Fiscal pressure and local economic growth

——An experiment from China income tax sharing system reform

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In this paper, we construct an "as-if" DID model on the basis of the 2002 "Income Tax Sharing System" reform and evaluate the changes in local fiscal pressure based on an exogenous shock that redefines the tax sharing rules between the central government and local governments. By using the DMSP/OLS satellite data at the city-level, we empirically examine the impact of fiscal pressure on the economic growth. We find that fiscal pressure significantly increase the satellite lighting. Furthermore, we obtain the findings as follows. Firstly, the incentive effects of fiscal pressure effects are less profound in cities that receive considerable intergovernmental transfers from high levels of governments. Secondly, the local governments are more likely to help the growth of real estate industry, which can reciprocally bring them considerable sales taxation. However, this homogenized growth pattern might be detrimental for economic diversification and finally enhance the risk of economical fluctuation. Finally, the fiscal pressure created by the reform restricts the extent to which jurisdictions compete with each other. However, the tax competition still exists because local governments are able to lower the tax rate once they gain enough revenues from land-sales. This paper provides a new explanation for China's high-speed growth in addition to expenditure decentralization or administration decentralization. It also offers extra evidence for exploring the growth incentives of local government within the framework of China's decentralization.

Keywords: fiscal pressure, DMSP/OLS satellite data, income tax sharing reform, difference-in-difference

1. Introduction and literature review

Fiscal decentralization is an important institutional factor of improving economic growth, and much literatuves studied the relationship between fiscal decentralization and economic growth. Davoodi and Zou (1998) used cross-national data to examine the impact of fiscal decentralization on economic growth, and attributed negative impact

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of fiscal decentralization on economic growth to structural expenditure deviation and lacking of regression. Then many researches at home and abroad explained the impact and mechanism of fiscal decentralization on economic growth by searching more accurate transmission mechanism (Shen and Fu, 2005; Zhang and Gong, 2005; Wang and Qin, 2008; Fang and Zhang, 2014). These literatures suggested that there were positive impacts of fiscal decentralization on economic growth. Many researches showed under China's fiscal decentralization, local governments had the urge to use public policies such as subsidy, tax cutting to help enterprises improve production efficiency in order to form sustainable economic growth basis on micro level. On the other hand, literatures on political promotion incentives also provided the internal mechanism of local economic growth under decentralization, which was that local officials had political impetus of promotion while there was distinguished horizontal economic competition among local governments at the same level. Decentralization provided local officials autonomous economic affairs decisive power and administration, so that they had impetus to put increased fiscal revenue to supply of economic public goods which were capital and favorable to gain GDP competitive advantage within their power, so to create considerable economic growth in short term (Fu, 2010; Yin and Zhu, 2011).

After the tax sharing reform in 1994, the distinctive feature of China's fiscal decentralization is that expenditure decentralization is along with tax revenue taking by higher level governments. During tax sharing reform in 1994 and "Income Tax Sharing System" reform in 2002, the central government adjusted tax revenue distribution among the central and local governments, incorporated 75% VAT revenue and 60% income tax revenue into central government respectively, which made the central fiscal revenue dominates national fiscal revenue. However, local governments' expenditure duty does not match their revenue, which forms financial gap. Under this kind of fiscal pressure, local governments' intervention on macro economy changes over time, but existing literature has not fully researched the incentive effects assessment of fiscal pressure on economic growth.

When local governments face actual fiscal pressure, their response could include as follows. On one hand, while nurturing financial resources within budget, they tend to support enterprises which provide the most tax revenue and assist high-tax industries such as financial industry, real estate and construction so to promote economic growth (Han and Kung, 2015). On the other hand, while nurturing financial resources outside budget, local governments sell public goods (mainly land) to obtain other fiscal revenue to cover financial gap by detouring budget restraining regulations (Liang, 2009), this leads to increase of land price and real estate price which are the most important composition of local governments' GDP.

Some studied have different opinions on effect assessment of local economic growth under fiscal pressure. Literature stated that when the central government increased the

proportion of tax sharing, the net profit of local governments' competition decreased, so fiscal pressure would inhibit excessive horizontal competition among local governments to some extent, rather than new fiscal centralization theory of "pressure increasing competition, competition leading to aid". If abovementioned assumption is true, there are profound differences between the result of "local governments' decision making under fiscal pressure" and this assumption (Oates, 1993; Fan and Zhang, 2010; Xie and Fan, 2015). Some studies showed that it might be not sustainable for local governments' "leading" changing economic growth mode under fiscal pressure. Some suggested that if fiscal pressure caused local governments to excessively depend on real estate and related industries, this kind of single growth mode might not be sustainable economic growth mode (Du, Lu and Tao, 2015).

This paper's main contributions are as follows. Firstly, we research the impact of fiscal pressure under China's fiscal decentralization on local economic growth. The assessment of this relationship makes it better to combine actual characteristics of China's fiscal decentralization and explore the actual basis of China's economic growth and complement existing literature. Secondly, we examine the mechanism of stressful fiscal incentive effect, including local differentiated industry selection strategy and horizontal competition change among governments. Thirdly, we improve technical method and data. On one hand, we use the 2002 "Income Tax Sharing System" reform as exogenous shock for local governments' fiscal pressure change, by constructing "as-if policy experiment" intensity DID (Difference-in-differences) model, approximately measure local fiscal pressure change caused by incoming tax vertical distribution, improve the process of endogenous factors which are not been paid enough attention by existing literature. On the other hand, we use city satellite lighting data from 1997 to 2012 as the indicator of GDP, so to better solve measurement errors such as hidden and false data while local governments' calculating GDP. Besides introduction and literature review, the rest of this paper includes following parts: the second part is institutional background and theoretical analysis; the third part is indicator, data and empirical strategy; the fourth part is empirical analysis; the fifth part is conclusion and revelation.

2. Institutional background and theoretical analysis

2.1. Institutional background

The tax sharing reform started from 1994 divided industrial and commercial tax into VAT, consumption tax and operation tax, among which 75% of VAT and 100% of consumption tax are owned by the central government, then the central government's fiscal revenue increased steadily: before 1994, the central government's fiscal revenue was less than 50% of local governments' fiscal revenue, while after 1994, the central government's fiscal revenue exceeded local governments' fiscal revenue rapidly. The

income tax sharing reform started from 2002 was considered as another important process of the central government taking the right of tax revenue. Before the reform, distribution of income tax was set according to enterprise affiliation, after the reform, distribution of income tax is not set according to enterprise affiliation, but local governments keep 50% of incoming tax (it has fallen to 40% since 2003), the rest of incoming tax revenue is owned by the central government.[1] This reform raised the central government's revenue proportion again. Statistical analysis shows that on the central government level, its revenue rapidly increased from less than 50% before the reform in 1994 to 1.26 in 1994, slightly decreased to 1.09 in 2001, but rapidly increased to 1.22 in 2002, and slightly decreased in 2004, and then this proportion keeps at 1.10. Meanwhile, local governments' expenditure duty increased steadily. Before 2000, the ratio of central government's expenditure to local governments' expenditure was between 0.4 and 0.5, after 2000, the ratio decreased gradually; and it was only about 21% by 2010.

New fiscal centralization theory provides a possible explanation for fiscal pressure's incentive effect: under fiscal pressure, facing tightened fiscal budgetary constraints, local governments will be more supportive for business tax and other exclusive tax-related industries. Therefore local governments may "aid" local high-tax industries by tax concessions, fee waivers and financial subsidies (Xu, 2011; Long *et al*., 2014). This paper discovers that after income tax sharing reform in 2003, industrial added value of business tax-related industries such as real estate, construction and transportation increased rapidly and profoundly.[2]

Analyzing from other fiscal revenue, when facing tightened fiscal budgetary constraints, local governments will turn to buy and sell public resources (the most typical resource is land asset) to obtain enough fiscal revenue. By selling more and expensive land, local governments can accumulate industrial capital and provide financial support for "Tiebout Competition" among jurisdictions, in order to support local infrastructure construction and attract manufacture-related productive factors inflow (Fang and Zhang, 2014; Chen and Chen, 2015). This paper discovers that between 2002 and 2003, the revenue of selling land across the nation increased rapidly, the increase rate of national revenue of selling land was up to 123%, and then this rate stays steady year by year.[3] So fiscal pressures urge local governments to sell more public resources to expand fiscal capital, so to guarantee industries related to manufacture and services getting enough support.

However, the incentive effect of fiscal pressure depends on two premises. Firstly,

[1] The reform adopted distribution reform of incremental revenue; so many local governments raised the income tax base. All data are collected and sorted by authors, related graphs and tables can be obtained directly from authors.

[2] related graphs and pictures can be obtained directly from authors.

[3] related graphs and pictures can be obtained directly from authors.

after the tax revenue of local governments was taken by the central government, whether local governments' fiscal pressure really expands or not. The income tax sharing reform changes local governments' financial structure from financial self-supply to depending on financial transfer payment from higher level governments.[1] After taking financial transfer payment into account, it needs to be examined whether local fiscal pressure still has incentive effects. Secondly, whether intergovernmental horizontal economic competition will be strengthened or weakened by the change of fiscal pressure. New fiscal centralization theory believes that given the three important conditions such as capital elements flow, manufacturing and service industry relationship and local governments' monopoly on the land market, fiscal pressure leads to local governments aiding economic development (Tao *et al.*, 2009; Zhang, 2012). While traditional fiscal centralization theory demonstrates that if other fiscal revenue remains the same, the decreased proportion of local governments' tax revenue will lead to decreased net profit from local governments' expenditure competition (or tax revenue competition)[2] (Lv, 2009), local governments' low equilibrium level inefficient competition will be partly corrected to some extent. The central government collects and manages the tax base with low viscosity; it is conducive to overcoming the low level of ineffective competition and improving resource allocation efficiency.

2.2. Theoretical analysis

In this part we construct theoretical model to discuss the possible link between fiscal pressure and local economic growth.

2.2.1. Household behavior decision

Based on Barro (1990), Barro and Sala-I-Martin's (1992) government and growth model, this paper expands Adam and Bevan's (2005) fiscal deficit and growth model. Suppose government imposes a linear tax on output, and a higher level government will give the government a certain percentage of financial transfer payments. The public goods provided by the government have a spillover effect on output. The government does not follow the budget balance in every budget cycle (i.e., the government can see a fiscal deficit). The main sources of local governments covering the deficit are: first, the debt issuing income; second, non-tax revenue which is mainly based on the land selling revenue.

[1] "Notice of the State Council on the Issuance of Income Tax Sharing Reform Program" (Guo Fa [2001] No. 37) pointed out that "the central government's revenue from income tax sharing reform is distributed to regions mainly the central and western regions to implement transfer payments in accordance with the principle of fairness and impartiality. "

[2] Local governments use fewer proportion of revenue to support expenditure competition or economic competition cost and will face higher fiscal risk.

In a decentralized economic environment, the household survives two periods and offers a unit of labor without flexibility. Assume that the population size does not change, ie. $L_t = \overline{L} = 1$. The utility of the household comes from two periods of consumption decisions, the utility function is logarithmic $U = blnc_t + (1\text{-b})\ lnc_{t+1}$, c_t and c_{t+1} represent the consumption volume of the first and second periods respectively, and b represents the preference parameter.[1]

2.2.2. Manufacturer behavior decision

Assuming the existence of a representative manufacturer, manufacturer invests in capital and labor for production. Government public products have spillover effects on manufacturers' production, refer to Adam and Bevan (2005), the production function is set to:

$$Y_t = (A_t K_t)^{\alpha} G_t^{1-\alpha} \tag{1}$$

Among them, Y_t represents the output of the representative manufacturer;[2] K_t represents the capital invested by the manufacturer; A_t is the production technology.

Representative manufacture pays capital interest, capital interest rate is r_t, and also needs to pay labor prices w_t.[3] We further assume that the government imposes production tax with a tax rate τ_t, then, according to the enterprise profit maximization, get the first order condition:

$$r_t = (1-\tau_t)\,\alpha A_t^{\alpha} K_t^{\alpha-1} G_t^{1-\alpha} \tag{2}$$

According to Euler equation:

$$w_t = (1-\tau_t)(1-\alpha) Y_t \tag{3}$$

Assume that the relationship between investment and capital stock is:

$$\frac{K_t}{I_t} = \phi_t \tag{4}$$

[1] The logarithmic form of the utility function is only a simplified form. As Prescott (2016) points out, "As long as you can solve a given problem, the simpler the model is, the better." The advantage of this form is that if the tax wage is *w*, then the first period consumption is *bw* and the second period consumption is *(1-b) w*, which greatly simplifies the analysis process later in this article.

[2] In the output expression, we assume that the local economy is the local tax base, simplifying the impact of shared taxes.

[3] It should be noted that the above-mentioned production function implies labor input, but the labor supply is standardized to 1, and in the economic equilibrium, labor demand equals to labor supply, therefore, the production function omits the labor input factor.

2.2.3. Government behavior decision

According to Barro (1990), Barro and Sala-I-Martin (1992) and Acemoglu (2009), assume that the relationship between government expenditure and economic output is $\omega = G_t / Y_t$. The government will receive transfers from higher levels of government. According to the Okam razor principle, it is assumed that the financial transfer payments are also linearly related to economic output, that is $T_t = \varphi_t Y_t$, and $\varphi_t < 0$, which means economically developed areas are net payments outflow areas.[1]

Local governments are allowed to see fiscal deficits, and fiscal deficits represent fiscal pressure. Assume that fiscal deficit is mainly dependent on the issuance of bonds and non-tax revenue to cover: the government issues short-term bonds, that is, at the beginning of period t, there is expiring bond D_t, and new bonds D_{t+1} will expire at the beginning of period t+1. In period t, the government has to pay interest on debt balance with interest rate of r_{dt}.[2] According to Adam and Bevan (2005), there is still a linear relationship between government bonds and economic output at the end of periods, that is $\frac{D_{t+1}}{Y_t} = d_{t+1}$. The government will also use extra-budgetary revenue AR_t to cover the fiscal deficit, assuming that the ratio of government's extra-budgetary revenue to economic output is θ_t.

Local governments' deficit is:

$$\pi_t Y_t = AR_t + (D_{t+1} - D_t) \tag{5}$$

Among them, π_t is deficit-production ratio of period t.

The government budget constraint is:

$$D_t \cdot (1 + r_{dt}) = (\tau Y_t + T_t + AR_t + D_{t+1} - G_t) \tag{6}$$

The left side of equation (6) represents local governments' debt repay volume of period t, here represents local governments financial pressure; the right side of the equation is local governments' current income deducting general public expenditure. Among them, Y_t represents total output of local tax source-related industries, T_t represents financial transfer payments, AR_t represents extra-budgetary income, D_{t+1} represents government debt newly issued, G_t represents financial expenditure.

[1] According to Yin and Zhu (2011), Lu *et al*. (2012), Jia and Yue (2012), there are certain "affluent" or "pro-poor" characteristics in financial transfer payments. According to the characteristics of financial transfer payments, here we set it as a negative relationship.

[2] From the perspective of the impact of government debt on economic development, government issuing bonds will not only gain revenue from bond sales, but also affect the local economic development from income side, and will also repay through debt, thus affect the local economic development from expenditure side.

From the government budget constraint equation (6), we can see that when T_t, AR_t, D_{t+1} and G_t remain the same, because the tax rate is determined by higher level government, fiscal pressure growth will encourage local governments to expand local tax sources Y_t to ease fiscal pressure. Thus we have proposition 1.

Proposition 1: When other conditions remain the same, in order to expand tax base, local governments choose to support the development of local tax source industry under fiscal pressure.

If T_t, πY_t, D_{t+1} and fiscal expenditure G_t remain the same, fiscal pressure growth will encourage local governments to increase extra-budgetary income AR_t to ease fiscal pressure. Thus we have proposition 2.

Proposition 2: When other conditions remain the same, the local government will expand the extra-budgetary revenue under fiscal pressure.

Transform equation (6) into a ratio constraint relative to output:

$$\frac{(1+r_{dt})}{(1+g_t)}d_t = \tau + \varphi_t + \theta_t + d_{t+1} - \omega_t \tag{7}$$

Among them, g_t represents output growth rate. It is not difficult to find that fiscal pressure is related to the proportion of fiscal transfers, the proportion of non-tax revenue, the proportion of new bonds and the relative scale of public expenditure.

2.2.4. Equilibrium value solution

From the utility function of household, savings of household of period t are:

$$S_t = (1-b)w_t \tag{8}$$

Household savings are mainly used for two purposes: one is investment, and the other is the purchase of government bonds:

$$S_t = (1-b)w_t = I_{t+1} + D_{t+1} \tag{9}$$

Thus, combine equations (4) and (9), and we have capital stock as:

$$K_{t+1} = \phi_t[(1-b)w_t - D_{t+1}] \tag{10}$$

Substitute equation (10) into production function (1), we have output growth rate as:

$$g_{t+1} = \frac{Y_{t+1}}{Y_t} - 1 = \frac{\{A_t\phi_t[(1-b)w_t - D_{t+1}]\}^{\alpha}G_t^{1-\alpha}}{Y_t} - 1 \tag{11}$$

Substitute equations (3) and (7) into the above equation, we have the following equation:

$$g_{t+1} = \left\{ A_t \phi_t \left[(1-b)(1-\alpha)(1-\tau_t) - (\omega_t - \tau_t - \theta_t - \varphi_t) + \frac{(1-r_{d_t})}{(1+g_t)} d_t \right] \right\}^{\alpha} \omega_t^{1-\alpha} - 1 \tag{12}$$

Equation (12) indicates that the local economic growth rate is determined by productivity A_t, depreciation rate ϕ_t, coefficient of fiscal revenue and expenditure (ω_t, θ_t and φ_t) and coefficient of fiscal pressure (government debt) d_t. From equation (12), it is not difficult to find that the greater the local governments' fiscal pressure (that is, the higher the debt burden of the government d_t), the higher the regional economic growth rate, so we have proposition 3.

Proposition 3: In the balanced growth path, if other conditions remain the same, the greater the local governments' fiscal pressure, the higher the regional economic growth rate.

3. Indicators, data and empirical strategy

This paper mainly examines the incentive effect of fiscal pressure on local economic growth and its transmission mechanism. As for technical method, this paper uses the income tax sharing reform to describe the exogenous shock of the local government's financial pressure, and construct the DID model of the "as-if policy experiment" to carry on the empirical research. This is not only conducive to overcoming endogenous problems caused by the use of macro data to construct the decentralization index, but also to more accurately reflecting the actual growth effect of China's tax system reform.

3.1. Urban economic performance

The core indicator of this paper is to describe the economic performance and fiscal pressure at city level. The measures of economic growth are very rich, including economic growth, per capita GDP and per capita GDP growth rate. However, these indicators are mostly subjective statistics, which may face measurement bias and subjective adjustment and other defects. Therefore, in addition to per capita GDP, this paper also uses satellite collection of urban night light brightness data to measure the level of regional economic development. In recent years, regional light intensity has been widely used as an efficient indicator of regional economic development (Henderson *et al*., 2012; Hodler and Raschky, 2014; Xu *et al*., 2015; Fan and Peng, 2016). Based on the night light images acquired by DMSP / OLS, this paper extracts

the total intensity data of urban lighting in China between 2000 and 2012, and measures the urban development status based on this. There are two problems to be solved in the calibration process of the long time series of DMSP / OLS night light image data: first, the image in the original image data set is non-continuous; second, the exists saturation in the pixel brightness value which represents the light intensity in the image. In order to solve these problems, we calibrate the night light image of each period based on the image correction method of a constant target area method, which is widely used in the correction processing of the long time series night light image data set (Wu *et al*., 2013; Cao *et al*., 2015). We will use image corrected night light data to carry on empirical process.[1]

3.2. The actual loss rate of income tax

Fiscal pressure is measured by actual loss rate of income tax. Income tax sharing reform began to implement at the national level in 2002 with the reform model of incremental division. The central government maintained local governments' income tax base unchanged, on this basis, for the incremental revenue, the central government and local governments shared revenue on a fifty : fifty basis in 2002, the central government's share increased to 60% in 2003. The tax "base" is a fixed number determined by the actual amount of corporate income tax actually obtained in 2001 substracting the value of assuming the income tax divided into two equal parts in 2001. After 2002, the central government will return this fixed number to local governments. However, since September 2001, local governments learned the information of income tax rate reform, local enterprises' income tax rate increased sharply in every province, so that in actual implementation process, the "base" is determined by recognizing the normal growth rate from January to September 2001, and get the 2001 return base using the total income tax in 2000 multiplied by the normal growth rate.

The actual loss rate of income tax is constructed as follows. Firstly assuming that the sum of the tax revenue retained by local governments is (income tax + other tax revenue), so the income tax retained by local governments after tax sharing is (total tax revenue–other tax revenue), then (total tax revenue–other tax revenues) divided by 40%, resulting in local income tax revenue before tax sharing. Secondly since the income tax is owned by local governments before the income tax sharing reform, and the central government owned 60% of the income tax after tax sharing, so compared with pre-reform, the tax income loss of local governments caused by the tax reform is (local tax revenue–other tax revenue) ×6/4. Finally, since the income tax sharing reform is incremental division, which means the central government needs to ensure that the local governments' pre-reform income tax is not "eroded", so that the income

[1] Specific impact correction ideas can be obtained directly from the author.

tax base will be returned. The actual loss rate of local income tax is ((local tax revenue–other tax revenue) × (60% / 40%)–income tax return base), the actual loss rate of income tax income sees formula (13):[1]

The actual loss rate of local income tax

$$= \frac{(local\ tax\ revenue - other\ tax\ revenue) \times \frac{6}{4} - income\ tax\ return\ base}{(local\ tax\ revenue - other\ tax\ revenue) \times \frac{6}{4} + local\ tax\ revenue - income\ tax\ return\ base}$$

$$= \frac{(1.5 - \frac{return\ base}{local\ tax\ revenue} - 1.5 \times \frac{other\ tax\ revenue}{local\ tax\ revenue}}{2.5 - \frac{return\ base}{local\ tax\ revenue} - 1.5 \times \frac{other\ tax\ revenue}{local\ tax\ revenue}} \quad (13)$$

We calculate the actual loss rate of income tax after the income tax sharing reform in different regions. The results show that the income tax loss of cities in eastern China is the largest, averagely, the actual loss rate of income tax of cities under the jurisdiction of Zhejiang, Jiangsu, Fujian and Shandong is the highest. The actual loss rate of income tax of central China is at middle level except that actual loss rate of income tax of Hubei and Anhui provinces is a little bit low. The actual loss rate of the income tax of the rest regions is basically kept at 5%; the actual loss rate of income tax of the western region is the smallest, the rate of most cities is 3% or less, those cities are target for financial transfer subsidies in income tax sharing reform.[2]

3.3. Intensity DID indicators

The loss rate of local income tax may be endogenous with the level of urban development, and the actual tax loss rate after using tax reform will lead to the change of financial pressure before and after the income tax sharing reform unrecognizable. From equation (13), it is not difficult to find two key variables that determine the actual loss rate of income tax revenue: "base / local tax revenue" and "other tax income other than income tax / local tax revenue". Since the return base is relatively fixed, the fiscal pressure caused by the loss of local income tax revenue is closely related to local fiscal dependence on income tax revenue (i.e., income tax revenue / local tax revenue). The

[1] Among them, the local tax revenue and income tax are from the "national cities and counties statistics", "China's regional economic statistics Yearbook". According to the actual situation of income tax sharing reform, the base calculation is based on the total income tax in 2000 multiplied by the normal annual growth rate of the three years from 1998 to 2000. The growth rate of income tax is calculated by using the geometric mean growth rate from 1998 to 2000. Because of the inability to obtain income tax revenue growth rates for January to September in each of the cities in 2001, the approach was used to replace them.

[2] Because of the layout limit, the form is not reported here, readers can request directly from the author.

higher the dependence of local taxes on income tax, the greater the fiscal pressure caused by income tax sharing reform.[1]

The intensity DID is a measure of regression similar to double differential model. In double differential model, the sample is divided into "experimental group" and "control group" according to whether or not the experiment is accepted. However, in the income tax sharing reform, all observed samples are subject to the "sudden" tax sharing shock, resulting in the case that we can not necessarily divide the "experimental group" and "control group". The intensity DID model uses the "degree of the impact of the reform" as the basis for dividing the experimental group and the control group. When using the intensity DID model, the experimental group and the control group are "relative" rather than "absolute".

Based on the above logic, this paper describes intensity indicators that reflect the change of fiscal pressure in the income tax sharing reform. The specific approach is: we measure structural average value of proportion of income tax of tax revenue in three years between 1998 and 2000 in different cities before the income tax sharing reform,[2] in order to describe different scale of impact from income tax reform in different cities. The greater the proportion, the greater the dependence of local fiscal revenue on income tax revenue, and the greater the fiscal pressure the local governments face caused by the reform. We analyze annual dynamic trends of income tax dependency and conduct quartile division according to the degree of dependence on income tax before the reform, and whether the income tax contribution rate will rapidly reduce or not after the reform in regions with high income tax dependence. The results are shown in Figure 1 and Table 1 respectively.

Figure 1 shows the relationship between tax losses and income tax dependence since the 2002 tax reform. The conclusion shows that, first of all, since the 2002 income tax sharing reform, the local governments' income tax revenue has decreased significantly. On average, the fiscal pressure caused by the income tax sharing exists in each region. Secondly, the actual loss rate of income tax revenue and income tax dependence maintain similar dynamic trend. When income tax dependence is low, the actual loss rate of income tax income decreases. When income tax dependence is high, the actual loss rate of income tax income increases. Finally, from the view of growth rate, one unit change of income tax dependence will cause more than one unit change of the actual loss rate of income tax revenue.

[1] For example, the pre-tax income tax dependence of area A is 50%, and the pre-tax income tax dependence of area B is 10%. Then, the tax loss rate of area A is 30%, the tax loss rate in area B is 6%, So the fiscal pressure on the income tax due to the loss of area A shall be greater than the area B.

[2] There are some benefits of doing so: first, it can reduce estimated bias caused by two-way causality, second, to take into account that the tax structure is generally relatively stable. We did not use the 2001 related value, because the income tax sharing reform is incremental division, so most of local governments increased the income tax revenue in 2001, resulting in risk of distortion if we add the 2001 income tax dependence to compare.

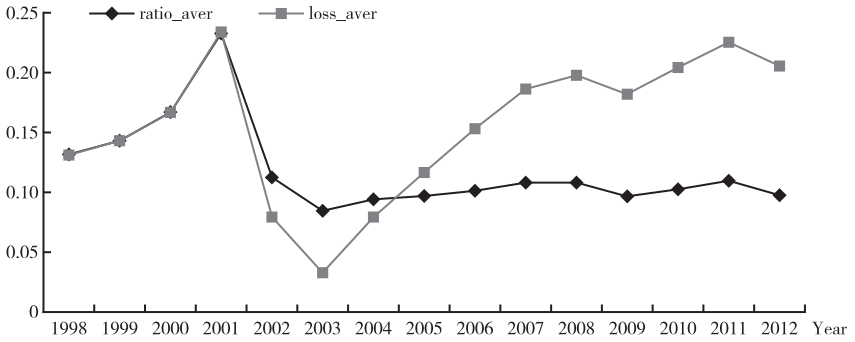

Figure 1. The actual loss rate and income tax dependence after income tax sharing

In order to further verify the correspondence between the degree of income tax dependence and the actual loss rate of income tax, we conduct quartile division in accordance with the average dependency of the pre-tax income tax, and examined whether income tax contribution rate decreased more or not in regions with greater income tax dependence[1] after the tax sharing reform, specifically see Table 1.

Table 1
Different quartile groups of income tax contribution rate Unit: %

Contribution rate change quartile group	0-25Quartile	25-50 Quartile	50-75 Quartile	75-100 Quartile
2001	10.90	7.85	8.11	7.91
2002	2.42	-2.65	-4.92	-8.45
2003	0.54	-5.02	-7.89	-12.02
2004	1.49	-4.18	-6.98	-10.93
2005	2.14	-3.97	-6.29	-11.35
2006	2.70	-3.58	-6.18	-11.19
2007	3.23	-3.00	-5.26	-10.16
2008	3.33	-2.70	-4.91	-10.53
2009	2.28	-3.39	-6.28	-12.02
2010	2.57	-2.92	-5.98	-10.90
2011	3.39	-2.41	-5.19	-10.53
2012	2.56	-3.03	-6.65	-11.78

Columns 2 and 5 in Table 1 show changes of the contribution of annual income tax compared to the contribution of income tax over the previous three years. It is not difficult to see from Table 1 that the proportion of income tax increased after income tax reform in regions with lower income tax before the reform. And with the proportion of income tax

[1] Here contribution rate is (income tax revenue/tax revenue).

getting higher and higher, income tax contribution decreased significantly after the reform. Income tax sharing reform has significantly impact on local fiscal revenue.[1]

3.4. Other variables

The control variables selected by this paper include population and population density, fixed asset investment rate (ratio of fixed assets to GDP), consumption rate (total retail sales of society as a percentage of GDP), government scale (fiscal expenditure as a percentage to GDP) and industrial structure (ratio of second and third industry output value to GDP).

3.5. Empirical strategy

In this paper, we set the measurement model as in equation (14):

$$light_{it}(pergdp_{it}) = \alpha_0 + \alpha_1 D_t + \alpha_2 D_t \cdot D_{group} + \alpha_k \cdot x_{itk} + \alpha_i + year_t + \theta_p \cdot year_t + \varepsilon_{it} \tag{14}$$

Among them, explained variable is per capita GDP or regional lighting brightness.[2] Dt represents the policy implementation time of the income tax sharing reform, D_{group} represents the "relative" experimental group (the value is 1) and the "relative" control group (the value is 0) according to the impact of the income tax sharing reform. Here are two criteria of grouping: the median and the original value of proportion of income tax. In the first mode, we set samples higher than the median value of the income tax as the experimental group, and samples lower than the median value of the income tax as the control group. In the second mode, we use the original value of proportion of income tax and policy year as intensity DID cross multiplication, that is, in each quartile, the urban samples larger than the proportion are the relative experimental groups of the sample to which the quartile belongs. X is the set of control variables.

[1] As the proportion of pre-tax income tax ratio is effect impacted by the income tax sharing reform from the structural point of view of different regions, we also use pre-tax regional income tax rate as a benchmark, investigate the scale of impact of fiscal pressure from the income tax sharing reform the scale of different regions: i.e. whether regions with faster income tax revenue growth rate experience greater fiscal pressure. From the scale effect, we can also find that, because the central government shared 60% of local tax revenue of all regions, leading to tax growth loss rate is lower in regions with lower pre-tax income tax growth rate and tax growth loss rate is higher in regions with higher pre-tax income tax growth rate. Later we will use pre-tax income tax revenue growth rate as a intensity indicator, to conduct robustness test. As the data involved is quite numerous, if the reader needs, can be obtained directly from the author.

[2] The brightness of the light here is the total brightness of the region fence. Since the total area of each region is constant, the area variable will "disappear" with controlling regional fixed effect. The estimated result is consistent with the light intensity per unit area.

In order to minimize missing variables and two-way causality errors, and given the possibility of gradual implementation of light lighting project in time, the model uses two-way fixed effect model to control time and region.[1] In addition, since the economic development of prefecture-level cities is largely influenced by provincial government, we have further controlled the trend effect of province and year ($\theta_p \cdot year_t$).

4. Empirical Analysis

4.1. The basic regression

4.1.1. Basic regression: not considering the financial transfer payment

Table 2 shows the results of the basic regression when the fiscal transfer payment factor is not taken into account. Column 2 and column 3 show the regression results when using income tax dependency median to divide experimental group and control

Table 2
Basic regression results

Variables	Lighting Median	Per Capita GDP Median	Lighting Intensity index	Per Capita GDP Intensity index
Tax sharing reform time	-0.576*** (-5.34)	-1.156*** (-15.72)	-0.942*** (-4.61)	-1.141*** (-9.37)
Tax sharing reform cross multiplication	0.485*** (2.65)	0.179 (1.38)	4.373*** (3.17)	0.662 (0.69)
Constant	2.396*** (5.18)	0.296 (0.96)	2.446*** (5.09)	0.307 (0.99)
Other variables	Control	Control	Control	Control
Time	Control	Control	Control	Control
Region	Control	Control	Control	Control
Time and province cross multiplication	Control	Control	Control	Control
R^2	0.6837	0.7281	0.6925	0.7299
F	34.82*** (0.00)	52.36*** (0.00)	35.33*** (0.00)	52.06*** (0.00)
Observed value	4154	4153	4093	4092

Notes: ***, ** and * represent significant confidence interval of 1%, 5% and 10% respectively. All standard errors are sound standard error, the same below.

[1] The division of the experimental group and the control group is based on the three-year average value of the income tax proportion from 1998 to 2000, and its mutual causal relationship is weak because it is difficult to speculate that the annual urban light intensity will adversely affect the local income tax proportion structure before reform. The impact of the initial level of local economy can be eliminated by difference through a fixed effect. Of course, later we will also use the method of controlling the previous year's GDP to further reduce the two-way causal effect.

group. Column 4 and column 5 show the regression results when using income tax dependency (intensity index) cross multiply the reform time.

The results show that: if we use intensity DID model, with the fiscal pressure increasing one unit, light brightness increases 4.373 units after the reform. If we use the median group, the fiscal pressure increases one unit, light brightness increases 0.485 units after the reform. Using per capita GDP as explained variable, the double difference term is positive but the coefficient is not strongly significant, that is, other macroeconomic policy impact at provincial level may explain the economic growth after the income tax sharing reform to some extent; also shows there are some differences to portray economic development by per capita GDP and light. In general, fiscal pressures have significantly contributed to local economic growth, and incentive effects of fiscal pressure have been validated for stimulating economic growth.

4.1.2. Basic regression: considering the fiscal transfer payment

Next, we will continue to consider the impact of fiscal transfers on stressful fiscal incentives. Referring to Jia and Yue (2012), we have classified sample cities into two categories: the first category includes Beijing, Tianjin, Shanghai, Jiangsu, Zhejiang, Guangdong, Liaoning, Fujian, Shandong, these provinces received no (or less) general balanced transfer payment before and after the reform, they are the balanced transfer payment net outflow regions, is assigned as 1; the rest provinces are the second category, they are the balanced transfer payment net outflow regions, assigned as 0. We will use transfer payment region group dummy variables to cross multiply the tax reform to be the triple difference item, and examine the heterogeneous effect of the economic growth effect of the stressful fiscal incentive on the different transfer payment regions. The results are shown in Table 3.

From the regression results, first of all, the income tax sharing reform cross multiplication are positive significant, that is, the fiscal pressure caused by income tax reform increases regional lighting intensity and GDP per capita. However, the triple difference between the transfer payment net outflow regions and the tax reform is positive significant in the light model, which means under fiscal pressure, economic growth effect of transfer payment net outflow regions is relatively stronger than that of transfer payment net inflow regions. The results show that the fiscal incentive effect is not significant because the financial transfer payment from the higher level government relieves local fiscal constraints in regions which receives more financial transfer.

Table 3
Fiscal transfer payment and stressful fiscal incentive

Variables	Lighting Median	Per Capita GDP Median	Lighting Intensity index	Per Capita GDP Intensity index
Tax Sharing reform time	-0.579*** (-8.75)	-1.145*** (-15.07)	-0.929*** (-10.47)	-1.148*** (-9.92)
Tax sharing reform cross multiplication	0.444*** (5.37)	0.302*** (2.91)	3.469*** (6.49)	1.159* (1.67)
Tax sharing reform * transfer payment	0.124 (1.00)	-0.376 (-1.44)	2.336*** (3.82)	-1.283 (-1.01)
Constant	2.402*** (11.26)	0.279 (0.92)	3.098*** (4.04)	0.304 (0.98)
Other variables	Control	Control	Control	Control
Time	Control	Control	Control	Control
Region	Control	Control	Control	Control
Time and province cross multiplication	Control	Control	Control	Control
R^2	0.6838	0.6220	0.6937	0.7304
F	244.27*** (0.00)	19.95*** (0.00)	252.01*** (0.00)	50.80*** (0.00)
Observation Value	4154	4153	4093	4092

Note: ***, ** and *represent significant confidence interval of 1%, 5% and 10% respectively.

4.2. Robustness test

4.2.1. Tax growth rate matching intensity indicator

Using proportion of income tax before the reform as grouping standard or as indicator of intensity portrays local relative loss of tax in the tax reform from the structural aspects. Here from the scale point of view, we use income tax revenue growth rate of three years before the reform as benchmark to construct intensity indicator and divide experimental group and control group, and test robustness of conclusions.[1] From the results of regression, the fiscal pressure caused by income tax sharing reform portrayed from the relative loss scale can also get the conclusion that fiscal pressure has positive effect on economic growth. Whether we use per capita GDP or light brightness, tax reform cross multiplication maintains positive and significant.

4.2.2. Increased fiscal pressure

There are two significant time nodes of income tax sharing reform: the central

[1] Due to layout limitations, the relevant regression results of the robustness test can be obtained directly from the author.

government and local governments equally split income tax revenue in 2002, and in 2003, the central government raised its proportion of income tax from 50% to 60%. If the basic conclusion is established, when we put intensity DID indicator using 2003 as reform time benchmark into basic model, the re-increase of the income tax proportion should have a positive effect on the light (or per capita GDP).

The regression results show that on the basis of controlling the 2002 tax reform transfer cross multiplication, all the 2003 tax reform cross multiplications are significant at the level of less than 1% at the same time, which is consistent with expectation, so the promotion effect of fiscal pressure on economic growth is verified. In the case of per capita GDP, the 2003 tax sharing reform cross multiplication is significant positive, but the 2002 tax sharing reform cross multiplication is not significant; that is, for the per capita GDP, the higher proportion, the economic growth effect of fiscal pressure is relatively more significant.

4.2.3. Control the initial level of urban economic development

Since we use the urban income tax structure between 1998 and 2000 as intensity indicator and grouped, we are concerned that the outcome of the regression will be affected by differences in the level of initial economic development. Thus, the model further controls time trend effect and per capita GDP of the previous year in each region.

The regression results show that in the case of controlling time trend and per capita GDP of the previous year, the tax and reform cross multiplication in the light model is still significant at the 1% level. The coefficient of income tax reform cross multiplication is reduced compared with the basic regression, indicating that the initial economic level and the effect of inertia growth have impact on the results, but it does not affect the basic conclusion.

4.2.4. Control decentralization reform: provincial governing county and boroughs transformed from counties

Besides the reform of the income tax sharing, other reform measures include the reform of “provincial governing county” and “boroughs transformed from counties”, we try to divest the economic incentives that other decentralization policies may bring, so the model further controls “provincial governing county” and “boroughs transformed from counties” reforms. We set two dummy variables of “provincial governing county” and “boroughs transformed from counties”. If the county under the city’s jurisdiction implemented “provincial governing county” reform that year, assigned as 1, otherwise as 0; and the city implemented “boroughs transformed from counties” that year, assigned as 1, otherwise as 0.

The regression conclusion shows: after controlling "provincial governing county" and "boroughs transformed from counties", the coefficient of core explanatory variables in the light model is smaller than that of the basic regression, but it is significant at the level of less than 1%. The basic conclusion is not affected by corresponding decentralization policy reform. Using per capita GDP can also obtain positive impact coefficient, but the significant reduces, indicating that light and GDP per capita are different in portraying the level of economic development.

4.2.5. Control other macroeconomic development strategies and coefficient weighting

Firstly, from 2003 to 2005, the State Council have proposed strategies of revitalizing the northeast old industrial base and the rise of the central China, which means nine provinces in the northeastern and central China receive some favorable polices. So we delete the data from these nine provinces and use the remaining samples to regress again. Secondly, by observing the data growth trend, we found that the tertiary industry increased rapidly and the data fluctuated abnormally after 2005, and the national land revenue grew at a negative rate in 2005. In order to control the basic regression results not to be systematically affected by unobservable factors after 2005, we shortened the samples to 1997- 2005 for regression. Thirdly, on the basis of the 1997- 2005 sample, we use the reweighting method on each indicator to reduce the difference in the initial economic development level among the samples.[1] The regression conclusion shows that the coefficient of income tax reform cross multiplication is significantly larger after deleting data of central and northeast China, but the coefficient is positive and the conclusion is robust. After shortening the time period of the sample, the double difference term and intensity DID regression was significantly positive and the conclusion was robust. The results also support the basic conclusion after reweighting coefficient.

4.3. Mechanism inspection

4.3.1. Industry development options

Next, we plan to verify the following three transmission mechanisms. Firstly, after the income tax sharing reform, the fiscal pressure stimulates the development of business tax related industries - the real estate industry. Secondly, after the income tax

[1] The per capita GDP of the experimental group (control group) was higher (lower) than that of the control group in base year, and the weight ratio was reduced (increased) in the corresponding "box", so that the experimental group and the control group can be compared as much as possible, and deleting systematic bias which may exist in different "boxes" in the sample. After we get the weight ratio of each box, we multiply the explanatory variable and the explained variable to weighting factor and regress. See Dinardo, Fortin and Lemieux (1996).

sharing reform, local governments support local economic development through land finance by selling land in high prices and other non-tax revenue. Thirdly, if we control the scale of land revenue unchanged, income tax reform affects economic growth by changing competition among local governments.[1]

Table 4 examines the mechanism of local governments promoting real estate development and increasing land revenue to impact regional economic growth under stressful fiscal incentive. We test the light brightness as the explained variable, using the median value grouping and intensity DID model to regress respectively. Among them, we use real estate investment accounted for the total value of GDP as the real estate investment rate, Herfinda Darfur index as investment diversity index, using square term of real estate investment volume accounting for total social fixed assets investment (the greater the value that the lower the diversity of investment) .

Table 4
Transmission mechanism examination 1

Indicators	Median Real estate investment rate	Intensity Real estate investment rate	Median Investment diversity	Intensity Investment diversity	Median Land revenue	Intensity Land revenue
Transmission indicator	2.170 (1.53)	0.194 (0.11)	-2.357 (-1.48)	-3.797* (-1.91)	-0.000* (-1.95)	-0.000** (-2.15)
Tax reform cross multiplication	0.252 (1.38)	2.398 (1.58)	0.304* (1.66)	2.805** (2.01)	0.266*** (3.28)	2.708*** (5.02)
Tax reform ×reform time ×transmission mechanism	2.864* (1.71)	24.501** (2.34)	5.068** (2.36)	36.607** (2.60)	0.00001*** (3.45)	0.0001*** (3.49)
Constant	2.488*** (5.54)	2.602*** (5.73)	4.057*** (8.80)	2.541*** (5.59)	1.799*** (6.12)	1.825*** (6.31)
Other variables	Control	Control	Control	Control	Control	Control
Time	Control	Control	Control	Control	Control	Control
Region	Control	Control	Control	Control	Control	Control
R^2	0.6903	0.7000	0.6874	0.6990	0.6904	0.6993
Time and province cross multiplication	Control	Control	Control	Control	Control	Control
F	34.49*** (0.00)	34.93*** (0.00)	39.92*** (0.00)	34.81*** (0.00)	197.06*** (0.00)	202.61*** (0.00)
Observed value	4143	4086	4143	4086	3408	3360

Note: ***, ** and * represent significant confidence interval of 1%, 5% and 10% respectively.

Regression shows that analyzing from single variable of the transmission mechanism, single investment structure and higher land revenue are detrimental to

[1] The economic competition is measured by weighted GDP growth rate of other cities in the same province. The expenditure competition is weighted proportion of the financial expenditure of other cities in the same province. The tax competition is weighted proportion of the tax revenue of the other cities in the same province. Weighted number is the reciprocal of the absolute value of the per capita GDP difference between the two cities.

economic growth (the negative effects of land revenue are relatively small). The triple cross multiplication of transmission mechanism is basically significant positive, indicating that in the region with greater fiscal pressure, if it has a higher real estate investment rate, more land revenue and investment structure partial to the real estate industry, then the lightning intensity of the region is brighter after the income tax sharing reform (similarly, the contribution of land revenue to economic growth under fiscal pressure is relatively small). Under fiscal pressure, the positive effect of economic growth brought by behavior partial to real estate investment or land transfer will offset the negative effect of the transmission mechanism itself. The conclusion shows that the fiscal pressure formed by the income tax sharing reform will promote local economic growth by promoting the local government to support the development of local high tax industry such as real estate. It is noteworthy that a large number of social investments are concentrated in the real estate sector, and local economic growth is at the expense of a single social investment structure, which is likely to exacerbate the fragility and volatility of the macroeconomic system.

4.3.2. Intergovernmental competition

As for inter-government competition under the stressful incentive, the traditional fiscal centralization theory holds that the tax revenue sharing lead the decrease of net profit of local tax revenue, so economic competition may expand the actual fiscal deficit,[1] so fiscal revenue centralization is conducive to reducing excessive competition among local governments and regional division. The central government taking liquidity tax base is conducive to effectively allocating resources in a more unified market, to improving economic development. While the new fiscal centralization theory holds that after the tax sharing reform, given capital factor flow, monopoly land income and political income of industrial development, under the pressure of centralized income, the local governments will still use non-tax revenue resources such as land transfer to "assist" enterprises and promote local economic growth. Here we mainly verify whether the pressure of fiscal incentives "enhance" or "weaken" the intergovernmental competition.[2]

[1] Tax competition makes local governments competitively reduce the actual tax rate, causing the decline of fiscal revenue; expenditure competition leads local governments to competitively raise expenditure; resulting in increasing local government actual fiscal deficit.

[2] According to the theory of political promotion championship, for each prefecture-level city, the economic competition index is the weighted average value of economic growth rate of all prefecture-level cities other than this city within the province, the tax competition index is the weighted average value of actual macro tax rate (tax revenue/GDP) of all prefecture-level cities other than this city within the province, the expenditure competition index is the weighted average value of relative expenditure size (fiscal expenditure/GDP) of all prefecture-level cities other than this city within the province, Weighted number is the reciprocal of the absolute value of the per capita GDP difference between the two cities.

In the mechanism testing in Table 5, we control the local land revenue scale, use light as explained variable, add government competition indicators and income tax sharing DID cross multiplication to form a triple difference, the test results are shown in Table 5.

The regression results show that triple difference between tax reform and intergovernmental competition are significantly negative, indicating that intergovernmental competition under fiscal pressure is detrimental to economic growth. The central government takes the tax collection and management rights of liquidity tax base and increases the proportion of tax revenue, reduces the net income of local governments' competition, increases fiscal risk of expenditure competition and fiscal pressure will restrict local governments to reduce the expenditure competition. But in the same land revenue scale, tax competition can still help local governments gain economic development advantages, so if local governments can obtain competitive fund through other financial resources, it is still conducive to industrialization and its associated industries conducting "Tiebout competition". In general, local governments' expenditure competition decreases under fiscal pressure and local governments have sufficient land sales revenue to strengthen the degree of tax competition and improve local economic growth advantage.

Table 5
Transmission mechanism examination 2

Indicators	Median_ economic competition	Intensity_ economic competition	Median_tax competition	Intensity_tax competition	Median_ expenditure competition	Intensity_ expenditure competition
Transmission indicator	0.007 (1.17)	0.061** (2.01)	0.001 (1.35)	0.003 (1.10)	0.005 (0.98)	0.012 (1.09)
Tax reform cross multiplication	0.496*** (2.69)	3.073** (2.56)	0.496*** (2.68)	3.043** (2.53)	0.321** (2.00)	3.045** (2.54)
Tax reform × reform time × transmission mechanism	-0.069*** (-3.07)	-0.509** (-2.39)	-0.014** (-1.97)	-0.033 (-1.42)	-0.036* (-1.76)	-0.174 (-1.60)
Constant	2.397*** (5.18)	1.764*** (2.63)	2.395*** (5.17)	1.819*** (2.76)	1.791*** (2.82)	1.806*** (2.73)
Land revenue scale	Control	Control	Control	Control	Control	Control
Other variables	Control	Control	Control	Control	Control	Control
Time	Control	Control	Control	Control	Control	Control
Region	Control	Control	Control	Control	Control	Control
Time and province cross multiplication	Control	Control	Control	Control	Control	Control
R^2	0.6839	0.6986	0.6839	0.6983	0.6893	0.6983
F	32.99*** (0.00)	37.13*** (0.00)	33.16*** (0.00)	36.45*** (0.00)	36.00*** (0.00)	36.42*** (0.00)
Observation value	4150	3358	4151	3358	3407	3359

Note: ***, ** and * represent significant confidence interval of 1%, 5% and 10% respectively.

5. Conclusions

In this paper, we construct an intensity DID model with the 2002 "Income Tax Sharing System" reform as exogenous shock of local fiscal pressure. By using the China's satellite night lighting data at the city-level to measure economic development and examine the impact and transmission mechanism of local fiscal pressure on urban economic growth. The study finds that under the stimulation of fiscal pressure, local governments tend to develop local high tax industries, stimulate local economic growth, but it also forms an economic development model of leaning towards real estate industry and reduces economic development diversity. In addition, fiscal pressure will constrain local governments to reduce expenditure competition. However, local governments will turn to use land sale revenue and other funds as a basis for regional tax competition to attract liquidity production factors.

Our research shows that fiscal institutional design will profoundly influence local governments' behavioral decision. It is easy for local governments to form a relatively single economic development mode and increase macroeconomic risk under fiscal pressure. Local governments use land revenue and other non-tax revenue sources as a new round of tax competition means under fiscal pressure, which is still not conducive to the formation of a unified domestic market and goes against the resources allocation mechanism of full and free flow of production factors. Therefore, we have following policy recommendations. Firstly, reasonably divide fiscal and powers responsibility between the central government and local governments, properly increase local governments' autonomous decision-making power while designing tax policy, which is conducive to preventing the development model of local governments too dependent on certain local high-tax industry and increasing local economic development diversity. Secondly, to regulate the government fund revenue management and reduce the local government's dependence on land revenue, which is conducive to prevent local governments from inefficient intergovernmental competition.

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