Comparison and Effect Analysis of Regional Technology Innovation Policies

Fuqin Zhang[a], Yue Wang[b, *]

Business School, University of Jinan, Jinan, China

[a]zhfq17@163.com, [b]se_wangy@ujn.edu.cn

*Corresponding author

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Abstract: This paper conducts cluster analysis according to the number of policy, and establishes panel regression to analyse influence and region difference of supply policies, environmental policies demand policies on technological innovation. The research results show that demand policies has the most significant impact on technological innovation, especially the first and second provinces. Environmental policies have a significant impact on the third and fourth types of provinces where technological innovation needs to be improved. Supply policies only have an impact on the fourth type of province. Technological innovation developed provinces are mainly driven by demand policies, supplemented by environmental policies, and areas with backward technological innovations need supply policies.

1. Introduction

Innovation is the source and inexhaustible driving force for economic and social development. It is an important choice for improving social productivity and international competitiveness. It is increasingly favored and valued by the world [1]. The relationship between regional technological innovation activities and social and economic development is becoming increasingly close. How to promote regional technological innovation has become one of the topics of importance in various regions. Due to the lack of effective supervision in the process of policy formulation and implementation, the evaluation of technological innovation policy has become the focus of scholars [2].

Among which the research by Rothwell et al. is the most representative. They believe that the technology innovation policy tool is a comprehensive policy system and an effective means for the government to intervene in technological innovation activities, and play a role in the whole process of technological innovation [3]. Fratesi proposes to use dynamic evolution simulation methods to represent knowledge flows within and between regions [4]. Mika discusses recent developments from the perspective of regional competitiveness and cohesion [5]. Laredo believes that the more procedural policies, the greater the need for local policies [6]. Tang Shiguo first discussed the technology innovation policy [7]. Fan Xia and Wu Jin systematically combed the texts of China's current decentralized common technology innovation policies using policy content analysis methods [8]. Based on the theoretical basis of the innovation policy, Zhao Lixiao constructed an evaluation standard system for innovation policy evaluation, and divided the policy process into three aspects: policy formulation, policy implementation and policy effectiveness [9]. Huang Cui et al. used policy literature to study the changes in the focus of scientific and technological innovation policies in different historical periods and the overall network characteristics of government-sector cooperation, local network features and single-node subnet features [10].

The value of this paper lies in the fact that on the one hand, textual analysis is used to classify technological innovation policies and cluster analysis. On the other hand, the measurement model is used to test the effect of national technological innovation policies, so as to provide reference value for the future development of technological innovation policies, with a view to promoting the development of regional technological innovation research.

2. Research design

2.1 Policy text selection

This paper mainly studies the internal structure and evolution trend of China's current technological innovation policies, and the differences between different regions and tests the effects. Therefore, the technical innovation policy of China from January 2009 to May 2018 was selected as the research object. A total of 1912 technical innovation policies were finally included in the research sample. The specific data of each province are shown in the following table.

Table 1. Sample of Technology Innovation Policy

05	Numbers	Province	Numbers	Province	Numbers	Province	Numbers
Beijing	21	Shanghai	57	Hunan	45	Shaanxi	62
Tianjin	38	Jiangsu	105	Hubei	77	Gansu	89
Hebei	63	Zhejiang	90	Guangdong	93	Qinghai	72
Shanxi	62	Anhui	80	Guangxi	26	Ningxia	61
Neimeng	59	Fujian	70	Sichuan	32	Xinjiang	44
Liaoning	69	Jiangxi	57	Guizhou	35	Hainan	36
Jilin	75	Shandong	108	Yunnan	76	Chongqing	56
Heilongjiang	57	Henan	85	Xizang	12		

2.2 Policy Classification

This paper analyzes the technical innovation policy research samples of each province, based on the classification ideas of Rothwell and Ziegfeld’s classic innovation policy, and divides the technology innovation policy into three basic types: supply, environment and demand. Supply policies include financial support, personnel training, service provision, project support, and infrastructure construction, which mainly play a role in promoting technological innovation. Environmental policies mainly include financial support, administrative measures, regulation, tax incentives, and strategic planning, which have an impact on technological innovation. Demand policies mainly include market cultivation, foreign trade, and government procurement, which play a role in the development of technological innovation.

3. Comparison of regional technological innovation policies

3.1 Distribution of Regional Technology Innovation Policies in China

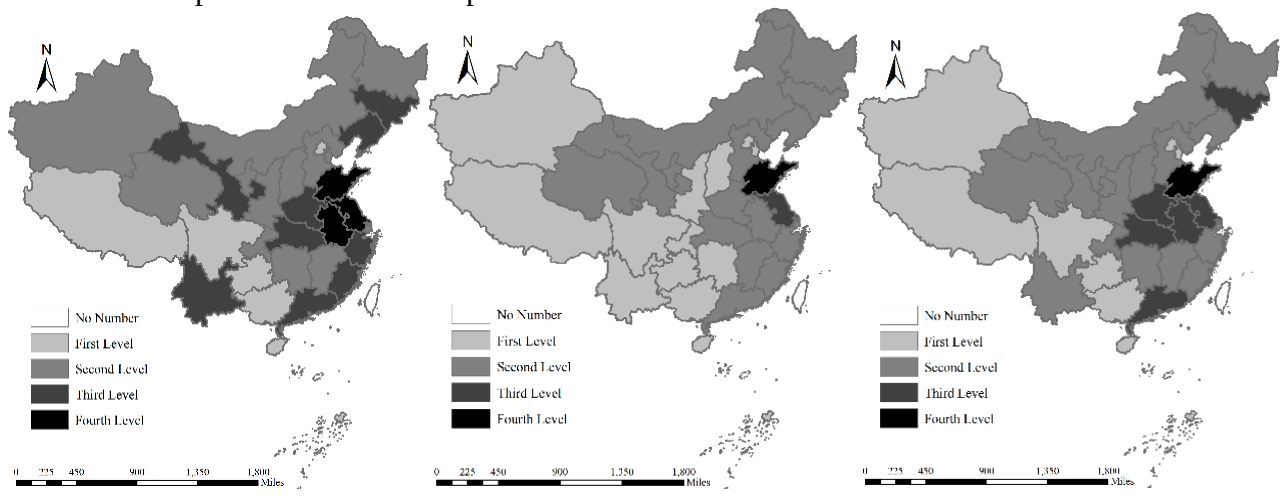
In order to analyse the distribution of China's technological innovation policies, the sample was classified according to supply, environment and demand. The specific quantification method is that if a field appears in the policy issued each year, the field is assigned a value of 1, otherwise 0, and the value of each policy type is quantized as the sum of all field values under the type. The three types of policies will be processed according to the ratio of 5:5:3, and the specific classification table of regional technological innovation policies will be obtained.

On the whole, China's regional technology innovation policy support has its similarities. The internal structure of the policy is roughly the same, with the support of the supply policies being the strongest, the support of the environmental policies being the second, and the support of the demand policies being the least. By calculating the proportion of technological innovation policies in 31 provinces in China, it can be seen that supply policies account for the highest proportion, accounting for 40.5% of all technological innovation policies, followed by environmental policies, accounting for 32.9% of technological innovation policies. Demand policies accounted for the lowest proportion, accounting for 26.6% of technological innovation policies. To a certain extent, this shows that China's technological innovation mainly relies on supply policies.

Table 2. Classification of regional technological innovation policies

Province	Supply policies	Environmental policies	Demand policies	Province	Supply policies	Environmental policies	Demand policies
beijing	19	16	13	hunan	40	34	27
tianjin	35	28	27	hubei	70	62	44
hebei	56	46	39	guangdong	74	65	54
shanxi	51	41	30	guangxi	23	17	16
neimeng	54	47	40	sichuan	28	23	14
liaoning	50	32	30	guizhou	27	24	18
jilin	51	29	30	yunnan	61	38	26
heilongjiang	53	48	33	xizang	16	11	9
shanghai	53	44	42	shaanxi	53	38	29
jiangsu	91	78	62	gansu	61	34	31
zhejiang	78	60	57	qinghai	58	45	35
anhui	65	38	33	ningxia	54	43	33
fujian	65	54	41	xinjiang	36	27	23
jiangxi	52	46	39	hainan	28	23	16
shandong	74	49	43	chongqing	42	33	23
henan	78	62	47				

In order to better compare regional technological innovation policies, this paper will conduct regional comparative studies in accordance with the three types of policies: supply policies, environmental policies and demand policies.



(a) Supply policies (c) Demand policies (b) Environmental policies

Figure 1. Distribution of three types of policy areas.

It can be clearly seen from Figure 1 that the three types of policies in Shandong are the most promulgated, which indicates that the Shandong provincial government attaches great importance to the development of technological innovation. Jiangsu and Anhui provinces have the largest number of supply policies and environmental policies, and they are higher than demand policies. This shows that the governments of Jiangsu and Anhui provinces are promoting technological innovation and paying more attention to supply policies. Promote and influence the environmental policies. The number of supply policies and environmental policies in Yunnan, Fujian, Shaanxi, Shanxi, and Hubei provinces is also higher than demand policies. In general, China's regional technological innovation policy pays more attention to the promotion of supply policies and the impact of environmental policies.

3.2 Regional Technology Innovation Policy Cluster Analysis

Based on the panel data, this paper clusters three types of technological innovation policies, and

combines the clustering pedigree map with the actual situation to divide the 31 provinces in China into four categories according to the support of technological innovation policy.

Table 3. Clustering analysis results of China's technology innovation policy

Category	Province
First	jiangsu
Second	hubei, henan, guangdong, zhejiang, fujian, shandong
Third	shaanxi, shanxi, jilin, liaoning, yunnan, anhui, gansu, heilongjiang, ningxia, qinghai, shanghai, hebei, jiangxi, neimeng
Fourth	chongqing, hunan, xinjiang, tianjin, xizang, beijing, guangxi, guizhou, sichuan, hainan

The first type of province is jiangsu, in which the number of supply policies, environmental policies, and demand policies all in the forefront of all provinces, and the number of supply policies, environmental policies, and demand policies are decreasing in turn, and the proportion of supply policies most. Moreover, compared with other provinces, these provinces have the largest number of technological innovation policies, which indicates that such provinces are focused on promoting the development of technological innovation through government policies. Correspondingly, the technological innovation water of such provinces is at the forefront of the country, which also proves that the technology innovation policy has played a very important guiding role.

The second type of provinces are Hubei, Henan, Guangdong, Zhejiang, Fujian, and Shandong. The number of supply policies, environmental policies, and demand policies in such provinces is second only to the first type of provinces, indicating that the relevant governments in such provinces attach great importance to creating technological innovation activities by increasing the supply of relevant elements of technological innovation. A good policy environment to promote effective investment in the province's superior resources to promote technological innovation in such provinces.

The third type of provinces are shaanxi, shanxi, jilin, Liaoning, yunnan, anhui, gansu, heilongjiang, ningxia, qinghai, shanghai, hebei, jiangxi, and neimeng. The number of supply policies, environmental policies, and demand policies is relatively balanced, but far lower than the first-class. Except for Shanghai and Hebei, most of these provinces belong to areas where the level of technological innovation in the central and western regions needs to be improved. Insufficient investment in innovation and low emphasis on technological innovation. Therefore, while improving economy, they should be accompanied by corresponding policies to promote technological innovation.

The fourth type of provinces are Chongqing, Hunan, xinjiang, Tianjin, Xizang, Beijing, guangxi, Huizhou, Sichuan, and Hainan. The technological innovation policies are among the lowest in all provinces. This is divided into two categories. The first is economically developed areas headed by Beijing and Tianjin. The level of technological innovation ranks among the top. The development of technological innovation no longer depends on the introduction of relevant policies. The other is economically underdeveloped areas such as xinjiang and Xizang. The level of technological innovation is backward, and the emphasis on technological innovation needs to be improved.

4. Regional technology innovation policy effectiveness test

According to the clustering analysis results of regional technological innovation policies, the effects of technological innovation policies were tested in four provinces, and the differences in the role of technological innovation policies in different provinces were analysed.

4.1 Variable Selection and Model Setting

The patent application quantity (PATENT) was selected as the dependent variable to measure regional technological innovation output, and the supply policies (GJ), environmental policies (HJ) and demand policies (XQ) policies were used as independent variables. The technological

innovation output of each province is affected by other factors. Based on the existing research of domestic and foreign scholars, this paper introduces R&D personnel (RDP) and the internal expenditure of R&D (RDE) of industrial enterprises above designated size in all regions as control variables.

Based on the panel data of 8 years (2009-2017), this paper examines the effects of regional technology innovation policies. In order to eliminate the heteroscedasticity problem in the data, the variables need to be processed logarithmically. The specific measurement model is as follows.

$$\ln PATENT_{i,t} = \alpha \ln GJ_{i,t} + \beta \ln HJ_{i,t} + \gamma \ln XQ_{i,t} + \delta \ln RDP_{i,t} + \theta \ln RDE_{i,t} + \varepsilon_i + \mu_{i,t} \quad (1)$$

Where $i = 1, 2, \cdots, N$ represents different provinces, $t = 1, 2, \cdots, N$ indicates different years, $\mu_{i,t}$ is a random error term to ensure the rationality of the measurement model. ε_i Is a random variable. α、β、γ、δ、θ Indicates the regression coefficient.

4.2 Unit root test and cointegration test

In order to avoid the phenomenon of "pseudo-regression", it is necessary to perform unit root test on each variable. In this paper, LLC and Fisher-ADF are used. The test results and stationarity judgment of each variable are shown in Table 4.

Table 4. Panel data unit root test results

Variables	LLC	Fisher-ADF	Test results
lnPATENT	-10.8790 (0.0000)	80.5934 (0.0564)	Smooth
lnGJ	-29.7238 (0.0000)	174.432 (0.0000)	Smooth
lnHJ	-24.6243 (0.0000)	175.085 (0.0000)	Smooth
lnXQ	-32.2010 (0.0000)	162.733 (0.0000)	Smooth
lnRDP	-16.6918 (0.0000)	101.095 (0.0013)	Smooth
lnRDE	-79.5092 (0.0000)	125.019 (0.0000)	Smooth

The results in Table 4 show that the P values of the test results of the five variables are less than 0.01, and the P value of lnPATENT is less than 0.1, both of which pass the unit root tests. Therefore, the six variable sequences are stationary sequences and all are I (0) sequences.

The panel data can be co-integrated after passing the stationarity test to ensure a long-term equilibrium relationship between the variables of the panel data model. From the unit root test results, it can be known that the six variables are I (0) sequences, so the cointegration test can be performed. In this paper, Kao and Pedroni are used to perform cointegration test. If they pass the test, it is considered that there is a long-term cointegration relationship among the variables. The results show that the P values of the Kao and the Pedroni are significantly less than 0.01. It is considered that there is a long-term cointegration between the six variables, and further regression analysis can be performed.

Table 5. Kao test and Pedroni test results

Methods	Hypothesis	Statistics	Results	P-value
Kao	H0: ρ=1	ADF	-4.488559	0.0000
Pedroni	H0: ρ=1	Panel-PP	-11.04803	0.0000
	H1: ρ<1	Panel-ADF	-4.581656	0.0000
	H0: ρ=1	Group-PP	-20.10993	0.0000
	H1: ρ<1	Group-ADF	-2.990814	0.0000

4.3 Panel regression analysis

The effects of the three types of policies on the impact of technological innovation in different types of provinces are different. To further explore the regional differences between the three types of policies on technological innovation, this paper analyzes the panel of the four types of provinces

respectively, and the analysis results are shown in Table 6.

Table 6. Effect of technological innovation policy in four provinces

Variables	lnGJ	lnHJ	lnXQ	lnRDP	lnRDE	R^2
The first			0.7274**	-0.4811	0.6121	0.9358
The second	-0.0525	-0.2650	0.3293*	-0.8964***	1.6371***	0.9761
The third	0.3453*	0.4601**	0.4820**	-0.5688**	1.2365***	0.9701
The fourth	0.6762*	0.9992**	0.2267	0.2427*	0.0642	0.9794
Note: * indicates $p < 0.1$, ** indicates $p < 0.05$, and *** indicates $p < 0.01$.						

For the first type of provinces, since only one province of Jiangsu, using stepwise multiple regression analysis, the model is the most significant when the independent variable is only lnXQ.

The results in Table 6 show that the coefficient of the demand policies in all regions are positive, indicating that demand policies will promote the growth of technological innovation. Except for the fourth type of provinces, the characteristics of lnXQ>lnHJ>lnGJ are presented, indicating that demand policies in most regions have the greatest impact on technological innovation output, followed by environmental policies, and supply policies have the least impact. Supply policies in the second and fourth provinces have a negative impact on technological innovation output, that is, increasing supply policies will inhibit the growth of technological innovation output. The three policy factors of the third type of provinces are significantly positive, indicating that the technological innovation policies in such regions have played a significant role in promoting the growth of technological innovation output.

From the results, among the four types of provinces, demand policies of the first the second type of provinces have the greatest impact on the growth of technological innovation, indicating that such provinces mainly rely on demand policies to drive the growth of technological innovation output. The environmental and demand policies of the third type of provinces have significant impacts on technological innovation, indicating that the technological innovation output of such provinces mainly depends on the influence of environmental policies and demand policies. The influence of the fourth provinces' supply policies and environmental policies is significant, indicating that the technological innovation output of such provinces is a product of the combined effects of supply policies promotion and environmental policies. The emergence of this phenomenon is mainly due to the fact that the first and second types of provinces are mainly in areas with relatively high level of technological innovation in the east. Technological innovation has developed to a certain extent, and the promotion and influence of non-supply policies and environmental policies are no longer needed. The third type of provinces are at the intermediate level of technological innovation. Under the circumstances of demand policies, environmental policies are still needed. The level of technological innovation in the fourth type of provinces is in a backward stage (except Beijing and Tianjin), and such provinces are in urgent need of supply policies to drive the growth of technological innovation output. Beijing and Tianjin are the leading provinces in China's scientific and technological innovation level. They have China's top talents and research institutes, but they need financial support and other support policies to support their technological innovation to a higher level.

5. Conclusion

This paper analyzes the regional differences in the impact of supply policies, environmental policies and demand policies on technological innovation output by clustering the data of technological innovation policies in various provinces across the country, and then performing panel fixed-effect regression on various provinces. Analysis. The main conclusions are as follows.

(1) According to the cluster analysis, Jiangsu Province is listed as a separate category, mainly because Jiangsu ranks first in the country in terms of technological innovation level, and the total amount of technological innovation policies and supply policies, environmental policies, and

demand types. The number of policy issues is the first in the country. The second type of provinces are mainly in the eastern coastal areas, and the level of technological innovation is also the leading position in the country. The number of supply policies, environmental policies and demand policies is second only to the first type of provinces. The third type of provinces, except Shanghai and Hebei, mostly belong to the areas where the technological innovation development level of the central and western regions needs to be improved, and the innovation investment is insufficient. The fourth category of provinces except Beijing and Tianjin are all areas with backward technological innovation levels.

(2) The pulling effect of demand policies in most provinces has the greatest impact on the level of technological innovation, followed by environmental policies, and the impact of supply policies is the least. The technological innovation development of the first and the second type of provinces mainly relies on the pulling effect of demand policies. The supply, environmental and demand policies coefficients of the third-type provinces are significantly positive, but the most important ones are environmental policies and demand policies. The supply policies and environmental policies of the fourth type of province have a significant impact on technological innovation. Areas with higher levels of technological innovation are mainly driven by demand policies, and environmental policies are used to assist them. Areas with backward technological innovation levels mainly rely on supply policies and environmental policies.

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