Statistical Analysis of Data Based on the Endogenous Growth Model to Study the Adequacy of Fiscal Social Security Expenditure and the Improvement of Social Security System

Xizi Xue

20113030@bjtu.edu.cn

Economics and Management of Beijing Jiaotong University, Beijing, China

Abstract—The purpose of this paper is to study the intrinsic mechanism of the impact of fiscal decentralization on social security expenditure from both theoretical and empirical perspectives, and to explore how China's social security system, as an extremely important function of the government, can reasonably and effectively determine the appropriate level of fiscal social security expenditure in which the "engine" role is assumed. By selecting "small-calibre" social security expenditure items, which are more in line with the current situation of big data applications in China, as statistical indicators of fiscal expenditure decentralisation, an endogenous growth model of central and local public goods supply is constructed to constrain social production and government budgets to obtain a general competitive equilibrium, and the first-order partial derivatives of fiscal decentralisation on local government public goods expenditure are calculated based on structural parameters. The study shows that there is a significant positive linear relationship between fiscal decentralisation and the level of local government public expenditure. The study further analyses the endogenous instrumental variables in the empirical model-public finance expenditure structure and transfer payments-on the decentralisation of affairs and the underlying mechanism by which fiscal decentralisation ultimately affects the impact of fiscal social security expenditure.

Keywords—endogenous growth model; Competitive equilibrium; security expenditure; statistical analysis

1. INTRODUCTION

The development of social security and the improvement of the social security system is a necessary part of China's efforts to build a harmonious society and promote economic development. With predetermined targets, the central and local governments have continued to increase the absolute level and relative proportion of public finance spending on social security, and data show that by 2020, a social security system covering both urban and rural residents has been established. In terms of fiscal decentralisation, the fiscal decentralisation effect hypothesis

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suggests that under China's current fiscal management system, indicators of the degree of fiscal decentralisation measured by different criteria have different effects on the behaviour of local governments in providing basic public goods, so that fiscal decentralisation reflects the relationship between the central government and local governments in the distribution of fiscal power [1].

Fiscal decentralisation has been an important issue in China's economic reform and development for over 20 years. There has been extensive research on this issue. Yingyi Qian and Wiengast argue that the reform of China's fiscal system, which began in the early 1980s and continued until 1994, provided effective incentives for local governments to pursue economic development and laid the foundation for China's spectacular economic performance [2]. More recently, Berkowiz and Li have argued that Chinese local governments have more clearly defined tax powers than Russian local governments and have used this to explain the difference in economic performance between the two countries [3]. Shleifer and Zhuravaskaya argue that fiscal incentives for local governments are key to China's economic prosperity [4]. Although there is a large literature on fiscal social security spending and fiscal decentralisation in China, little literature has examined the impact of fiscal decentralisation on the adequacy of fiscal social security spending in terms of the underlying mechanisms. Based on the analysis of provincial panel data, Fengxi Pang and Xiaozhen Pan find that the degree of revenue decentralisation is negatively related to the size of local government social security expenditure, while the degree of expenditure decentralisation is positively related to the size of local government social security expenditure. In addition, a Kuznets inverted U-curve phenomenon is found for local government social security expenditure. However, there is almost no research on the mechanisms underlying the effect of fiscal decentralisation on the level and structure of social security spending after the 1994 tax regime.

This paper first constructs an endogenous growth model with central and local social security expenditures, and obtains a general competitive equilibrium by constraining budget revenues and budget expenditures, based on which the first-order relationship between fiscal decentralisation and fiscal social security expenditures is explored, examining whether the impact of fiscal decentralisation incentives on the appropriateness of the structure of the level of fiscal social security expenditures causes "bias ". The paper is structured as follows: Part II describes the changes in fiscal social security expenditure in the context of fiscal decentralisation after the 1994 tax reform, introducing the current situation of fiscal social security expenditure and the structural 'bias' problem; Part III constructs an endogenous growth model, conditional on a dynamic optimal equilibrium under an equilibrium growth path; Part IV the article concludes with a discussion of the institutional effects between fiscal decentralization and the adequacy of social security expenditure.

2. THE DIVISION OF FISCAL AUTHORITY AND FINANCIAL POWER UNDER DATA STRUCTURE PARAMETERS

Decentralisation included a series of fiscal arrangements that gave local governments, particularly at the provincial level, residual control over fiscal revenues. These provided important fiscal incentives for local governments to promote economic reform and enhance the livelihoods of the local economy [5]. In fact, the fiscal freedom incentives given to local

governments under the decentralised system weakened the central government's tax base, which in turn led to a steady decline in the central government's revenue as a proportion of total revenue, from 35 per cent in 1978 to 12 per cent in 1992. As a result, a tax reform was introduced in 1994 to fundamentally change the division of revenue between the central and provincial governments. Under China's current tax system, local governments are the main suppliers of public products within their jurisdictions, so the scale and structure of local government expenditure directly determines the level of social welfare of the residents in their jurisdictions [6].

From the perspective of data application, at present, the statistics on the application of big data for the supply of social security public goods in China are mainly based on local governments, and their statistical calibres generally include the three major categories of pensions and social welfare relief payments, social security subsidies and retirement payments for administrative and institutional units in the former government revenue and expenditure classification accounts. For example, in 2009, China arranged a total expenditure of 760.686 billion yuan for social security and employment projects, of which 715.231 billion yuan was spent by local governments, with local government expenditure at all levels accounting for 94.03% of all government expenditure; the expenditure structure of health care projects is also similar to that of social security and employment projects, with local government expenditure at all levels accounting for 98.41% of all government expenditure. On the other hand, from the perspective of the structure of government expenditure, China's social security expenditure has been increasing year by year, but is still insufficient. Table 1 shows that from 2003 to 2017, fiscal expenditure on social security increased from 144.491 billion yuan to 246.12 billion yuan, an average annual increase of 9.7%, and the proportion of social security expenditure to fiscal expenditure increased from 10.3% in 2003 to 12.1% in 2017, an increase of 1.8 percentage points. From Table 1, it is easy to see that the proportion of fiscal social security expenditure to fiscal expenditure has increased steadily from 2003 to 2017. The main reasons for this are: China's social security reform has made certain achievements, the social security fund has improved its self-balancing mechanism, and both fiscal expenditure and economic growth have maintained a high growth rate. For example, in 2009, the fiscal expenditure on social security and employment accounted for 9.37% of the fiscal expenditure for the year, and there is still a big gap between the coverage and protection of social security in China and that of developed countries. There is still a big gap between the coverage and protection of social security nationwide and that of developed countries, such as the level of coverage of people in informal employment and the protection of urban and rural medical insurance and pension insurance.

Table 1. China's financial social security and employment expenditure, 2003-2017

Item		Total	2013	2014	2015	2016	2017
Amount of Expenditure (billion yuan)	Total Financial Expenditure	858716	140212	151786	175878	187755	203085
	Social Security and Employment Expenditure	95681	14491	15969	19019	21591	24612
	Financial Assistance to the Social Insurance Fund	31124	4403	5043	6596	7634	7229
	Retirement from Administrative Institutions	24051	3208	3668	4361	5235	7579
	Employment Assistance	4167	823	871	871	785	817
	Urban Minimum Livelihood Security	3543	763	737	754	716	572
	Natural Disaster Living Allowance	1112	241	210	196	273	192
	Rural Minimum Livelihood Security	4486	861	869	911	941	904
Share of Total Fiscal Expenditure (%)	Social Security and Employment Expenditure	11.1	10.3	10.5	10.8	11.5	12.1
	Financial Assistance to the Social Insurance Fund	3.6	3.1	3.3	3.8	4.1	3.7
	Retirement from Administrative Institutions	2.8	2.3	2.4	2.5	2.8	3.7
	Employment Assistance	0.5	0.6	0.6	0.5	0.4	0.4
	Urban Minimum Livelihood Security	0.4	0.5	0.5	0.4	0.4	0.3
	Natural Disaster Living Allowance	0.1	0.2	0.5	0.1	0.1	0.1
	Rural Minimum Livelihood Security	0.5	0.6	0.6	0.5	0.5	0.4
Increase over Previous Year (%)	Total Financial Expenditure		11.3	8.3	13.2	6.3	7.6
	Social Security and Employment Expenditure		15.1	10.2	17.0	13.5	15.0

Figure Labels: Data from the General Treasury Account.

In terms of the construction of fiscal social security decentralised accounting indicators, this paper has selected three indicators in accordance with the normative standards, which reflect the situation of social security expenditure at different levels, including: the first is the GDP share of fiscal social security expenditure, which is analysed from the perspective of the level of economic development; the second is the share of social security in total fiscal expenditure, which is measured from the perspective of fiscal burden and structure, and also The third indicator is the level of fiscal social security expenditure per capita, which is a horizontal comparison criterion. All three indicators can be expressed by the following formula:

fiscal social security expenditure as a proportion of GDP = fiscal social security expenditure/GDP*100 (1)

share of fiscal social security expenditure = fiscal social security expenditure/fiscal expenditure*100 (2)

per capita fiscal social security expenditure = fiscal social security expenditure/population (3)

Since the gradual improvement of the social security system in China, the bulk of social security expenditure is now reflected in the latter two are the share of the investment price of housing and the share of the investment price of housing. The latter two, which are the investment price of housing and the subsidies, no longer correspond to the current situation since the abolition of welfare housing in the 21st century. This leaves a 'small' size (excluding residential investment and price subsidies) that is consistent with the current state of development of our welfare economy and meets the principle of adaptability in the selection of economic indicators for big data. According to the relevant measurement big data and standards, the main part of social security expenditure in this paper is the government's social

security expenditure, which takes the form of social welfare, social security subsidies and social pension expenditure.

3. AN ENDOGENOUS GROWTH MODEL OF SOCIAL SECURITY SPENDING AT THE CENTRAL AND LOCAL LEVELS

To construct an endogenous growth model of central and local public goods supply, general competitive equilibrium is obtained by constraining social production and government budgets, based on which the linear relationship between the first-order partial derivatives of fiscal decentralisation on local government expenditure on public goods is discussed. According to the endogenous model already constructed by Zhang Yabin and Que Wei [7], given the initial condition k(0) = k, h(0) = h and satisfying economic competitive equilibrium, the optimal expression for local government expenditure is

$$g_s^* = \left[(1-\tau_c-\tau_s) - \frac{\lambda\beta\tau_c\left[\left[\left(1+\varphi\right)(1-\xi)-(\tau_s+\eta_2 e)\frac{\gamma y^*}{k_{st}}\right]\right.}{(\gamma+\beta)\eta}\right] \times\left[\frac{(1-\tau_c-\tau_s)\alpha A k_{ct}^{\beta+\gamma}\eta^{\gamma}}{\rho\delta_1+\sigma x}\right]^{\frac{\alpha}{1-\alpha}}\left[\frac{\varphi-(1-\rho x^{-1})}{\varphi}\right]^{\frac{1-\alpha-\beta-\gamma}{1-\alpha}} \quad (4)$$

The agent is assumed to have an infinite lifetime and to maximise utility, C_t to be consumption at time t, σ to be the inverse of the intertemporal elasticity of substitution of the consumer, and ρ to be the rate of time preference. At each point in time, the agent is given 1 unit of labour time to allocate at will to the production of goods and leisure. A represents the society-wide level of production technology, which is constant. $k_{pt}k_{ct}k_{st}$ represents the productive expenditure paid by the private sector, central government and local government respectively for the total social product. α,β,γ are the coefficient of capital input for the production of the final product in these three different sectors. uh is the effective labour input and depends on the human capital input h and the effective labour time u . $k_{st}/k_{ct}=\eta$ is the share of local public productive expenditure in relation to central public productive expenditure, thus measuring decentralisation at the expenditure end.

Under a general equilibrium public goods supply, the necessary condition for an efficient level of production is to satisfy the marginal rate of transformation of public and private goods equal to the marginal rate of substitution of the two, with the following public goods provision by central and local governments.

$$g_c = Ck_{ct}^{\beta}(uh_c)^{1-\beta} \quad (5)$$

$$g_s = Bk_{ct}^{\beta}k_{st}^{\gamma}(uh_s)^{1-\beta-\gamma} \quad (6)$$

g_s^* is optimal for local government spending, τ_c, τ_s represents central and local taxes, and λ is used to measure information differences in preferences for heterogeneity in demand for public goods by local residents. g_{cos} is local government consumption, T_r represents central government transfers to local governments, ξ is the proportion of central to local transfers, and sets the structural parameters of public expenditure as

$$\varphi = {g_{cos}}/{k_{s.}} \quad (7)$$

Therefore, decentralisation on the expenditure side has a positive impact on the level of public expenditure by local governments

$$\frac{\partial g_s^*}{\partial \eta} = \frac{(1-\tau_c-\tau_s)\alpha A k_{ct}^{\beta+\gamma}}{\rho\delta_1+\sigma x} \times \left[\frac{\varphi-(1-\rho x^{-1})}{\varphi}\right]^{\frac{1-\alpha-\beta-\gamma}{1-\alpha}} \eta^{\frac{\gamma\alpha+2\alpha-2}{1-\alpha}} \frac{\gamma\alpha}{1-\alpha} \times \left[\frac{1-\alpha-2\gamma\alpha}{1-\alpha}\left[\frac{\lambda\beta\tau_c\left[(1+\varphi)(1-\xi)-(\tau_s+\eta_2 e)\frac{\gamma y^*}{k_{st}}\right]}{\gamma+\beta}+(1-\tau_c-\tau_s)\eta\right]\right] > 0 \quad (8)$$

As can be seen from the equation, the decentralisation of the fiscal expenditure end has a positive impact on the level of public expenditure of local governments, such as the fiscal social security expenditure of local governments, reflecting the supply advantage of local public goods, and the decentralisation of affairs implies that local governments hold the information advantage in order to expand the level of fiscal social security expenditure. Local governments, as the main providers of social security public goods, are generally required to spend more than their revenues due to the large scale of capital investment required for social security public goods and the fact that a higher degree of decentralisation of expenditure means that the central government delegates more fiscal spending power to local governments [8]. The difference is mainly solved by means of transfer payments from the central government to local governments. While the central government provides financial subsidies to local governments, there are often certain restrictions on the use of the funds, with the central government generally requiring local governments to spend more of the transfer funds on basic public service products that improve the welfare of the people in their jurisdictions, such as social security spending [9]. Therefore, a higher degree of fiscal decentralisation means that local governments receive more targeted transfer funds from the central government, and local governments have more incentives to provide more social security public goods to residents in their jurisdictions.

In contrast, public goods that are not directly reflected in political performance and do not have significant externalities are social security, and in the absence of explicit requirements from higher levels of government on the use of funds, local governments prefer to invest in infrastructure spending that is more reflective of political performance and attracts investment, and in administrative spending that is more likely to improve the welfare of officials [10]. The higher degree of revenue sharing means that local governments have less incentive to spend on public goods such as social security, which can only improve the well-being of the people in their jurisdiction.

4. CONCLUSION

Within the principle of timeliness of big data economic statistics and China's decentralized fiscal management system, local governments are the main suppliers of public goods within their jurisdictions, and the scale and structure of local government expenditures directly determine the level of social welfare of residents in their jurisdictions [11]. By selecting "small-calibre" social security expenditure items, which are more in line with the current situation in China, as a statistical indicator of fiscal expenditure decentralization, an endogenous growth model for the supply of public goods at the central and local levels is constructed, and the first-order partial derivatives of fiscal decentralisation on local government expenditure on public goods are calculated according to structural parameters. Decentralisation of fiscal expenditure has a significant positive linear correlation with the level of local government public expenditure**.**The conclusion is that fiscal decentralisation has a positive impact on the level of public expenditure of local governments, and further analyses that the internal mechanism of the impact of fiscal decentralisation on social security expenditure lies in the decentralisation of affairs, transfer payments from the central government, and the positive incentive effect of fiscal decentralisation on local governments.

In order to motivate local governments to invest more in social security and other public goods that are related to the welfare of residents in their jurisdictions, China should further improve the fiscal transfer system while maintaining the current high degree of expenditure decentralisation and low degree of revenue decentralisation, and establish an institutionalised, standardised and oriented fiscal transfer system to guide and motivate local governments to change their spending on social security. The system should guide and incentivise local governments to change the structure of fiscal expenditure and increase the proportion of fiscal social security expenditure moderately in line with the gradual approach of developed countries. This will reduce the "deviation" in the implementation of local fiscal authority and responsibility for social security expenditure, and truly fulfil the role of local governments as the main providers of social security public goods. In addition, some social security public goods are more effectively provided by the central government, for example, pension insurance public goods are more effectively provided by the central government in line with the law of large numbers, so while emphasising the responsibility of local governments as the main providers of social security public goods, it is also necessary to strengthen the central government's spending on relevant social security public goods.

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