Chinese-Style Fiscal Decentralization and TFP: Race to the Bottom or Race to the Top

Yongze Yu, Dayong Liu*

This paper reveals the effect of Chinese-style fiscal decentralization on regional total factor productivity (TFP), i.e., whether it leads to a race to the bottom or a race to the top. Theoretical analysis shows that Chinese-style fiscal decentralizations affects technological progress by changing the conditions of resource allocation. The empirical results show that Chinese-style fiscal decentralization has significantly improved the level of TFP in China, but it also generates the problems of factor mismatch and distortion of fiscal expenditure structure, and cause the distortion of factor market to a certain extent, which is not conducive to technological progress. Based on further observation of the internal composition of TFP, it is concluded that fiscal decentralization has caused technological progress (TP) and technical efficiency (TE) to show a more obvious race to the top, but the race to the top of TFP is weakening.

Keywords: Chinese-style fiscal decentralization, total factor productivity (TFP), race to the bottom, race to the top

1.Introduction

Since the reform and opening-up, China's economy has maintained rapid growth in the past 40 years, achieving the "miracle of China". In exploring the reasons why China's economy has maintained a more than 30-year high growth, in addition to the better external environment of world economic development during this period, most scholars consider the institutional factors of fiscal and administrative decentralization reform that began in 1979 one of the most important reasons. Qian and Weingast (1997) and Qian and Roland (1998) put forward the theory of "federalism with Chinese characteristics", and held that the administrative system of political centralization and moderate economic decentralization

* Yongze Yu (email: yongze125@126.com), Ph.D. in Economics, Professor, Vice Director of Industrial Development Institute at Nanjing University of Finance & Economics, China; Dayong Liu (email: dayongliu@126.com,corresponding author), Ph.D. in Economics, Lecturer, Department of Management and Economics, Tianjin University, China. Fund Projects: National Natural Science Foundation of China "Choice of Suitability Innovation Model and Regional Total Factor Productivity Improvement: Based on Innovation Value Chain and Space Spillover" (71403115), National Social Science Foundation "Strategy for China's Industrial Technological Advances Based on Technology Authorization" (15CJY009), Jiangsu Province 333 Project "Why Haven't Innovation Investments Been Turned into Technological Progress: Research Based on Suitability Innovation Model". The authors are grateful for the support by Jiangsu Province Brand Major and Jiangsu Province Superior Discipline Construction Project. The authors take sole responsibility for their view in this paper.

was the fundamental institutional reason for the development of economy by local governments in China. Under Chinese-style decentralization system, local governments may choose an increasingly fierce race to the bottom (Zodrow and Mieszkowski,1986; Tao *et al*., 2009) in order to attract capital inflows, which has a negative impact on regional growth efficiency, including distortions in the structure of fiscal expenditure (Fu and Zhang, 2007), race to the bottom of the reduction of environmental regulation (Zhu *et al*., 2011), regional market segmentation and overlapping projects (Zhou, 2004), excessive infrastructure investment (Wang and Xu, 2009) and other issues.

In the existing research on Chinese-style fiscal decentralization, many scholars have discussed the effect of fiscal decentralization on Chinese-style economic growth, but few scholars have made an in-depth study on the relationship between fiscal decentralization and TFP. In the small amount of domestic literature, there are divided viewpoints: one is that fiscal decentralization can improve economic efficiency (Fan and Zhang, 2009); the other is that fiscal decentralization has transformed local governments from "helping hands" to "grabbing hands", further undermining economic efficiency (Chen *et al*., 2002). In the empirical research, due to the controversy over the measurement of fiscal decentralization (Bird, 1986; Martinez-Vazquez and McNab, 2003), different conclusions about the impact of fiscal decentralization on technological progress have been reached. At the same time, most of the previous research on this issue is restricted to the test of the relationship between the two, failing to reveal the internal mechanism and transmission mechanism of the impact of Chinese-style fiscal decentralization on technological progress, nor did it incorporate "tournament competition" into the analytical framework of the impact between fiscal decentralization and technological progress, which made it impossible to conclude whether the impact of fiscal decentralization on technological progress is formed by the race to the top or by the race to the bottom. The innovative significance of this paper lies in not only revealing the internal mechanism of fiscal decentralization and technological progress in theory, but also empirically testing the transmission mechanism of fiscal decentralization affecting technological progress.

2. Chinese-Style Fiscal Decentralization and Technological Progress: Logic and Mechanism

The inter regional competition formed under the Chinese-style fiscal decentralization, like two sides of a coin, may form optimal allocation of resources by significantly improving the infrastructure, opening-up conditions and human capital in an area, or distort factors by market segmentation, building redundant projects, and insufficient investment in unproductive public services. These two roles have different effects on productivity: optimal allocation of resources will promote technological progress, while distortion of factors will inhibit technological progress.

The internal mechanism and logic of promoting effect of Chinese-style fiscal decentralization on technological progress (that is, optimal allocation of resources) are mainly reflected in the following. (1) Chinese-style fiscal decentralization has significantly improved local infrastructure, leading to the flow of factors, knowledge spillover, and lower transportation costs, as well as the improvement of scale efficiency, and then the level of technological progress in a region has been raised. (2) Chinese-style fiscal decentralization can effectively promote the innovation behavior of enterprises and improve the level of technological progress. Zhou *et al*. (2011) showd that fiscal decentralization can improve the level of local fiscal investment in science and technology. (3) Chinese-style fiscal decentralization helps to increase the opening-up of various regions, and raise the level of global allocation of resources, and thus is conducive to the improvement of the level of technological progress. Research by Miller and Upadhyay (2000) showd that opening-up can effectively promote the level of technological progress in the country's economy. (4) Under Chinese-style fiscal decentralization, local governments can obtain key resources such as human capital for economic growth in a short period through the competition of talents, and then improve the level of technological progress (Zhang, 2005).

Chinese-style fiscal decentralization also has an inhibitory effect on the technological progress, that is, distortion of factors, and its internal mechanism and logic are mainly reflected as follows. (1) The investment impulse caused by Chinese-style fiscal decentralization may be detrimental to the efficiency of resource allocation. Under the system of economic decentralization and political centralization, local governments, in order to win the competition of economic growth, often stage an investment competition war that ignore their own resources, location and industrial structure constraints, which could lead to the mismatch of credit resources (Guo and Jia, 2006). These will be detrimental to the easing of financial constraints on innovation and the fragmentation of innovation risks, thus inhibiting the rise in the level of technological progress. (2) Excessive competition under Chinese-style fiscal decentralization may lead to the inadequacy of unproductive public goods such as education, health care and social security (Ma and Yang, 2010). These are important factors that potentially affect the sustainability of technological progress. (3) The practice of local official tenure and interregional officials' exchanges under Chinese-style fiscal decentralization may cause local officials to ignore the long-term goal of economic growth and lead to the short-term economic objectives. The game for promotion may lead to overlapping projects, vanity projects and other issues, which are detrimental to the promotion of economic efficiency to a certain extent (Zhou, 2004; Zhou, 2005). (4) Chinese-style fiscal decentralization may lead to a certain degree of market segmentation, thus undermining the promotion of technological progress level. Under Chinese-style fiscal decentralization, local governments, out of the consideration of local fiscal revenue, may limit the full flow of resources and products

to a certain extent, especially for areas where there is no competitive advantage, market segmentation may be a rational choice for local governments (Lu *et al*., 2004).

3. Theoretical Model

This paper attempts to illustrate the intrinsic mechanism of Chinese-style fiscal decentralization affecting TFP using a simple theoretical framework. This paper holds that the performance of regional economic growth is positively correlated with the efforts of local government officials, based on the decentralization models of Zhou (2004), Sun and He (2008), sets the relationship between economic performance and the degree of official efforts, and further incorporates the productivity conditions (p) of local enterprises into the framework of theoretical analysis of Chinese-style fiscal decentralization to explore the effect of Chinese-style fiscal decentralization on productivity and its internal mechanism. In the models, this intrinsic mechanism is reflected in the following: the degree of efforts of local government officials as a result of the fiscal decentralization and the inter-regional interactions that accompany the emergence of fiscal decentralization (the effect of optimal allocation of resources and the effect of distortion of factors) can have an impact on productivity. By decomposing the interaction between regions in fiscal decentralization, this paper depicts the effects of optimal allocation of resources optimization and distortion of factors.

We assume that there are two local governments of the same rank, which are region 1 and region 2, with government officials as officials 1 and officials 2 and productivity of the enterprises in the two regions as p_1 and p_2. Under fiscal decentralization, local governments have certain autonomy of fiscal revenue and expenditure and the initiative of developing economy, and the resulting efforts of local governments in developing local economy are a_1 and a_2, and the economic performance of two regions is y_1 and y_2:

$$y_1 = p_1 a_1 + r_2 p_2 a_2 + e_1 \tag{1}$$

$$y_2 = p_2 a_2 + r_1 p_1 a_1 + e_2 \tag{2}$$

Here, the degree of efforts of local officials, a_1 and a_2, and the productivity of regional enterprises, p_1 and p_2, are the core variables affecting the economic performance of a region, that is, the greater efforts local government officials make, the higher the productivity of regional enterprisesis, and the higher the level of economic performance in the regionis. In addition, e_1 and e_2 are exogenous random perturbation variables which are mutually independent. It is assumed that (e_1–e_2) obeys the distribution function $F(\cdot)$ with an expectation of 0, whose density function is $f(\cdot)$.

According to Tsui (1993), Zhang *et al*. (2005), Wang *et al*. (2006), the central government cannot get adequate information concerning the efforts of local officials and the characteristics of regional economic development, so it may use the comparison of

economic performance among regions as the basis and yardstick of judgment to make promotion decisions. In order to achieve promotion, local officials may launch the "yardstick competition" between regions, which leads them to interact with each other in investment, production and economic policy, and the interregional "yardstick competition" is not only about the promotion game, but also accompanied by regional efforts for economic performance and fiscal revenue. Under fiscal decentralization, the interaction caused by "yardstick competition" between regions can be seen in the following. Local governments, through their efforts to bring better economic performance and fiscal revenue, may indirectly affect the economic growth model in other regions, and this influence is related to the promotion game between local governments. In this paper, the coefficient r is used, with r_1 being the coefficient of the effect of "yardstick competition" of region 1 on region 2, and r_2 being the coefficient of the effect of "yardstick competition" of region 2 on region 1. It is assumed that $|r|<1$, indicating a and p have greater effects on the local economy than they do on the surrounding area. In order to accurately describe the specific role of "yardstick competition", we postulate the following:

$$r = r(\omega, \tau) = \omega - \tau \tag{3}$$

Here, ω is the coefficient of optimal allocation of resources, and τ is the coefficient of distortion of factors. The regional economy will interact with each other in terms of resource allocation conditions. As a result of increasing the possibility of market size expansion, specialization division of labor and regional synergy, the economic development of a region will promote the economy of the surrounding area, improve the efficiency of resource allocation, which is recorded as ω (which can be reflected in the following: in order to win in the promotion tournaments, a region improves infrastructure and supporting conditions through investment, achieves factor flow and cost reduction, improves R&D incentives and market openness, and improves human capital conditions, etc.); at the same time, due to the existence of local protectionism and administrative monopoly, the regional economy will also encounter the distortion of factor input, which is recorded as ι (which can be embodied in the segmentation and overlapping projects of the respective regional markets, the investment impulse driven by the short-term development goal, and the insufficient supply of unproductive public goods). It follows that when $\omega>\tau$, $r(\omega,\tau)>0$, the characteristics of benign interaction and effective allocation of resources between regions are more obvious, and when $\omega<\tau$, $r(\omega,\tau)<0$, the characteristics of excessive competition and factor distortion between regions are more significant.

According to the competition rules of tournaments under a decentralized structure, officials with higher levels of local economic performance may be given the opportunity to be promoted. Assume that an official gets utility V from his promotion and utility v without promotion, and we assume $V>v$. The costs that local official 1 pays in making efforts to develop the economy are expressed as $C_1(a_1)$, while those of local official

2 are expressed as $C_2(a_2)$. $C_1(a_1)$ and $C_2(a_2)$ are increasing function of the officials' efforts a_1 and a_2 respectively, that is, the more efforts the officials make, the greater the costs they pay. When $y_1>y_2$, local official 1 gets promoted, and the probabilistic condition is:

$$P_r(y_1 > y_2) = P_r(p_1a_1 + r_2p_2a_2 + e_1 > p_2a_2 + r_1p_1a_1 + e_2)$$

Combine equation (1) and equation (2), and we get the probability that official 1 can be promoted 1 is:

$$\begin{aligned} P_r(y_1 > y_2) &= P_r[e_2 - e_1 < (1-r_1)p_1a_1 - (1-r_2)p_2a_2] \\ &= F[(1-r_1)p_1a_1 - (1-r_2)p_2a_2] \\ &= F(\cdot) \end{aligned}$$

The probability of official 2 being promoted is:

$$P_r(y_2 > y_1) = 1 - F(\cdot)$$

Take the derivative of $F(\cdot)$, the probability of official 1 being promoted, and we get:

$$\frac{\partial F(\cdot)}{\partial a_1} = [1 - r_1(\omega, \tau)]p_1 f(\cdot) \tag{4}$$

$$\frac{\partial F(\cdot)}{\partial a_2} = -[1 - r_2(\omega, \tau)]p_2 f(\cdot) \tag{5}$$

Based on the utility and probabilistic conditions of the promotion of officials, we can get the utility functions of local official 1 and local official 2 respectively:

$$E[U_1(a_1)] = V \cdot F(\cdot) + v \cdot [1 - F(\cdot)] - C_1(a_1) \tag{6}$$

$$E[U_2(a_2)] = V \cdot [1 - F(\cdot)] + v \cdot F(\cdot) - C_2(a_2) \tag{7}$$

Take the partial derivative of the utility functions of local official 1 and local official 2 respectively, and we obtain their utility maximization conditions. The following conditions are met when the utility of official 1 and official 2 is maximized:

$$\begin{cases} \dfrac{\partial U_1}{\partial a_1} = \dfrac{\partial \{V \cdot F(\cdot) + v \cdot [1 - F(\cdot)] - C_1(a_1)\}}{\partial a_1} = 0 \\ \dfrac{\partial U_2}{\partial a_2} = \dfrac{\partial \{V \cdot [1 - F(\cdot)] + v \cdot F(\cdot) - C_2(a_2)\}}{\partial a_2} = 0 \end{cases}$$

Combined with the hypothetical conditions in the preceding model, based on the calculation results of the above partial derivatives, the necessary conditions for maximizing the welfare of local officials can be obtained:

$$[1-r_1(\omega,\tau)]p_1(V-v)f(\cdot)=C_1'(a_1) \tag{8}$$

$$[1-r_2(\omega,\tau)]p_2(V-v)f(\cdot)=C_2'(a_2) \tag{9}$$

According to equation (8) and equation (9), when p_1 and p_2 remain unchanged, $C_1'(a_1)$ and $C_2'(a_2)$ will change reversely with the change of $r_1(\omega,\tau)$ and $r_2(\omega,\tau)$, which shows that in the process of promotion tournaments under fiscal decentralization structure, there is a certain alternative relationship between the incentive of local officials' efforts and the role of "yardstick competition" in the regional economy. To compare the productivity characteristics of the local economy under the conditions of maximization of its own welfare and the maximization of social total welfare, we set the social total welfare function as *W,* which is expressed as follows:

$$\begin{aligned} W &= W(a_1,a_2) \\ &= \max\{[p_1a_1+r_2(\omega,\tau)p_2a_2-C_1(a_1)]+[p_2a_2+r_1(\omega,\tau)p_1a_1-C_2(a_2)]\} \end{aligned}$$

Take the partial derivative of the social total welfare function, and we obtain the necessary conditions to satisfy the maximization of social total welfare:

$$\begin{cases} \dfrac{\partial W}{\partial a_1}=p_1+r_1(\omega,\tau)p_1-C_1'(a_1)=0 \\ \dfrac{\partial W}{\partial a_2}=p_2+r_2(\omega,\tau)p_2-C_2'(a_2)=0 \end{cases}$$

After sorting out the above partial derivative conditions, we obtain the following:

$$p_1+r_1(\omega,\tau)p_1=C_1'(a_1) \tag{10}$$

$$p_2+r_2(\omega,\tau)p_2=C_2'(a_2) \tag{11}$$

Based on equation (10) and equation (11), we get the relationship between *p*, the productivity of regional enterprises, and *a*, the efforts of local governments, and the relationship between *p* and *r*, the role of "yardstick competition" between regions under the structure of fiscal decentralization and under the condition of maximizing the total welfare of society:

$$p_1=\frac{C_1'(a_1)}{1+r_1(\omega,\tau)} \tag{12}$$

$$p_2 = \frac{C_2'(a_2)}{1 + r_2(\omega, \tau)} \tag{13}$$

Under the conditions of "promotion tournaments", local governments pursue their optimal welfare, and based on equation (8) and equation (9), we can get the mutual influence relationship between regional enterprise productivity p, local government effort degree a and the role of "yardstick competition" between regions $r(\omega,\tau)$ under the conditions of the tournament:

$$p_1 = \frac{C_1'(a_1)}{[1 - r_1(\omega, \tau)](V - v)} = \frac{C_1'(a_1)}{(1 - \omega + \tau)(V - v)} \tag{14}$$

$$p_2 = \frac{C_2'(a_2)}{[1 - r_2(\omega, \tau)](V - v)} = \frac{C_2'(a_2)}{(1 - \omega + \tau)(V - v)} \tag{15}$$

According to equation (12) - (15), whether it is under the condition of maximizing the welfare of local officials or under the condition of maximizing the total welfare of society, when $C_1'(a_1)$ and $C_2'(a_2)$ increase, p_1 and p_2 will increase accordingly. This results in:

Proposition 1: Under the condition of fiscal decentralization, the efforts made by local governments to realize their own welfare optimization will promote technological progress, which has the same effect as the pursuit of the social total welfare optimization. Therefore, under fiscal decentralization, a race to the top of technological progress may be formed between regions.

This paper analyzes the function of "yardstick competition" between regions under the structure of fiscal decentralization: according to equation (14) and equation (15), when $r(\omega,\tau)>0$, the greater the value of $|r(\omega,\tau)|$ is, the higher p is; when $r(\omega,\tau)<0$, the greater the value $|r(\omega,\tau)|$ is, the lower p is. Thus:

Proposition 2: Under fiscal decentralization, the interaction of "yardstick competition" between regions will have an impact on the productivity. When the role of "yardstick competition" is positive, it will promote technological progress and form a race to the top between regions, and when the role of "yardstick competition" is negative, it leads to the decline of productivity, and forms a race to the bottom.

The internal mechanism that affects the change of technological progress is the joint action of resource optimization coefficient ω and factor distortion coefficient τ. It is the comparison between ω and τ that determines whether the value of coefficient $r(\omega,\tau)$ is positive or negative. When $\omega>\tau$, i.e. $r(\omega,\tau)>0$, the regional economy has a positive driving effect on the surrounding area on the whole; the situation of $r(\omega,\tau)<0$ may arise only when there is excessive competition between regions, such as refusing regional cooperation or even resorting to vicious

competition in order to lower the ranking of competitors (Zhou, 2004) as the situation of $\omega<\tau$ is not frequent.

Equation (14) and equation (15) indicate that the greater the value of $\omega$is, the higher the value of $p$is, and that the greater the value of $\tau$is, the lower the value of $p$is. In the regional economic interaction, as local governments increase their own efforts, "yardstick competition" will stimulate the improvement of regional infrastructure, innovation level, human capital and other conditions, and the coordinated development of regional economy combined with the complementary advantages of resources helps to increase ω, promoting productivity; on the other hand, if local governments, under the pressure of high economic performance in neighboring areas, intend to chase after the others in ranking by imitating the investment-driven, high input and energy-intensive growth model in other regions, they will incur the problems of building redundant projects, market segmentation and extensive development, which may result in serious distortion of factors, that is, the value of τ is very large, reducing productivity. Thus:

Proposition 3: Chinese-style fiscal decentralization system affects technological progress by changing the conditions of resource allocation. When competition between local governments realizes the effective allocation of resources through market opening, factor flow and infrastructure improvement, the decentralization system promotes technological progress and form a race to the top, and when local governments use ways such as segmenting the market as a means of competition, which can distort the factors, the decentralization system inhibits technological progress.

4. Empirical Framework and Variable Setting

4.1. Empirical Framework

To reveal the internal mechanism of the impact of Chinese-style fiscal decentralization on technological progress, we use the intermediary effect test method of Baron and Kenny (1986) to take the following steps to test the impact of Chinese-style fiscal decentralization on technological progress and its intrinsic mechanisms based on the propositions obtained from the theoretical analyses in the second and the third parts of this paper.

The first step is to verify the impact of Chinese-style fiscal decentralization on TFP, that is, whether the phenomena of the race to the bottom and the race to the top exist. To do this, we establish the following regression models for validation:

$$TFP_{it} = \alpha_0 FD_{it} + \alpha_j \sum_{j=1}^{n} Z_{jit} + \varepsilon_{it}, \ i = 1, 2, ...n \tag{16}$$

Here, *TFP* represents total factor productivity, *FD* represents the degree of decentralization, and *D* represents a series of control variables. If the coefficient of α_0 in the above equation is negative, the effect of decentralization on TFP is negative, that is, there is a race to the bottom of TFP under Chinese-style decentralization. If the coefficient of α_0 in the above equation is positive, the effect of decentralization on TFP is positive, that is, there is a race to the top of TFP under Chinese-style decentralization.

The second step is to test the two action mechanisms of resource allocation under Chinese-style fiscal decentralization proposed in the analysis of the theoretical mechanism of this paper, namely, the optimal allocation of resources and the distortion of factors. According to the analysis of the theoretical mechanism of this paper, the empirical part selects three variables of transportation infrastructure, R&D input, and FDI as the proxy variables of the effect of optimal allocation of resources, and two variables of education and medical input and overcapacity as the proxies of "factor distortion" effect to tests whether there exist the effect of optimal allocation of resources and the effect of factor distortion on resource allocation under Chinese-style fiscal decentralization. To this end, we establish the following equations:

$$OA_{it} = \beta_0 w_{ij} \cdot OA_{it} + \beta_1 FD_{it} + \beta_2 Z_{it} + \varepsilon_{it} \tag{17}$$

$$DM_{it} = \beta_0 w_{ij} \cdot DM_{it} + \beta_1 FD_{it} + \beta_2 Z_{it} + \varepsilon_{it} \tag{18}$$

Among them, *OA* represents the proxy variables of the optimal allocation of resources, including infrastructure construction, innovation investment and FDI, represented by the level of transport infrastructure, the share of R&D investment, and the proportion of FDI in fixed assets investments. *DM* represents the proxy variables for the distortion of factors, including the distortion of public service expenditure structure and factor mismatch, represented by the proportion of education and medical input in fiscal expenditure and overcapacity. Equation (17) and equation (18) are spatial autoregressive models, and w_{ij} is spatial weight matrix which reflects the spatial connection of individual section individuals, that is, the "competition" relationship between local governments. Spatial weight matrix in this paper is set as the economic distance space weight matrix, and the specific setting method refers to Yu (2015). β_0 directly reflects the strength of spatial relationship and the symbol reflects the direction of spatial relation. In this paper, β_0 is used to depict the "competition" relationship between local governments in the factors of economic growth under Chinese-style fiscal decentralization. The above empirical model uses spatial GMM autoregressive model for regression.

The third step is to verify whether these intermediate variables affect the TFP level. This section regresses the above four variables with TFP. Whether these

intermediate variables significantly affect the TFP level can be decided by the significance of the regression coefficient. To this end, we establish the following equation:

$$TFP_{it} = \lambda_0 + \lambda_1 OA_{it} + \lambda_2 DM_{it} + \lambda_j \sum_{j=1}^{n} Z_{jit} + \varepsilon_{it}, \ i = 1, 2, ...n \tag{19}$$

The fourth step is to put the intermediate variable and the fiscal decentralization variable into the model at the same time, and then verify whether the intermediate variable further affects the TFP through the adjustment effect of fiscal decentralization.

$$TFP_{it} = \theta_0 + \theta_1 FD_{it} + \theta_2 OA_{it} + \theta_3 DM_{it} + \theta_j \sum_{j=1}^{n} Z_{jit} + \varepsilon_{it}, \ i = 1, 2, ...n \tag{20}$$

4.2. Data and Variable Selection

The accounting of TFP, drawing on the research of Yu (2015), uses SFA (Stochastic Frontier Analysis) to estimate the transcendental logarithmic production function, and the TFP is obtained based on the decomposition method of Kumbhakar and Lovell (2000). Two sets of accounting methods by Zhang *et al*. (2004) and Shan (2008) are adopted in processing the data of capital stock. Drawing on the research results of Zhang and Gong (2005), and Gong and Lei (2010), we divide Chinese-style fiscal decentralization into fiscal revenue decentralization and fiscal expenditure decentralization, measured by four indicators of the revenue autonomy rate, the ratio of fiscal revenue, the fiscal expenditure autonomy rate, and the ratio of fiscal expenditure. The specific calculation method is shown in Table 1.

In addition to the five proxy variables of the optimal allocation of resources and the distortion of factors, different control variables are set in different regression models according to the framework of empirical research. Among them, the control variables affecting TFP are set to four variables of human capital, marketization, openness and industrialization; the control variables affecting traffic infrastructure are set to four variables of industrialization, urbanization, openness and marketization; the control variables that affect the input of independent innovation are set to four variables of industrialization, human capital, openness and financial development level; the control variables affecting FDI are set to marketization, financial development level, human capital and industrialization; the control variables affecting education and medical input are set to four variables of urbanization, human capital, population density and number of primary and secondary school students per hundred people; and the control variables affecting the degree of capacity process are set to four variables of industrialization,

financial development level, marketization and openness. The above variables mainly come from *China Statistical Yearbook* and *China Statistical Yearbook on Science and Technology* over the years. The processing and statistical description of the variable are shown in Table 2.

Table 1. Measurement of Fiscal Decentralization Indicators

Indicators		Formulas	Variables
Income fiscal decentralization (IFD)	Local revenue autonomy (RA)	$RA_i = \left(\frac{BR_i + OBR_i}{WBR_i + OBR_i} \right)$	BR_i: budgetary revenue at the provincial level of province i OBR_i: extra-budgetary revenue at the provincial level of province i WBR_i: budgetary revenue of province i BR_e: budgetary revenue at the national level OBR_e: extra-budgetary revenue at the national level POP_i: population size of province i POP_N: population size of the nation BE_i: budgetary fiscal expenditure at the provincial level of province i OBR_i: extra-budgetary fiscal expenditure at the provincial level of province i WBR_i: budgetary fiscal expenditure of province i $Transfer_i$: transfer payments from the central government to province i
	Local revenue ratio (RR)	$RR_i = \left[\frac{\frac{BR_i + OBR_i}{POP_i}}{\left(\frac{BR_i + OBR_i}{POP_i} \right) + \left(\frac{BR_e + OBR_e}{POP_N} \right)} \right] \times \left(1 - \frac{GDP_i}{GDP_N} \right)$	
	Local expenditure autonomy (EA)	$EA_i = \left(\frac{(BE_i - Transfer_i) + OBR_i}{WBR_i + OBR_i} \right)$	
Expenditure fiscal decentralization (EFD)	Local expenditure ratio (ER)	$ER_i = \left[\frac{\frac{BR_i + OBR_i}{POP_i}}{\left(\frac{BE_i + OBE_i}{POP_i} \right) + \left(\frac{BE_e + OBE_e}{POP_N} \right)} \right] \times \left(1 - \frac{GDP_i}{GDP_N} \right)$	BR_e: budgetary fiscal expenditure at the national level OBR_e: extra-budgetary fiscal expenditure at the national level GDP_i: GDP of province i GDP_N: national GDP

Table 2. Variable Processing and Statistical Description

Variable type	Variable symbol	Variable name	Calculation of the variable	Standard deviation	Mean value	Minimum	Maximum
Dependent variable	*TFP*	Total factor productivity (%)	SFA	1.929	0.680	–7.958	9.901
Core variables	*IFD*	Revenue fiscal decentralization	The calculation method in Table 1	0.133	0.506	0.255	0.825
	EFD	Expenditure fiscal decentralization	The calculation method in Table 1	0.097	0.602	0.287	0.861

Variable type	Variable symbol	Variable name	Calculation of the variable	Standard deviation	Mean value	Minimum	Maximum
Intermediate variables	*HD*	Transport infrastructure	Highway network density (km/ sq.km)	36.162	26.605	0.001	189.260
	RD	Independent innovation investment (%)	R&D investment/ GDP	1.002	1.064	0.081	6.333
	FDI	Proportion of foreign investment (%)	The proportion of FDI in fixed assets investment	16.700	15.125	0.923	94.475
	EM	Education and medical input (%)	The proportion of education and medical input in fiscal expenditure	3.086	23.326	15.484	30.611
	EPC	Overcapacity	Industrial capacity utilization calculated by reference to Dong *et al*. (2005)	17.662	57.155	19.404	94.943
	UZ	Urbanization (%)	The proportion of urban population	16.414	42.896	14.039	89.300
	TD	Openness (%)	Total volume of import and export /GDP	5.334	4.187	0.387	24.444
	IF	Marketization	Marketization index	2.340	6.196	1.290	13.380
	ID	Industrialization (%)	The proportion of the second industry	7.878	45.354	19.735	59.045
Control variables	*finance*	Financial development level	Location quotient of financial employees	0.259	1.019	0.459	3.179
	HC	Human capital	Average education length	1.087	8.104	4.693	12.187
	SOE	Proportion of SOEs (%)	The proportion of SOE investments in fixed assets investment	14.538	41.507	11.928	84.424
	PD	Population density	Population per square kilometer	556.33	402.67	6.88	3753.94
	EP	Education	The number of primary and secondary schools per hundred people	3.349	14.724	4.325	20.535
	HP	Medical service	The number of hospitals per 10,000 people	0.196	0.528	0.131	1.194

5. Empirical Results and Discussion

5.1. Empirical Results and Analysis

Under the above empirical framework, this paper first verifies the impact of Chinese-style fiscal decentralization on TFP, that is, whether there exist the phenomena of race to the bottom and race to the top.

Because the OLs estimation method of panel data often faces the self-correlation of disturbance terms and the problem that some regression variables are not strictly exogenous but pre-emptive variables. In addition, TFP has certain time continuity characteristics and cross-period elasticity, so the TFP lagged term is incorporated into the measurement model as one of the explanatory variables. Blundell *et al*. (2001) believed that in the process of dynamic panel data model estimation, many disappointing features in ordinary estimation method could be overcome by using the system GMM estimation method. For this reason, we mainly use the dynamic system GMM estimation method in the following regression.

The regression results of Table 3 show that the effect of Chinese-style fiscal decentralization on TFP is significant, both under the time and region fixed effect model and in the system GMM model of adding time effect, whether it is fiscal revenue decentralization index or fiscal expenditure decentralization index that is used. This suggests that Chinese-style fiscal decentralization has indeed significantly affected China's TFP levels. However, we find that there is a clear negative correlation between Chinese-style fiscal decentralization and scale efficiency, but there is a clear positive correlation with technological progress and technological efficiency. This shows that under the short-term constraints of economic growth targets, the excessive infrastructure investment and overlapping projects and vanity projects caused by the promotion game may undermine the scale economy effect of economic growth, while local governments' competition in attracting FDI and encouraging innovation, which is conducive to technological progress and technological efficiency, is still a race to the top.

Next, we test the two mechanisms of resource allocation under Chinese-style fiscal decentralization put forward in the analysis of the theoretical mechanism of this paper, that is, the effect of the optimal allocation of resources and the effect of distortion of factors. In order to reflect the "competition" of the two action mechanisms of resource allocation under Chinese-style fiscal decentralization, we first test the spatial correlation of five intermediate variables by using the Moran I index. Among them, the setting of spatial weight matrix adopts Yu (2015), and the test results show that there is obvious spatial positive correlation between transportation infrastructure construction, FDI, R&D investment, educational and science and technology investment, and capacity utilization. In addition, we test the space error model (SEM) and spatial

autoregression model (SAR), and this paper concludes that SAR is better than SEM based on LM and Robust-LM test combined with Log likelihood value, AIC and SC value.

Table 3. Regression of Chinese-Style Fiscal Decentralization and TFP

	TFP		TFP		SE		TP		TE	
	FE	GMM	FE	GMM	FE	GMM	FE	GMM	FE	GMM
Lagged term		0.465*** (7.62)		0.450*** (18.54)		0.549*** (9.71)		0.756*** (25.09)		0.456*** (9.55)
IFD	5.111*** (3.70)	2.270*** (8.62)			–0.711*** (–3.30)	–1.107*** (–2.71)	1.219*** (2.96)	1.050*** (2.56)	3.760*** (3.60)	3.712*** (2.95)
EFD			2.665** (2.02)	1.568* (1.83)						
AR(1)		0.048		0.023		0.013		0.022		0.013
AR(2)		0.326		0.306		0.199		0.199		0.210
Hansen test (*p* value)		0.221		0.297		0.190		0.235		0.241
Sargan test (*p* value)		0.170		0.175		0.186		0.155		0.167
Number of instrumental variable		35		35		32		37		32
R-squared	0.136		0.146		0.232		0.209		0.212	
Control variable	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observed value	464	464	464	464	464	464	464	464	464	464

Notes: ***, ** and * represent passing the significance tests at 1%, 5% and 10%, respectively (the same hereinafter). In parentheses are *t* value or *z* value.

Last, we examine whether the above five intermediate variables can effectively promote TFP, and after the addition of the intermediate variables whether fiscal decentralization has further affected TFP through the intermediate variables. The empirical results from Table 5 can basically verify the propositions and the theoretical mechanism proposed in this paper, that is, Chinese-style fiscal decentralization has indeed significantly improved the level of TFP in China. This improvement is achieved more through the "competition" among local governments for infrastructure construction and foreign investment under Chinese-style fiscal decentralization. At the same time, this paper also observes that Chinese-style fiscal decentralization will also generate problems such as undermining market-oriented promotion and fiscal expenditure structure, and will also cause the distortion of factor market to a certain

extent, which is not conducive to technological progress. However, on the whole, Chinese-style fiscal decentralization plays a greater role in the optimal allocation of resources than factor distortion, which leads to a significantly positive impact of Chinese-style fiscal decentralization on TFP in general. More importantly, this paper not only confirms the positive impact of Chinese-style fiscal decentralization on the level of TFP, but also proves that this role is formed under the race to the top of resource allocation.

The regression results of the empirical model in Table 4 show that, whether it is the fiscal revenue decentralization index or the fiscal expenditure decentralization index, the fiscal decentralization variable has a significantly positive impact on the transportation infrastructure construction and FDI, which is realized through the "competition" for infrastructure construction and foreign investment under Chinese-style fiscal decentralization, and represented by the significantly positive spatial spillover coefficient β_0. However, as regards R&D input, the fiscal decentralization has inhibited the investment in R&D, indicating at least that under Chinese-style fiscal decentralization the R&D investment has not shown the characteristics of racing to the top although this inhibition has not passed the significance test. Concerning the test results of the effect of distortion of factors, whether it is the index of fiscal revenue decentralization or the index of fiscal expenditure decentralization, the impact of fiscal decentralization variables on education and medical care is significantly negative, while the impact on capacity utilization rate is significantly positive, and the spatial spillover coefficient β_0 is significantly positive. This shows that under Chinese-style fiscal decentralization, the local governments' fiscal investment in education and medical care has the characteristics of racing to the bottom, while with regard to capacity utilization, there is a race to the top. However, the theoretical mechanism analysis in this paper tries to expound that the investment impulse caused by the fiscal decentralization system will be detrimental to the efficiency of resource allocation, or that the fiscal decentralization system should have no positive effect on the increase of capacity utilization. Here this paper measures the capacity utilization rate of 2000–2012, and when the time is limited to the post-financial crisis stage, the empirical results show that the fiscal decentralization variables have no significant impact on the increase of capacity utilization rate, and even have a negative impact. According to the above regression results, we can conclude that under Chinese-style fiscal decentralization, local governments have realized the "optimal allocation of resources" through the race to the top of transportation infrastructure construction and opening-up, which helps promote the improvement of TFP, while the characteristics of race to the bottom have been presented in education and medical input, and there is no race to the top in capacity utilization, but the possibility of "factor distortion", which is not conducive to promoting the increase of TFP.

Table 4. Regression of Chinese-Style Fiscal Decentralization and Intermediate Variables

Variable	*HD*		*FDI*		*RD*		*EM*		*EPC*	
	Fiscal revenue decentralization									
Model	FE	SGMM	FE	SGMM	FE	SGMM	FE	SGMM	FE	SGMM
IFD	51.520*** (3.54)	15.231** (2.33)	3.022** (2.21)	9.799** (2.14)	–0.173 (–0.54)	–0.232 (–0.51)	–6.333** (–2.55)	–6.178 (–1.50)	20.221** (2.47)	62.432*** (9.20)
β_0		0.346*** (12.55)		0.438*** (10.92)		0.344*** (9.32)		0.503*** (20.11)		0..232*** (20.80)
Control variable	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
R-squared	0.8032	0.7909	0.2324	0.6660	0.7288	0.6024	0.3977	0.2342	0.3190	0.8432
AIC		82.033		39.524		3.232		4.382		16.123
SC		87.282		42.032		3.112		4.932		17.477
	Fiscal expenditure decentralization									
EFD	63.93*** (7.12)	13.332 (1.51)	4.320* (1.71)	14.229** (2.43)	–0.322 (–0.97)	–0.320 (–1.03)	–7.743 (–1.43)	–1.632** (–2.03)	20.531** (1.96)	39.322** (6.43)
β_0		0.333*** (12.32)		0.343* (9.43)		0.378*** (9.43)		0.422*** (19.09)		0.242*** (17.10)
Control variable	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
R-squared	0.8330	0.8092	0.2699	0.6432	0.7223	0.6039	0.3932	0.1644	0.3321	0.8243
AIC		82.326		40.163		3.233		4.785		15.543
SC		87.332		42.332		3.132		5.332		16.990
Observed value	464	464	464	464	464	464	203	203	348	348

Note: In parentheses are *t* value or *z* value.

Table 5. Test Results of Intermediate Mechanism

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
L.TFP	0.465*** (7.62)	0.450*** (18.54)	0.694*** (6.933)	0.632*** (2.632)	0.701*** (6.133)	0.660*** (7.282)	0.662*** (3.232)	0.648*** (3.061)
HD			0.002 (1.232)	0.014 (0.842)	0.002 (1.273)	0.001 (1.085)	0.003 (1.134)	0.002 (1.046)
RD			0.413 (1.491)	0.571 (0.476)	0.332 (0.931)	0.542 (1.483)	0.472 (1.333)	0.334 (1.259)
FDI			0.028* (1.809)	0.026* (1.667)			0.034 (1.332)	0.020 (1.423)
EM				0.144 (1.601)			0.121 (0.496)	0.123 (0.855)
EPC				0.011* (1.658)			0.008* (2.153)	0.011** (2.196)

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
IFD	2.270*** (8.62)				0.336 (0.218)		1.884* (1.928)	
EFD		1.568* (1.83)				1.839 (0.947)		1.038 (1.373)
Control variable	YES	YES	YES	YES	YES	YES	YES	YES
Hansen test (*p* value)	0.253	0.220	0.157	0.230	0.338	0.278	0.250	0.256
Sargan test (*p* value)	0.170	0.175	0.145	0.167	0.190	0.198	0.176	0.180
Number of instrumental variables	35	35	33	35	34	35	35	34
AR(1)	0.048	0.023	0.030	0.030	0.025	0.023	0.012	0.016
AR(2)	0.326	0.306	0.354	0.143	0.317	0.338	0.199	0.174

Note: In parentheses is *z* value.

5.2. Robustness Test

The robustness test is mainly conducted from three aspects. First, the research is divided into two stages, 1997–2002 and 2003–2012 respectively, so as to observe the relationship between Chinese-style fiscal decentralization and TFP in different stages of economic development. Second, a one-step study on the relationship between fiscal decentralization variables and TFP is adopted, that is, the fiscal decentralization variables are placed in the regression equation for calculating TFP. Third, the method of calculating TFP is replaced by the DEA method, and the capital stock is replaced by the method of Shan (2008). Due to limited space, the above empirical results are not given. The robustness test results also support the main conclusions of this study.

6. Conclusions and Recommendations

This paper attempts to reveal whether there is a race to the top or a race to the bottom in TFP in various regions of China from the perspective of Chinese-style fiscal decentralization. Research shows that Chinese-style fiscal decentralization has indeed significantly improved China's TFP. And this improvement is achieved more through local governments' race to the top for infrastructure construction and FDI under Chinese-style fiscal decentralization. At the same time, this paper also observes that Chinese-style fiscal decentralization also produces factor mismatch and fiscal expenditure structure distortion and other issues, and causes the distortion of factor market to a certain extent, thus hindering technological progress. However, on the whole, Chinese-style fiscal decentralization plays a greater role in the optimal

allocation of resources than in factor distortion. However, with a single political incentive and biased economic incentives, the negative output of fiscal decentralization to TFP is gradually increasing. The impact of race to the top of Chinese-style fiscal decentralization on TFP is weakening.

The main policy implications based on the analysis include the following three aspects. First, we need to further improve the conditions of the rule of law and market rules, establish a market-based competitive environment conducive to the efficient flow of factors, prevent resource distortion behaviors such as excessive investment, disregard of environmental costs, and cheap land supply which are caused by the race to the bottom through scientific constraints and reasonable regulation, and then strive to build a relatively healthy "moderate competition" mechanism, so as to effectively release both the positive impact of Chinese-style fiscal decentralization on TFP and the institutional dividends. Second, we should moderately adjust the official assessment mechanism, highlight the increase in productivity and long-term economic growth of the development goals, and avoid the biased incentives brought by a single "top-down" political promotion system. Third, we need to build on the current factor endowment structure, to comprehensively deepen reform to stimulate the vitality and growth potential of market allocation of resources, and to establish new comparative advantages and competitive advantages so as to improve the overall productivity.

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