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Government Intervention and Innovation Factor Market's Distortions in China

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Abstract
The innovation-oriented factor's allocation, especially the capital factor, is more distorted than the general factor. Based on production function using China's provincial panel data from 2007 to 2018 in China, the calculation results indicate there are negative distortion effects both in innovation labor and capital market. The degree of innovation labor factor market's distortion is less than that of capital factors market. Fiscal competition, such as technological subsidies and tax competition, has played an important role in regional innovation factor market's distortion, but the effect of tax competition is relatively small. The effect of fiscal expenditure is not statistically significant.

Keywords: *Fiscal Competition, Innovation Factors, Factor Market's Distortion*

Introduction

Accelerating market-oriented reforms and promoting the free flow of various factors are important condition to realization innovation-driven development strategy, because not only the input but also the efficiency of factors, is the key for economic growth in the future (Cai, 2013)[1]. However, under the background of fiscal decentralization and performance evaluation in China, government intervention can make factors' market prices deviating from their opportunity costs, which in turn leads to non-optimal allocation of factors (Yuan & Yang, 2014)[2]. The factor market's distortion causes market resources misallocation, then lead to economic structural imbalance and efficiency loss (Jeong & Townsend, 2007; Restuccia & Rogerson, 2008)[3-4]. Considering innovation-driven development strategy, if innovation resources allocation deviates from the Pareto optimum, its impact on economic

development and efficiency losses will be further enlarged. So, it's very important to study the innovation factor market's distortion and its causes.

Existing researches on factor market's distortion mainly focus on the measurement, economic effects and reasons. Measurement methods include stochastic frontier analysis (SFA), index, production function model, shadow cost model, etc. Basing on macro data from 1998 to 2001 in China, Sheng (2005)[5] measured the average distortion degree of China's industrial factor market using stochastic frontier analysis. Yuan & Yang (2014)[2] used the shadow cost model to examine distortion of China's factor market in different areas, time and factors. The latest research by Li et al. (2020)[6] extended calculation of factor market's distortion to 260 cities using trans-logarithmic production function. Economic effect of factor market's distortion is the important field, which includes innovation capabilities and performance, total factor productivity, industrial structure and upgrading, technology spillovers and employment. Hsieh & Klenow (2009), Jian (2011)[7-8] measured the impact of factor mismatching on China's economic performance based on the traditional economic growth framework. Zhang et al. (2011)[9] suggested that factor market's distortions may have an inhibitory effect on Chinese corporate innovation. Dai &Liu (2015)[10] investigated how factor market's distortions affected innovation efficiency of China's high-tech industries.

Scholars have already given some answers about reasons for factor market's distortion. Traditional literature considering institutional reason mainly mentions government intervention, household registration system, dual economic structure, etc.(Jin et al., 2015)[11]. Vollrath (2009)[12] pointed out that the imperfection of factor's market in developing countries has great relationship with government policies, market monopoly and institutional culture. Restuccia & Rogerson (2008)[4] found that non-equivalence of enterprises' marginal output and income could cause serious labor and capital misallocation, and government subsidies and taxation enlarged this misallocation by making cost differences between enterprises. Han & Zheng (2014)[13] further explained the channel that government intervention affects factor misallocation, which is by influencing market entry of different productivity enterprises and factor allocation between enterprises. Yang & Bai (2019)[14] found factor allocation in China shows a "U"-shaped trend, and government intervention has significantly promoted the improvement of factor allocation. In addition, household registration system, dual economic structure, foreign direct investment, etc. also have a certain impact.

It can be found that existing literature on factor market's distortions mainly focuses on general factor markets, and there is very little research on innovation factor market's distortions. However, innovation factors are important strategic resources to ensure the implementation of innovative national strategies, and can promote social technological progress and productivity improvement (Wang & Liu, 2017)[15]. The influence of government intervention on innovation factor market and general factor markets should be different due to stronger policies attracting innovation factors by various means of fiscal competition. So, this article first builds an innovation factor market's distortion measurement model, then establishes a empirical model to estimate effects of a variety of local governments' fiscal competition on innovation factor market's distortion.

Measurement and Comparison of Innovation Factor Market's Distortion

Measurement of innovation factor market's distortion

Most researches focus on general factor market's distortion. However, innovation factors play a more important role in economic growth and development than general factors in the background of national innovation, and research on innovation factor market's distortion has become more urgent. About the measurement of factor market's distortion, Bai & Bian (2016)[16] pointed out that the production function method has some advantages: can directly measure the marginal output of production factors, can measure market's distortion of different factors.

This article will apply this method to innovation factor input and innovation output. The model is specifically expressed as:

$$LnY_{it} = \alpha_0 + \alpha_1 LnL_{it} + \alpha_2 LnK_{it} + \alpha_3 Ln^2 L_{it} + \alpha_4 Ln^2 K_{it} + \alpha_5 LnK_{it} LnL_{it} + \epsilon_{it} \quad (1)$$

Where *Y*= innovation output in region *i* at time *t* which is measured by the number of patents granted. *K*=Stock of innovation capital which represents innovation capital factor. The depreciation rate for perpetual inventory method is 15%, and the growth rate is the average growth rate of R&D capital in each region. *L*=innovation labor factor which is measured by the index of full-time researcher. ϵ_{it} it is the random disturbance term, $\alpha_1 \sim \alpha_5$ is the corresponding partial regression coefficient.

Taking the derivative of *L* and *K* respectively, the marginal output of innovation labor and capital can be obtained. The essence of factor market's distortion is the distortion of factor price, that is, the degree of deviation between real price and marginal output of the factor. Therefore, innovation labor and capital factor market's distortion can be expressed as the marginal output of innovation factor divided by their price. The expression is:

$$Distort_L = MP_L / w \quad (2)$$
$$Distort_K = MP_K / r \quad (3)$$

Where $Distort_L$ and $Distort_K$ represent the distortion degree of innovation labor and capital, and real prices of innovation labor and capital are denoted by w and respectively. The price of innovation labor, is measured by the average wage of urban employed in scientific research, technical services, and geological exploration, and is adjusted into a constant price in 2009. The one-year loan interest rate of financial institutions in each year is used to measure the price of innovation capital. If *Distort*>1, there is a negative distortion effect which indicates factor's real price is less than the marginal output. If *Distort*<1, there is a positive distortion effect which means factor's real price is greater than the marginal output.

Comparison of innovation factor market's distortion

According to above formulas, we can know the national average distortion degree of innovation labor factor market from 2009 to 2018 is 4.19. This conclusion indicates there is a negative distortion effect in innovation labor factor market, which is positive for general labor factor market' distortion in the literature of Bai & Bian (2016)[16]. The reason may be as follows. On the one hand, the same innovation labor factor will get a higher marginal output compared with the general labor factor, because researchers, as human capital, have a higher level of education and production efficiency. On the other hand, it may also be due to the long-term periodicity of innovation activities, which means the growth of researchers' real price is slower than the marginal output. Furthermore, wage gap between mental and manual labor is still not fully reflected due to the existing wage system, employment environment, and wage rigidity in China. However, the degree of innovation labor factor market's distortion is less than the conclusion of Deng (2019)[17]. This may be mainly caused by the difference between patent authorization and new products.

We can also calculate the national average distortion degree of innovation capital factor market from 2009 to 2018 is 7.12, which indicates there is also a negative distortion effect. Firstly, there are various preferential policies for R&D capital, which may cause the real price of innovation capital to stay artificially lower. Secondly, the strength of R&D capital management makes the marginal output of innovation capital relatively higher than general capital. The higher marginal output and lower real price for innovation capital factor, contribute to the higher distortion

degree of innovation capital factor market comparing with general capital factor market. However, we need to be cautious about this conclusion. The incomplete marketization of interest rates and various preferential policies in the use of innovation capital, may cause interest rates can't fully reflect the real price of innovation capital.

It can be further concluded that the distortion degree of the national average innovation labor factor market is lower than that of the innovation capital factor market. With the reform of household registration system and labor marketization, many institutional barriers that restrict the flow of labor across regions have gradually been weakened. All regions have tried their best to attract more innovation labor to promote the economic development. Therefore, the degree of labor marketization is relatively higher than that of the capital market. The price of innovation labor factor lies more on market mechanisms rather than government policies and the impact of government intervention on innovation capital factor market is relatively small.

The effect of fiscal competition on innovation factor market's distortion

Theoretical analysis of mechanism and channels

Since the reform and opening up in China, the market has played an increasingly role in various factors' allocation, and government intervention in economic activities has gradually decreased. However, it is still an objective phenomenon that local governments contribute to factor market's distortion by excessive competition. The innovation factor market's distortion cann't be ignored, especially under the condition of all governments trying to adjust industrial structure and promote technological innovation. With fiscal decentralization, government intervention has affected supply and demand of factors by fiscal competition such as fiscal expenditure, technological subsidies, tax competition, then leads to misallocation of innovation factors.

Firstly, fiscal expenditure of local governments has some influences on innovation factor market's distortion. Fiscal expenditure can attract the inflow of commodities and factors, accelerate the accumulation of factors, and increase regional production efficiency by improving economic and social environment. However, if local governments over-participate in economic competition, the phenomenon of innovation factor market's distortion may occur and lead to overcapacity in this region. For example, they speed up the process of developing emerging industries too much, and carry out low-level repetitive production, the will cause resources wasting.

Secondly, technological subsidies, which mean get the financial support from local governments for innovation, will affect innovation factor's allocation. Financial support from local governments will help for meeting the capital need of enterprises' innovation in the early stage, and strongly stimulate innovation factor's allocation among enterprises and regions. On the one hand, government financial support will guide market funds to enter innovative and technology-intensive enterprises, but may result in innovation capital factor market's distortion at the same time. Because low-cost or even cost-free capital input of local governments can directly reduce the average price of capital and make it far lower than market price. On the other hand, if financial support of local governments will be helpful for increase wage of human capital, and gain higher marginal output. The growth rate of marginal output may be much higher than that of innovation labor factor prices, which may lead to innovation labor factor market's distortions.

Fiscal competition of tax has a direct or indirect impact on the external economy and internal production of enterprises. It can change the price of products and the actual cost of factors, which will affect the status of factors' allocation in the market, and causes factor market's distortions. Tax policies that are continuously adjusted with economic development and industrial structure, have an inclination for emerging industries and technology-intensive industries. Compared with traditional industries and general factors, it is easier to change the scale and structure of innovation labor factor.

Empirical estimation of the effect

This section focuses on estimating the effects of fiscal expenditure, technological subsidies, and tax competition on innovation factor market's distortion respectively. The previously estimated degree of distortion will be used as explained variable in the model, and different fiscal competition will enter the model as explanatory variables separately. Considering other control variables, the empirical model is set as:

$$LnDistort_{it} = \beta_0 + \beta_1 LnEX_{it} + \beta_2 LnIN_{it} + \beta_3 LnTR_{it} + \beta_4 LnFD_{it} + \mu_{it} \quad (4)$$

$$LnDistort_{it} = \beta_0 + \beta_1 LnRD_{it} + \beta_2 LnIN_{it} + \beta_3 LnTR_{it} + \beta_4 LnFD_{it} + \mu_{it} \quad (5)$$

$$LnDistort_{it} = \beta_0 + \beta_1 LnTA_{it} + \beta_2 LnIN_{it} + \beta_3 LnTR_{it} + \beta_4 LnFD_{it} + \mu_{it} \quad (6)$$

Where Distort represents the distortion degree of innovation labor and capital, and *EX, RD, TA* refer to fiscal expenditures, technological subsidies and tax competition respectively. *IN, TR* and *FD* are control variables which refer to industrial structure, economic openness and foreign investment. *u* is the random disturbance term.

Taking into account the overall financial power of local governments, fiscal expenditure *(EX)* is measured by the ratio of local government fiscal expenditure to GDP, and the data of fiscal expenditure refer to expenditure in final accounts, which reflects the actual fiscal expenditure in each region. Technology subsidies *(RD)* are measured by the ratio of local government fiscal expenditures on science and technology to total fiscal expenditures. The government's subsidy for scientific and technological activities reflects well the competition between local governments for innovation resources (Hu & Wang, 2020)[18]. Since manufacturing is the main engine of economic growth, and corporate income tax is closely related to manufacturing (Fu & Geng, 2011; Zhao et al., 2020)[19-20], the ratio of corporate income tax to GDP is selected as the tax competition(TA). About control variables, the industrial structure *(IN)*, economic openness *(TR)* and foreign investment *(FD)* are measured by the proportion of large and medium-sized industrial enterprises' output, the proportion of total import and export in GDP, and the proportion of total foreign investment in GDP respectively.

The data used in this article is the panel data of 30 provinces (except Tibet) from 2009 to 2018 in China. The data mainly comes from the "China Statistical Yearbook", the "China Fiscal and Taxation Database" of EPS and the statistical yearbooks of various provinces. Very few missing data are repaired by weighted moving average method.

Table 1: The effect of fiscal competition innovative factor market's distortion

	Labor			**Capital**		
	（1）	（2）	（3）	（4）	（5）	（6）
LnEX	0.0218 （0.0198）			0.0425 （0.0531）		
LnRD		0.2186*** （0.0699）			0.3021** （0.1439）	
LnTA			0.1096* （0.0600）			0.0945* （0.0522）
LnIN	0.0964* （0.0521）	0.0812 （0.0625）	0.1211 （0.1514）	-0.1045** （0.0487）	0.6317 （0.7003）	-0.1832 （0.1665）
LnTR	-0.0635*	-0.0892	-0.0544*	-0.1416*	0.1767*	0.1035*

	（0.0347）	（0.5329）	（0.0299）	（0.0765）	（0.0950）	（0.0567）
LnFD	-0.1536* （0.0846）	-0.1314 （0.1471）	-0.1753* （0.0959）	-0.2362** （0.1100）	-0.3014*** （0.0964）	-0.2105** （0.1004）
Controlled time	yes	yes	yes	yes	yes	yes
Controlled region	yes	yes	yes	yes	yes	yes
observations	300	300	300	300	300	300
R^2	0.4213	0.3393	0.4039	0.4155	0.5092	0.3786

Note: Before ( ) are estimated values of parameters. Stationary standard errors with heteroscedasticity adjusted are in ( ). ***, **, * denote 1%, 5% and 10% significance levels respectively.

Fiscal competition methods such as fiscal expenditures, technological subsidies, tax competition, are the core variables of this article. Column (1)—(3) of table 1 show the estimated effects of innovation labor factors market's distortion of innovative, columns (4)—(6) report the estimated results of innovation capital factor market's distortions. In the process of estimation, fiscal competition methods such as fiscal expenditures, technological subsidies, and tax competition are put into the model separately while controlling other factors. It is convenient to classify and verify the different effects of various fiscal competition methods. The estimated results in Table 1 show that various fiscal competitions have indeed had an impact on innovation factor market's distortion. These conclusions indicate that the intervention of local governments has changed the factor's allocation in market. However, the impact is different in its significance, direction and magnitude. Local governments need control the strength and direction of fiscal competition methods to alleviate innovation factor market's distortion.

Fiscal expenditure *(EX)*, as a basic means for local governments to intervene in economic development, has an impact on innovation factor market's distortion, but it is not statistically significant. Fiscal expenditure, at a broader perspective rather than the specific innovation perspective, means the covering of the whole national economy and the controlling of all factors in society. This intervention will stimulate input, affect the marginal output, and impact factor prices' formation. However, compared with general factors, the allocation of innovation factors which emphasize higher-quality labor and innovation-oriented capital, should be more affected by government interventions in innovation projects, companies and institutions, etc. This can be confirmed by the following estimation on technology subsidies. Therefore, fiscal expenditure has not shown a significant acceleration in innovation factor market's distortion.

Technology subsidies *(RD)* have an accelerating effect on the innovation factor market's distortion, including labor and capital factors. The estimated coefficient is significantly positive at the 5% level. Although Local governments' support for regional innovation activities played a certain role in reducing innovation factor market's distortion by promoting the flow of innovation factors among region, industries and enterprises. But restricted by government functions, evaluation and public project selection mechanisms, there are often repeated subsidies, excessive subsidies, and low subsidy performance when local governments provide technology subsidies. These selective government technology subsidies restrict the role of the market mechanism, and cause serious distortions in innovation factor market. For example, some industrie with low innovation performance can get more technology subsidies (Yan & Huang, 2020)[21]. In strategic emerging industries, government financial subsidies not only significantly improve production performance, but also exacerbate overcapacity (Li & Yang, 2019)[22]. It is necessary for local governments to reasonably maintain the intensity and direction of technological subsidies, and strengthen the performance evaluation of technological subsidies.

Tax competition *(TA)* also causes price distortions which affects the market allocation of innovation factors. The estimated coefficient of tax competition is significantly positive at the level of 1%. With an increase in tax competition by 1%, the distortion degree of innovation factors market will increase by about 0.1% on average. On the one hand, the increase in corporate taxation has increased the burden of companies, and companies will shift the tax burden. This will cause product price distortions which will lead the allocation of factors deviate from the optimal. On the other hand, more corporate taxation, more regional fiscal revenue. This will change the ability of local governments intervening market economy. Moreover, the increase in regional fiscal revenue means more technology subsidies, which has accordingly accelerated innovation factor market's distortion. The conclusion also shows that the impact of tax competition on innovation factor market's distortion is significantly smaller than that of technological subsidies.

The estimation of the control variables indicate the effect of industrial structure *(IN)* on innovation factor market's distortion are uncertain, and economic openness *(TR)* and foreign investment *(FD)* are significantly negative. The coefficient of industrial structure on innovation labor is positive and that of innovation capital is negative, but neither is statistically significant. The increase in the proportion of industrial enterprises, especially technology-intensive and high-end manufacturing enterprises, should have contributed to the rational allocation of invation labor. But the results have given an opposite conclusion because the repeated construction of these industries has led to overcapacity and similar industrial structure in this region, which has increased the degree of innovation labor mismatch.

Main Conclusion and Recommendation

How to allocate innovation factors reasonably and effectively? Is there any innovation factor market's distortion now? What role does government's fiscal competition play in these? These are some important issues during market economic system reform, improving efficiency of innovative production, and building an innovation country in China. Focus on innovation factors, this article uses the trans-logarithmic production function to calculate and compare the degree of innovation labor and capital factor markets' distortion, then explores the impact of local government fiscal competition on innovation factor market's distortion from theoretical and empirical perspective. The main conclusions include:

(1) During this period, innovation labor and capital factor markets all had negative distortion which is higher than general factor market, and the distortion degree of innovation labor factor market is lower than that of innovation capital factor market. Unlike most previous literatures on general factor market that believe there is positive distortion, this article shows a negative distortion of innovation labor factor market. Although labor input is same, innovation labor will obtain higher marginal output, and the wage gap between innovation labor and general labor cannot be fully reflected due to wage rigidity. As a result, the estimated distortion degree of innovation labor factor market is significantly greater than 1.

(2) The regression model results show that fiscal competition has indeed changed allocation of innovation factor in different extent: technological subsidies has a more significant acceleration effect on innovation factor market's distortion, and the effect of fiscal expenditure is not significant. The local government's competition for innovation factors cause a deviation between marginal output and price of factor by changing inflow and price formation of innovation factor. Selective technology subsidies, repeated subsidies, and low subsidy performance of governments may induce serious distortion in innovation factor market. Technological subsidies, compared with tax competition, causes a higher misallocation of innovation factor through government's artificial guidance.

In order to correct the price formation mechanism, alleviate the degree of market's distortion, promote the agglomeration and innovation performance, it is necessary to dialectically handle the relationship between the

market and the government. When local governments perform factor allocation functions of factor, the form and intensity fiscal competition should be reasonably selected. These main methods include:

(1) Accelerate marketization of innovation factor. Innovation labor and capital factors are the core of regional innovation capabilities. Whether the price formation is reasonable, and the allocation among industry, enterprise, and region is optimal, have played an important role in innovation performance improvement of region and country. Local governments shouldn't excessively interven and control over innovation projects, enterprise and institutions. It will increase the rent-seeking cost of innovation activities and induce distortion in innovation factor market, if local governments designate technological subsidies to specific group or individual.

(2) Improve the public service mechanism of local governments supporting innovation activities. On the basis of market prices, market competition, supply and demand, local governments should establish a public service mechanisms to support innovative activities. Local governments should transfer to service function. This public service mechanism should take market price of innovation factor as a reliable signal to create a sound institutional environment by alleviating flow and promotion barriers for talent, and broadening the capital channels for innovation entities. Technological subsidis are cost-calculated according to market prices and the output performance of innovation entities is evaluated, before local governments give support to innovation activities.

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