

The dependent variable and independent variables as follow.

*Fiscal expenditure efficiency:* using the SE-DEA to calculate the fiscal expenditure efficiency of local government. In the calculation of financial efficiency of local governments, the input index is the size of financial expenditure. The output index concludes nine indexed: GDP in different regions, number of full-time teachers, number of patents, total energy consumption of residents, number of new health institutions, per capita social security expenditure, capacity of new water supply, mileage of new city railway, mileage of new city highway. The data comes from “China Financial Yearbook”, “China Statistical Yearbook”, and “China’s regional economic statistical yearbook”.

**Independent variables**

*Proportion of tax refund:* the index is reflected by the proportion of tax refund in the size of transfer payment, the function is as follows:

$$\text{proportion of tax refund} = \frac{\text{tax refund}}{\text{central financial subsidy}}$$

In the formula, the central financial subsidy concludes tax refund, categorical grant and condition grant. The data of tax refund in local governments is from “compilation of local financial statistics”, “China’s financial Yearbook”, and “summary of financial statistics”.

*Proportion of condition grant:* the index is reflected by the proportion of condition grant in the sum of categorical grant and condition grant. The formula is as follows:

$$\text{proportion of condition grant} = \frac{\text{condition grant}}{\text{condition grant} + \text{categorical grant}}$$

In the existing public statistics, only the “local fiscal statistics” from 2007 to 2009 provides the data of condition grant and categorical grant in local governments. Since the longitudinal time is short, the mixed data quantile regression method is adopted in the empirical study of the impact of condition grant structure on the financial efficiency.

**Controlled variables**

In addition to the indicators of central financial grant structure, other factors that influence the financial expenditure efficiency include:

*Proportion of financial transfer payment:* the existing literature generally suggests the efficiency of transfer payment is lower than the local government’s own tax revenue (Oates, 1994); The proportion of financial transfer payment is calculated by the size of transfer payment from central to local divided by the total financial revenue of local government. The formula is as follows:

$$\text{proportion of financial transfer payment} = \frac{\text{transfer payment from central to local government}}{\text{financial revenue of local government} + \text{transfer payment from central to local government}}$$

According to the majority of existing literature (Qiao et al., 2006, Fan and Zhang 2010), the greater the proportion of financial transfer payment, the lower the financial efficiency of local government. In the formula, the data of local government revenue is from “China Statistical Yearbook” and “China Financial Yearbook”. The data of transfer payment from central to local government is from “compilation of statistical of local finance” and “summary of financial statistics”.

*Population density:* the essence of finance is to provide effective products and services that meet the public demand. Public demand is closely related to population density. The population density can affect the public service and size that local government supplies and further influence the financial efficiency of local government. Grossman et al. (1999) suggested that the cost of management and supervision is negatively correlated with population density. It is due to the scale effect that the expenditure efficiency is increased. However, Athanassopoulos and Triantis (1998) and Loikkanen and Susiluoto (2006) suggested that the effect of population density on government efficiency is negative. The

population density is calculated by dividing the population in each region by the total area. Relevant data is from the “China Statistical Yearbook” and “China population and employment statistic yearbook”.

*Per capita GDP:* Since the rich people have higher demand of government public services and exert local government greater pressure, it is generally considered that arrears with higher economic development have higher financial expenditure efficiency. Afonso and Fernandes (2005) found that the high-income residents promote local government to provide the public goods and services with a more efficient way, which contributes to a higher financial expenditure efficiency. However, Loikkanen and Susiluoto (2006) suggested that economic development leads to an extensive expansion of government personnel and expenditure, which results in the uncontrolled administrative costs and no effective financial expenditure efficiency. The data is from “China Statistical Yearbook”, and the data is reduced by the CPI index.

*Education level:* Some studies (Hamilton, 1983; Hayes et al., 1998) suggested that the education level of residents would improve the political consciousness, as well as the ability to supervise the local government, which can affect the government financial expenditure efficiency. Borger and Kerstens (1996), Afonso and Aubyn (2005), Loikkanen and Susiluoto (2006) confirmed the conclusion that residents’ education level is positively related to the financial expenditure efficiency. For the index of per education year, this paper calculates with the current schooling periods as the coefficient. Period of college education is set at 16 years, high school education is at 12 years, junior high school is at 9 years, primary school is at 6 years and illiterate is at 0 year. The data is from the “China’s population and employment statistics yearbook”.

*Proportion of budget revenue:* In compared with the out-budgetary revenue, budgetary revenue has the higher efficiency due to its stringent supervision (Davis and Hayes, 1993). Ping and Bai (2006) also suggested that the out-budgetary revenue has lower efficiency due to the decreasing scale returns. However, Chen and Zhang (2008) empirically studied and found that local government would improve the expenditure efficiency of the out-budgetary revenue’s discretionary power. The index data is from the “compilation of local fiscal statistics”, “China’s financial yearbook”, and “summary of financial statistics”.

*Degree of marketization:* the degree of marketization can reflect whether a region has a complete legal environment and mature factor market. These factors would affect financial efficiency of government. At the same time, in the regions with higher marketization, the government scale is relatively high. Borger and Kerstens (1996) considered that the bigger the financial size of government, the more lacking of effective incentives of resources use, which leads to the low expenditure efficiency. It is generally believed that the marketization degree is positively related to the fiscal expenditure. This paper uses the proportion of private economy employment in the total employment to reflect marketization degree. The data is from “China’s population and employment statistic yearbook”.

## **Results and discussion**

In order to avoid the spurious regression problem, the unit root test of panel data is needed. Panel unit root test can be divided into two types: homogeneous panel and heterogeneous panel unit root test. This paper tests with these different methods: LLC,

IPS, ADF-Fisher, PP-Fisher and Breitung. The results in Table 2 show that LLC test rejects the hypothesis that all the variables have unit root. Although other methods have different results on the test, the variables are generally stable: the variables have no unit root.

This paper estimates the parameter with the method of quantile regression suggested by Koenker and Bassett (1978). In compared with the method of traditional least squares, the advantage of the quantile regression is low sensitivity to outliers. When the error is non normal distribution, the quantile regression is more effective than OLS, and more statistical information can be acquired by the quantile regression method (li and Ye, 2012). The parameter estimated by the quantile regression uses the method of linear programming. The R software provides the procedure of quantile regression for the panel data suggested by Koenker (2004). Since the data is not uniform, the proportion of condition grant has only 3 years data, the study in the paper could be empirically analyzed by two regression equation methods. First use the data from 2000 to 2011 to examine the effect of tax refund on expenditure efficiency. There are fixed and random effects in setting the model of econometric equation. The value of Hausman is 41.89, which refused the assumption of random effects model. The paper then use the panel data quantile regression proposed by Koenker (2004) to estimate the panel data. According to the criterion of minimum sum of squares of residuals, the penalty coefficient  $\lambda$  is 0.9. In the Table 3, the model 1 gives the results of FEQR of five main sites.

Since the data of proportion of condition grant are only acquired from 2007 to 2009, the effect of proportion of condition grant on financial efficiency is added on regression equation. Since the time sequence of proportion of condition grant is short, so the pooled data is used to quantile regressed. In the regression analysis, the residuals are assumed to be independent and non-identical distribution. Therefor the Huber method proposed by R software is approximately estimated for the covariance matrix. The

**Table 2** Test result of unit root of variables

Variable	LLC	IPS	ADF-Fisher	PP-Fisher	Breitung
Fiscal expenditure efficiency	-6.17451*** (C,T,1)	-0.15025 (C,T,1)	84.1437** (C,T,1)	154.155*** (C,T,1)	4.06919 (C,T,1)
Proportion of tax refund	-23.7420*** (C,T,1)	-3.75580*** (C,T,1)	152.458*** (C,T,1)	109.134*** (C,T,1)	0.04343 (C,T,1)
Proportion of financial transfer payment	-7.17973*** (C,T,1)	0.18014 (C,T,1)	59.1414 (C,T,1)	185.491*** (C,T,1)	-2.91290*** (C,T,1)
Population density	-9.32558*** (C,0,1)	1.44065 (C,T,1)	49.5195 (C,T,1)	296.060*** (C,T,1)	1.01631 (C,T,1)
Per capita GDP	-7.76914*** (C,T,1)	0.02933 (C,T,1)	129.052*** (0,0,1)	222.806*** (0,0,1)	-0.15045 (C,T,1)
Education level	-9.83629*** (C,T,1)	-0.59993 (C,T,1)	77.9654* (C,T,1)	161.307*** (C,T,1)	-2.49907*** (C,T,1)
Proportion of budget revenue	-15.4158*** (0,0,1)	0.08470 (0,0,1)	251.691*** (C,T,1)	380.493*** (C,T,1)	-0.13604 (C,T,1)
Degree of marketization	-14.5442*** (C,T,1)	0.28879 (C,T,1)	68.8743 (C,T,1)	81.1704* (C,T,1)	3.39272 (C,T,1)

Note: the brackets of  $\odot$  have set the test form. C is constant, T is trend item and the last item is lagging order. \*, \*\* and \*\*\* represents 10, 5, and 1% significant level respectively. Since the variable of proportion of condition grant has only part of annual data, there is no unit root test

**Table 3** The quantile regression results of financial efficiency

Variable	Model 1: quantile regression of panel data					Model 2: quantile regression of mix data				
	0.1	0.25	0.5	0.75	0.9	0.1	0.25	0.5	0.75	0.9
Constant	-1901119 (-1.58913)	-26.3694*** (-3.78311)	-12.36654* (-1.80535)	29.08985*** (4.09741)	25.00064 (1.50226)	14.48595 (1.09793)	-12.44011 (-0.46223)	11.03235 (0.30328)	5.14809 (0.20617)	11.27833 (0.48578)
Proportion of tax refund	0.57745*** (7.16811)	0.62308*** (7.40576)	0.57892*** (8.89608)	0.37847*** (4.29930)	0.29948*** (3.65326)	0.77165*** (11.04981)	0.84927*** (5.96192)	0.66690*** (3.46371)	0.47226*** (3.57324)	0.55524*** (4.51839)
Proportion of condition grant										
Proportion of financial transfer payment	-0.03355** (-2.33520)	-0.00329 (-0.76149)	-0.00615 (-1.42557)	-0.01595*** (-4.57422)	-0.01659*** (-2.63667)	-0.04624*** (-8.51703)	-0.02966*** (-2.67888)	-0.00898 (-0.60005)	-0.00517 (-0.50325)	-0.00566 (-0.59198)
Population density	-0.40781** (-2.05557)	-0.44742* (-1.91752)	0.03264 (0.10537)	1.22461*** (3.85641)	1.66547*** (4.09892)	-0.19289 (-0.90525)	-0.45290 (-1.04199)	0.62253 (1.05963)	1.94916*** (4.83338)	2.38806*** (6.36897)
Per capita GDP	-10.62017 (-2.69518)	-9.38714** (-2.41739)	-6.48708 (-1.34878)	3.02845 (0.61234)	8.40883* (1.96650)	-15.4897*** (-4.53204)	-1.89780* (-1.70657)	5.83165 (0.61885)	4.95819 (0.76652)	-2.43753 (-0.40529)
Education level	7.38000*** (7.12654)	7.62204*** (9.66954)	7.17285*** (8.94870)	4.32834*** (5.80688)	4.19406** (2.48495)	5.34559*** (3.83007)	8.94833*** (3.14309)	6.73494* (1.75020)	7.25184*** (2.74541)	8.36351*** (3.40539)
Proportion of budget revenue	0.19619*** (3.41957)	0.22834*** (4.09420)	0.17623*** (4.32710)	0.09363 (1.37880)	0.23452*** (4.27094)	0.21537*** (2.69728)	0.06624 (0.40670)	-0.09188 (-0.41734)	0.06410 (0.42415)	-0.02393 (-0.17032)
Degree of marketization	0.05296 (0.38798)	0.11786 (0.96446)	-0.18009 (-1.52762)	-0.64916*** (-4.83944)	-0.65869 (-4.43159)	0.04206 (0.28911)	-0.39348 (-1.32601)	-1.00761** (-2.51221)	-0.83117*** (-3.01896)	-0.90470 (-3.53417)
R <sup>2</sup>	0.76170	0.69668	0.64870	0.61091	0.58495	0.65890	0.54643	0.55378	0.57853	0.58977
LR	372.8789	365.5931	360.6661	288.6559	180.1155	85.57791	64.21197	78.51349	71.72961	55.68724

Note: the t statistic is in the bracket. \*, \*\* and \*\*\* refers to the significant level of 0.1, 0.05 and 0.01, respectively

results of five sub loci are listed in model 2 in Table 3.  $R^2$  is the fitting degree of quantile regression. LR reflects the overall significant level of quantile regression.

According to the results of quantile regression in Table 3, the conclusion about grant structure and financial efficiency: first is that increasing the proportion of tax refund is conducive to improving the financial efficiency of local government. The regression analysis of panel data and mixed data shows that there is a significant positive correlation between tax refund and financial efficiency. The quantile estimation of different parameters shows that either panel data regression model or mixed regression model, the coefficient of proportion of tax refund is significant with high value at the low point of 0.1 and 0.25 while the coefficient of proportion of tax refund is significant with low value at the high point of 0.75 and 0.9. This also indicates that along with the improvement of financial efficiency, the effect of tax refund structure on local government efficiency would decline. Second is that there is no obvious difference between condition grant and categorical grant. In the regression model of mixed data, there is correlation at the significant level of 10% between proportion of condition grant and financial efficiency at the fractile of 0.9, and there is no significant level at the other fractile. The conclusion is different from previous expectation and there are two possible reasons: one is that there is the widespread situation that local government misappropriates the condition grant (China National Audit Office, 2006). A lot of financial funds nominally are condition grant, but actually are used as department funding or systematic funding. The other one is that in the central government's allocation of categorical grant, fairness rather than the efficiency is taken more consideration, which leads to the low efficiency. The third is that proportion of financial transfer payment has negative impact on financial efficiency at the fractile of 0.1 and 0.25, which verifies the general view that financial efficiency of transfer payment is lower than local government's own tax revenue (Oates, 1994, Borck and Owings, 2003). The fourth is the influence effect of control variables varies. The population density (*pop*) has positive impact on fiscal efficiency, which is basically consistent with the conclusions of Fan and Zhang (2010), Tang and Wang (2012); The higher the population density, the lower the government's supervision and management costs, the government can transfer the financial expenditure to other links, the relative financial expenditure efficiency is higher. The level of education (*edu*) and proportion of budget revenue (*bug*) is directly proportional to the financial efficiency, the higher the level of education, the higher national education level, and the level of education will significantly improve the national political consciousness, improve the supervision ability of local governments, and then improve the efficiency of fiscal expenditure; there are strict supervision and management system in budget revenue, budget revenue accounted for the higher, more revenue will be strictly regulated, thus improve the efficiency of fiscal expenditure; In addition, the results of quantile regression also indicate the effect of per capita GDP and degree of marketization is not obvious on financial efficiency and only has correlation relationship at some loci.

## Conclusions

This paper focuses on the effect of transfer payment structure on the financial efficiency of local government. Analyzing the data of financial transfer payment structure, this paper found that the way and structure of transfer payment from central to local government changes obviously. The proportion of tax refund is decreased from

73.7% in 1995 to 11.3% in 2012. The proportion of categorical grant and condition grant is increased. Tax refund is no longer the major way of transfer payment from central to local government. After calculating the efficiency of national financial fund by the model of EDA, this paper found that the overall efficiency of China's financial capital showed a downward trend. Based on the theory of consumer behavior analyzing the financial expenditure, the reason of declining financial funds is analyzed and two hypotheses about the transfer payment structure on financial efficiency is put forward: one is that in the situation of size of transfer payment and tax refund unchanged, increasing the categorical grant while decreasing the condition grant with similar size could make the efficiency of financial funds be lower than the original level. The other is that due to a certain cost needed in local government completing for the central subsidy, the tax refund is transformed into the categorical grant and condition grant, which leads to low financial efficiency of local government. Based on the theoretical analysis, this paper uses the regression method with the panel data and mixed data to examine the relationship between transfer payment structure and financial efficiency. The empirical results show that tax refund has a significant positive correlation with financial efficiency of local government, which indicates the declining proportion of tax refund the one of reasons that financial efficiency is declining. Moreover, the empirical results has not supported the hypothesis that condition grant has significant difference with categorical grant. The possible reason is that in the appropriation of condition grant, central government pays more attention to fairness rather than efficiency.

Since the central transfer payment has the double goal of “fairness” and “efficiency” (Zhu, 1997), not only the “efficiency”, but also the “fairness” should be taken into consideration. The domestic literature on transfer payment having fairness effect (Yin et al. 2007; Jia, 2009) has indicated that tax refund and condition grant is the way of transfer payment that is most unequal. In combined with the results, the policy can be acquired: the categorical grant is conducive to fairness, and tax refund is more conducive to efficiency. But the condition grant has neither fairness nor efficiency. The direction of optimizing the transfer payment structure is to reduce the proportion of condition grant while increasing that of categorical grant or tax refund.

## Endnotes

<sup>1</sup>The categorical grant is called financial transfer payment before 2008.

<sup>2</sup>In addition to the transaction costs, central government tend to pursue more fairness when providing categorical grant and condition grant, which results in the loss of efficiency (Borck and Owings, 2003)

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## Authors' contributions

All authors equally contributed to this paper. All authors read and approved the final manuscript.

## Competing interests

The authors declare that they have no competing interests.

## Author details

<sup>1</sup>School of Economics and Business Administration of Chongqing University, Chongqing, China. <sup>2</sup>School of Public Affairs, Chongqing University, Chongqing, China.

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