

# Optimization and Design of Regional Innovation Resources Allocation Strategy in China

—Based on the Measurement of Innovative Polarization Contribution

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**Abstract**—This paper uses the factor analysis method to measure the degree of polarization of innovation resources in China. The results show that between 1997 and 2016, the degree of polarization of innovation resources in China has generally shown an upward trend, that is, the flow of regional innovation resources is characterized by a significant “Matthew effect”, causing by the defects in the operational mechanism of the current gradient transfer resource allocation method in China. Therefore, in order to alleviate the unbalanced dilemma of regional innovation resources allocation in China, China urgently needs to establish a regional innovation resource symmetry compensation mechanism based on the contribution of innovation polarization, that is, give priority to the allocation of innovative resources to the Inner Mongolia Autonomous Region, Jilin Province, Ningxia Hui Autonomous Region and Xinjiang Uygur Autonomous Region, thus alleviating the reality of insufficient innovation resources and better helping its economy take off through fiscal and tax subsidies, industrial policy tilt, etc..

**Keywords**—resource allocation; regional coordinated development; innovative resources; innovation polarization

## I. INTRODUCTION

The problem of resource allocation has always been the essence and core of economic research. Faced with the limited constraints of scarce resources, reasonable resource integration, collocation and reorganization can not only fully release the production potential of the elements, but also effectively improve the economic efficiency. The classic Soro growth model has revealed to us that the input of innovation factors has a positive contribution to economic growth, and that backward regions need to have more innovative resources and optimize their allocation in order to achieve economic catch-up. However, at present, the heterogeneous distribution and polarization trend of regional innovation resource endowments in China are becoming more and more intense. Taking R&D expenditure intensity index (ratio of R&D expenditure to regional GDP) as an example, in 2016, the R&D expenditure intensity of Guangdong Province has reached 13%, while Xinjiang is only 0.59%. Correspondingly, the GDP of Guangdong Province in 2016 has exceeded 8.09 trillion Yuan,

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while there is only 0.96 trillion Yuan in Xinjiang. It can be seen that the unbalanced allocation of regional innovation resources is seriously restricting the release of the late-developing potential of the backward regions, aggravating the “Matthew effect” of the regional economy, and even deepening the resolution of the main contradictions in our society. Therefore, it is of great significance to scientifically design and implement the strategy of optimizing the allocation of innovative resources for the coordinated development of China's regional economy.

## II. THE MEASUREMENT OF THE POLARIZATION OF INNOVATION RESOURCES IN CHINA AND THE OPERATIONAL DEFECTS OF THE CURRENT INNOVATION RESOURCE ALLOCATION MECHANISM

### A. Estimation of the Polarization of Innovation Resources in China

The TW economic index created by Hong Kong scholar Tsui Kai-yuen is widely used to measure the degree of polarization of regional innovation. Its specific calculation formula is as follows:

$$TW_{kt} = \frac{\theta}{\sum_{i=1}^{N_{kt}} P_{kti}} \sum_{i=1}^{N_{kt}} P_{kti} \left| \frac{y_{kti} - m_{kt}}{m_{kt}} \right|^r \quad (1)$$

Among them,  $TW_{kt}$  is the innovation polarization of the  $k$ th region in the  $t$ th period;  $y_{kti}$  the number of innovative comprehensive scores  $I_{kti}$ / patent authorizations  $P_{kti}$  for the  $i$ -th sample of the region  $k$  in the  $t$ -year;  $N_{kt}$  is the number of samples for region  $k$  in the  $t$ -year;  $m_{kt}$  is the median of  $y_{kti}$  for all samples of region  $k$  during the  $t$ -year;  $P_{kti}$  is the number of patent grants for the area  $i$  in the  $i$ -th sample area of the  $t$ -year;  $\theta$  and  $r$  are constant coefficients between 0 and 1. In view of the intention of this paper to measure the degree of polarization of innovation resources in China, the value of  $k$  is 1. Due to the incomplete statistics of Tibet's technological innovation data,  $N_{kt}$  is 30 that is, 30 provinces and cities in China. Meantime, since innovation resources are a comprehensive concept, it not only includes patented technology, but also covers many factors such as R&D talents, high-end equipment, R&D investment and supporting incentive policies. Therefore, in order to more comprehensively and accurately measure the degree of

polarization of China's innovation resources, this paper will refer to the evaluation index system constructed by Bai Jia (2012) and use the factor analysis method to measure the comprehensive value of regional technological innovation capability in China based on the four dimensions of economic environment, innovation environment, innovation resource

input and innovation achievement output to obtain the  $y_{kti}$  values of 30 provinces and cities in China from 1997 to 2016<sup>[1]</sup>. The specific evaluation indicators are shown in the following TABLE.

TABLE I. EVALUATION SYSTEM OF REGIONAL TECHNOLOGICAL INNOVATION CAPABILITIES

Economic environment	GDP per capita (yuan/person)
	Household consumption level (yuan)
Innovative environment	The proportion of the population above junior college and above
	Total post and telecommunications business (100 million yuan)
	Education funding (100 million yuan)
Innovation resources investment	R&D personnel at the time of the full volume (person / year)
	R&D expenditure internal expenditure (100 million yuan)
	The proportion of government fiscal technology expenditure to local fiscal expenditure
Innovative resource output	High-tech market turnover (100 million yuan)
	Number of patent grants (items)
	High-tech industry main business income (100 million yuan)

The above data are from the China Science and Technology Statistical Yearbook, the Regional Statistical Yearbook and the China Urban Statistical Yearbook from 1998 to 2017. In summary, the innovation polarization level of China from 1997 to 2016 is as follows:

It can be seen from the TABLE that the degree of polarization of innovation resources in China has generally

shown an upward trend, which was only 0.591 in 1997, and reached a peak of 0.767 in 2010, and then slightly dropped back to 0.701 in 2016. This means that along with the deepening development of the regional economy, the trend of China's innovation resources gathering in specific regions is becoming more and more obvious, and the distribution of innovation resources among regions is becoming more and more imbalanced.

TABLE II. CHINA'S REGIONAL INNOVATION POLARIZATION INDEX FROM 1997 TO 2016

Years	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
TW index	0.592	0.586	0.579	0.494	0.562	0.598	0.591	0.658	0.691	0.691
Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
TW index	0.737	0.721	0.736	0.767	0.722	0.747	0.727	0.692	0.702	0.702

**B. Operational Defects of China's Current Innovation Resource Allocation Mechanism**

Since the reform and opening up, China has always adhered to the principle of "efficiency first and fairness" and achieved leap-forward progress in technological innovation. This resource allocation concept follows the essence of the traditional resource allocation theory -- the gradient transfer theory. However, in the course of China's real regional economic development, there is often a dilemma of "efficiency first and fair lag", and the diffusion effect of the accumulation of innovative resources in developed regions appears to be minimal. For example, according to the analysis of the results of the fifth and sixth censuses, the National Development and Reform Commission showed that the average annual population outflow of the Northeast region was as high as 200,000, and most of them were high-level talents. That is to say, after the innovation resources are transferred to the high-gradient areas through the low-gradient areas, the resources are solidified, and the backward areas are gradually losing effective means to attract the return of innovative

resources. In the backward areas, there are usually the drawbacks of the lag between the hard environment and the soft environment. The innovation factor cannot form a benign resource allocation under the existing system, that is, the lagging of the system construction will seriously drag down the allocation efficiency of the innovation elements and restrain the release of the backward advantage of the backward areas. Therefore, limited innovation resources continue to flow to high-gradient regions under the polarization of innovation. In the long run, this will not only directly lead to the "hollowization" of innovative resources in the backward regions (Zhejiang, 2009), but will also greatly weaken its technical capacity<sup>[2]</sup>.

### III. OPTIMIZATION AND DESIGN OF REGIONAL INNOVATION RESOURCES ALLOCATION STRATEGY IN CHINA—BASED ON THE MEASUREMENT OF INNOVATIVE POLARIZATION CONTRIBUTION

#### A. Design Logic of China's Regional Innovation Resource Allocation Strategy

In view of the fact that this paper has proved that the balance distribution of China's regional innovation resources cannot be realized under the traditional resource allocation theory (gradient transfer theory), and the hollowing out of innovation resources will make the main contradictions in China's society more irreconcilable, the coordination of regional innovation resources in China urgently requires a new resource allocation method. More importantly, the innovative resource optimization configuration design scheme that promotes the release of advantages in backward areas needs to closely rely on the principle of "considering fairness" and strictly follows the evolutionary characteristics and laws of regional innovation polarization. Therefore, this paper will optimize the innovation resource allocation contradiction in China from the construction of symmetry compensation mechanism in backward areas that is, based on the polarization contribution of innovation resources. We will determine the implementation order of symmetry compensation policies by measuring the urban contribution of regional innovation polarization effects, thus balancing the unbalanced reality of innovation resources among regions. In this paper, with reference to the design of Wang Chengcheng, Li Hongmei, and Wei Shouming (2017), the following indicators are selected to interpret the urban contribution of regional innovation polarization effects<sup>[3]</sup>.

$$C = \frac{\sum_{i=1}^n N(i) \sum_{i=1}^{n+1} S(i) \left| \frac{q(i)-m}{m} \right|^r}{\sum_{i=1}^{n+1} N(i) \sum_{i=1}^n S(i) \left| \frac{q(i)-m'}{m'} \right|^r} \quad (2)$$

Among them, C is the urban contribution of the regional polarization effect, n is the number of cities, s(i) is the patent grant of the i-th city in a province, N is the patent grant amount of the i-th city, m is the median value of the comprehensive value I/patent authorization of all cities in a province, and m' is the median value of the integrated value I/patent authorization for other cities in a province that does not include the city. q(i) is the i-th city innovation comprehensive value I/patent authorization amount in a province. If the contribution is greater than 1, the city will promote the regional innovation polarization effect, and vice versa. Based on this model, we can analyze the distribution characteristics of cities with different polarization contributions in the spatial domain, and formulate corresponding innovation resource symmetry compensation policies and feedback high polarization contribution regions according to the contribution degree. It can be seen that the optimal allocation of innovative resources in the region is more focused on scientifically quantifying the implementation of government science and technology support policies. It plays an important role in promoting the implementation and deep implementation of relevant policies. It can be seen that the optimal allocation of innovative resources in the region is more focused on scientifically quantifying the implementation of government science and technology support policies. It plays an important role in promoting the implementation and deep implementation of relevant policies.

#### B. Estimation of Polarization Contribution of Regional Innovation Resources in China

In order to better observe the polarization contribution of China's regional innovation resources in the new era, this paper measure the polarization contribution of innovation resources in China's 30 provinces and cities (excluding Tibet) from 2012 to 2016 based on the formula of polarization contribution of innovation resources (2), as shown in TABLE III below.

Based on the calculation results, it can be found that A total of 18 provinces and cities have contributed more than 1 to the polarization of China's innovation resources. They are Tianjin, Shanxi, Inner Mongolia Autonomous Region, Liaoning Province, Jilin Province, Shanghai, Jiangsu Province, Zhejiang Province, Anhui Province, Shandong Province, Guangdong Province, Hainan Province, Sichuan Province, Yunnan Province, Gansu Province, Qinghai Province, Ningxia Hui Autonomous Region and Xinjiang Uygur Autonomous Region. This means that these regions have a positive effect on the agglomeration of China's innovation resources, and compensation should be given priority in the process of compensation for innovation resources.

By ranking the absolute values of regional innovation polarization contribution, Jiangsu, Zhejiang and Guangdong provinces are among the top three economically developed regions, followed by Inner Mongolia Autonomous Region, Jilin Province, Ningxia Hui Autonomous Region and Xinjiang Uygur Autonomous Region. This calculation result has a good fit with the theoretical analysis of this paper. Economically developed regions, due to their sufficient factor endowments and superior resource allocation capabilities, can spontaneously form innovative resource agglomerations based on market mechanisms, thereby stimulating local economic take-off. The dilemma of a large number of innovative resources and the weakening of economic development potential exists in economically underdeveloped areas due to the disadvantages of climate, geography, resource stocks and supporting policies.

#### IV. CONCLUSION AND COUNTERMEASURES

In the new era, in order to resolve the main contradictions in our society, the optimization and reconstruction of innovative resource allocation methods need to follow the principle of "considering fairness". Under this logic, the design of the innovative resource optimization configuration scheme needs to closely focus on the "symmetry compensation" feature and follow the measurement results of the innovation polarization contribution. At the same time, under the influence of the market mechanism, the flow of innovation factors needs to fully follow the principle of demand guidance, and the backward regions with comparative advantages will be preferentially affected by the diffusion of innovation polarization. When the market regulates the existence of blind spots or failures, the government's moderate intervention is also extremely necessary. For example, in the process of constructing a compensation mechanism based on the contribution of innovation resources, determining the fiscal and tax compensation amount and industrial transfer policy of the net export of innovative resources requires the government to use quantitative analysis methods for scientific calculation. In summary, the optimal allocation of regional innovation

resources based on the contribution of innovation polarization can help to correct the shortcomings of China's "efficiency first" resource allocation principle on the one hand and make for highlighting the concept of "considering fairness" in the

process of resolving major social contradictions, which will better help the smooth resolution of major social contradictions in our country in the new era.

TABLE III. POLARIZATION CONTRIBUTION OF INNOVATION RESOURCES IN 2012-2016 IN 30 PROVINCES AND CITIES IN CHINA (EXCLUDING TIBET)

Area	2016	2015	2014	2013	2012	Average value
Beijing	0.999435	1.007527	0.99996	0.99228	0.989486	0.997737
Tianjin	1.001234	1.014615	1.012224	1.00135	1.001137	<b>1.006112</b>
Hebei Province	0.992937	0.993034	0.987176	0.991787	0.990609	0.991109
Shanxi Province	1.009698	1.015723	1.009421	1.002588	0.997986	<b>1.007083</b>
Inner Mongolia Autonomous Region	1.015129	1.020184	1.014105	1.007899	1.005892	<b>1.012642</b>
Liaoning Province	1.005537	1.015329	1.012166	0.999386	0.981209	<b>1.002726</b>
Jilin Province	1.011912	1.017352	1.012294	1.006617	1.003482	<b>1.010331</b>
Heilongjiang Province	1.006392	1.00296	0.995316	0.992021	0.989786	0.997295
Shanghai	1.011311	1.017638	1.016517	0.998425	0.97886	<b>1.00455</b>
Jiangsu Province	1.026182	1.025035	1.045618	1.06416	1.080633	<b>1.048326</b>
Zhejiang Province	1.023744	1.014494	1.014896	1.021433	1.024859	<b>1.019885</b>
Anhui Province	1.004688	1.002357	1.000829	1.003137	1.004758	<b>1.003154</b>
Fujian Province	0.996142	0.988322	0.979859	0.98848	0.989317	0.988424
Jiangxi Province	0.995405	0.989929	0.997626	1.001402	0.998387	0.99655
Shandong Province	0.998705	1.000893	1.000646	1.002151	1.004499	<b>1.001379</b>
Henan Province	0.997804	0.996	0.993998	0.996737	0.998924	0.996693
Hubei Province	0.984952	0.979855	0.976595	0.98764	0.997285	0.985265
Hunan Province	0.99245	0.990448	0.99037	0.994182	0.995969	0.992684
Guangdong Province	1.02427	1.011965	1.013437	1.00717	1.013899	<b>1.014148</b>
Guangxi Zhuang Autonomous Region	0.998567	0.995796	0.992408	0.991541	0.997808	0.995224
Hainan Province	1.011357	1.016105	1.010091	1.004823	1.003123	<b>1.0091</b>
Chongqing	0.986821	0.995971	0.99062	0.995564	0.998209	0.993437
Sichuan Province	1.004232	1.000973	1.001502	1.001378	1.003787	<b>1.002374</b>
Guizhou Province	1.003282	1.01021	0.99168	0.995847	0.998137	0.999831
Yunnan Province	1.00491	1.011296	1.005862	1.002008	0.999422	<b>1.0047</b>
Shaanxi Province	0.988487	0.988637	0.988475	0.993566	0.995559	0.990945
Gansu province	1.005686	1.012919	1.00713	1.001222	1.000154	<b>1.005422</b>
Qinghai Province	1.010894	1.015555	1.010034	1.004305	1.002465	<b>1.00865</b>
Ningxia Hui Autonomous Region	1.012736	1.017525	1.011163	1.005538	1.003399	<b>1.010072</b>
Xinjiang	1.011134	1.016097	1.011223	1.005606	1.003294	<b>1.009471</b>

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