

DID model based research on the policy effect of national independent innovative demonstration zones

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Abstract. National Independent Innovation Demonstration Zone set up as combination of regional technology innovation policy in nine areas of Beijing Zhongguancun, East Lake in Wuhan, Shanghai Zhangjiang as a national independent innovation demonstration area as a sample of policy mix to when the impact of technological innovation ability by using Difference-In-Difference model. Studies have shown that compared to after the implementation of the policy, local regional technological innovation capability has increased, and fail to carry out the policy of Chongqing, Shenyang, Beijing and Wuhan, to carry out the policy of regional technological innovation capability enhancement is more obvious;The whole society investment in fixed, population density and area of technical level of regional technology innovation in inhibition, human capital, research funding, foreign real investment and government funding support to promote the regional technology innovation, After we re-estimate the same models by the stability test and conclude the similar results.

Key words: regional technology innovation, DID model, national independent innovation demonstration zone, policy effect

1 Introduction

Since the 21st century, enterprise competition intensifies, the development environment showing a high degree of uncertainty, especially in the era of economic marketization, information technology, consumer demand diversification, adjusting the industrial structure, optimizing the economy has become the main form of economy, science and technology plays a more and more important role in the modern economic transformation, role of technological innovation in transition acted as a catalyst. It can improve the technological innovation ability of enterprises, enhance the core competitiveness of enterprises, has become the determinants for enterprises to enhance their market, the comprehensive national strength competition determinants.

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Since the first National Independent Innovation Demonstration Zone – the establishment of Zhongguancun in Beijing in March 2009, by the end of April 2016, there have been in Lake Donghu, Wuhan, Shanghai Zhangjiang hi-tech park, Tianjin Binhai, etc. 14 national independent innovation demonstration zone established. The establishment of demonstration zone is to play a role in the demonstration of independent innovation and the development of high and new technology, lead, radiation, driven the development of regional economy, how to measure the effect in the demonstration area, which the most important standard is The most important criterion is whether the demonstration zone policy can promote the regional technological innovation ability.

For the impact of regional technology innovation capability, the effect of National Independent Innovation Demonstration Zone of policy on regional innovation capability is immeasurable. Therefore, evaluate Net policy effect, adjust the policy and implementation direction, has a certain theoretical and practical significance, Research on the national independent innovation demonstration zone policy has reference value on Implementation and improvement. This article attempts to use of policy effect evaluation of the mainstream analysis method – double difference analysis method from the quantitative perspectives, analysis and compare the National Independent Innovation Demonstration Zone policy combination of the net effect analysis.

2 Literature review

Research on the technological innovation policy. The main part of the research on the efficiency of technology innovation policy; In the article, Tijssen proposed the of innovation effect principle (including the proposed the design principle of the system), including a specific, measurable, accept, and with time and change. Forster et al. proposed the use of scientific and technological achievements of the industrial income tax revenue as a measure of the efficiency of scientific research tools and supply the existing research benefits of the evaluation tool range [1].

Research on policy performance and policy effect. Wang Baoshun used the data envelopment analysis to evaluate the efficiency of China's local urban environmental governance, and empirically tested the environmental variables that affect the efficiency of fiscal expenditure [2]. Deng Li calculated and analyzed the total factor productivity of Guangdong province by using non-parametric DEA Malmquist index method, estimated from 1980 to 2004 in Guangdong Province 21 prefecture level cities total factor productivity growth, efficiency change and technological progress rate. The analysis showed that the economic growth of Guangdong was mainly driven by the increase of factor inputs [3]. Liu Qilin analyzed the sources of growth in China's energy industry productivity, technical progress, technical efficiency, difference and the change trend of empirical analysis by Malmquist DEA method, the selection of data in 1999-2010 includes 29 provinces in China, energy industry panel data [4]. The trend of total factor productivity and the key factors and convergence conditions are analyzed. Chenqiuying used the analysis method of DEA CCR model, BCC model and Malmquist index analysis of the Xiamen, Zhangzhou and Quanzhou City of science and technology policy performance to pure technical efficiency change, scale changes, total factor productivity, technical efficiency change, technical change index [5].

Research on the application of DID method. Cao Honghua et al. analyzed of the control effect of ecological agricultural policy on the point source pollution of industrial and service industries, selected the Erhai River Basin as the study area, and revealed the effect of ecological agriculture policy [6]. Wang Rongcheng et al. constructed the "mountain town" policy effect evaluation system, the policy effect of prediction and test of plateau towns [7]; Yang Shali et al. surveyed 2009 the transformation of value-added tax after the enterprise business environment from the micro level enterprises, economic benefit and the effect of

policy [8]; Zhao Luan et al. assessed the reform of rural credit cooperatives to improve the effect of financial support for agriculture policy [9]; Lin Chen et al. studied on higher education expansion policy on technology innovation efficiency effect [10].

On the long-term development of the level of regional technology, the influence of National Independent Innovation Demonstration Zone of policy of regional technological innovation capacity is far-reaching, for that reason, this article will use the DID model, nine regions of 2010-2017 Zhangjiang hi-tech park, Zhongguancun, Beijing, Shanghai, Wuhan East Lake policy area, zone and non policy area, zone technology innovation capacity index of double difference analysis, comparing the variations between the regional policy and non policy area, the impact of measure policy of regional technological innovation capacity, in-depth analysis of policy in the implementation process of influence factors and the extent of the impact.

3 Data and methods

3.1 Model setting

The analysis of Policy effect mainly include causal model and treatment effect model, causal model although is widely used, but whether causality is true causal relationship and to much extent reflect causality was still in doubt [11].

DID model (difference - in - difference model) in recent years was used in the implementation of the policy effect evaluation, the principle is according to the divided into the experimental group and the control group before and after the implementation of the policy of different performance or the implementation of the policy and without the implementation of policy effects, according to the number of changes before and after the specified index calculated the fold difference policy on the implementation of the policy in the experimental group, the net effect can be obtained. By its basic principles, the establishment of a national autonomous innovation demonstration area for the experimental group, the country did not get the national independent innovation demonstration zone as the control group.

The general model of the model is as follows:

$$Y_{i,t} = \beta_0 + \beta_1 D_{i,t} + \beta_2 T_{i,t} + \beta_3 D_{i,t} * T_{i,t} + \beta_4 X_{i,t} + \epsilon_{i,t} \quad (1)$$

The result of the individual i is $Y_{i,t}$ in the period, the group dummy variable is $D_{i,t}$, $D_{i,t} = 1$, indicate that the individual belongs to the policy value, $D_{i,t} = 0$, indicate that it belongs to the non-policy group, the period of virtual variables $T_{i,t}$, the experimental period $T_{i,t} = 1$, non-experimental group $T_{i,t} = 0$. $D_{i,t}T_{i,t}$ is effect of interastion. For the parameter β to be estimated, for random $\epsilon_{i,t}$ disturbance term. According to the purpose of use can be divided into four groups: control group before the implementation of the control group after the implementation of the policy, the policy, the implementation of the policy of the experimental group and after the implementation of the policy of the experimental group, the net impact of the policy implementation of the results β_2 , as shown in Table 1.

Table 1. Policy effect and coefficient of National Independent Innovation Demonstration Zone

	Experience group	Reference group	Difference
After the policy implementation	$\beta_0 + \beta_1 + \beta_2 + \beta_3$	$\beta_0 + \beta_1$	$\beta_2 + \beta_3$
Before the policy implementation	$\beta_0 + \beta_2$	β_0	β_2
Difference	$\beta_1 + \beta_3$	β_1	β_3

Source: Authors.

3.2 Variable selection and description

According to the double differential measurement model of thought, we must first select the experimental group and the control group, because currently has 14 national independent innovation demonstration zone of our country, excluding newly established policy no obvious effect of the demonstration zone, finally, select Zhongguancun, Beijing, Shanghai Zhangjiang and Wuhan East Lake as the experimental group, Xian, Shenzhen, Chengdu, Chongqing, Guangzhou, Shenyang as the control group.

The selected variables are: invention patents, high-tech enterprise scientific research personnel number, high-tech enterprise R & D expenditures, whole society fixed assets investment, torch plan government funding support, the actual foreign investment, population density and GDP.

Specific models are as follows:

$$IPA_{i,t} = \alpha_0 + \alpha_1 \ln L_{i,t} + \alpha_2 \ln R \& D_{i,t} + \beta_1 T_{i,t} + \beta_2 D_{i,t} + \beta_3 T * D_{i,t} + \alpha_3 \ln K_{i,t} + \alpha_4 \ln GF_{i,t} + \alpha_5 \ln PD_{i,t} + \alpha_6 \ln FDI_{i,t} + \alpha_7 \ln GDP_{i,t} + \eta_{i,t}$$

In this paper, the main sources of data from the China Torch Statistical Yearbook (2010-2017), the science and technology of China Statistical Yearbook (2010-2017), China Statistical Yearbook (2010-2017), as well as parts of The national economy and social development bulletin (2010-2017).

The statistical characteristics of the above variables are shown in Table 2, the sample size is the 72 National Independent Innovation Demonstration Zone 2010-2017 years in 9 cities.

Table 2. Statistical characteristics of regression variables

	Conceptual data			Experience group			Control group			Symbol
	Max	Min	Std	Max	Min	Std	Max	Min	Std	
Invention patent authorization amount	78129	354	14749.29605	78129.00	766.00	22245.70	13068	354	3242.706439	IPA
Scientific research personnel of high and new technology enterprises	431259	27121	114502.985	431259.00	45432.00	128626.35	336823.5333	27121	82722.81869	L
High tech enterprise R&D funds internal expenditure	51943354	441142	12848140.1	51943354.00	3663326.00	15174457.56	32962323	441142	7602693.432	R&D
Fixed assets investment	69625338	2353.15	22310749.9	69625338.00	3814.70	22210806.45	66203700	2353.15	21746843.46	K
The torch plan to implement the project government funding support	106983	300	22710.524	106983.00	7779.00	24680.87	102020	300	19721.7526	GF
Population density	3826	546.82	924.432	3826.00	965.47	1140.25	3328	546.82	753.6092199	PD
Actual foreign investment	904000	828.88	261920	904000	2244.16	312343.33	876000	828.88	235866.0523	FDI
Gross Regional Product	167068719	4676.1	49216638.6	100694800	9846.81	33735446.03	167068719	4676.1	51585649.5	GDP

Source: Authors.

Overall, in addition to the regional GDP, overall data in all the maximum of all data sources in the experimental group, and general data about minimum values are derived from the control group, show and control groups, the experimental group in funds and personnel input, innovation output is more significant.

4 Empirical results and analysis

This paper for panel data are variable intercept model with fixed effects regression variable intercept model and random effects regression, after using the Hausman test, test results reject the fixed effect model assumptions. Therefore, the random effects model is more appropriate.

By using Stata 12.0 to analyze the model, regression results as shown in Table 3. Model 1 is the basic model, which contains the influence of the internal expenses, the control group, the time and the cross terms of the R&D funds of the high and new technology enterprise's scientific research personnel and the high and new technology enterprises. Model 2 to 6 model is continue to join the other explanatory variables in the regression results of model 6 includes a scientific research personnel of high-tech enterprises, high-tech enterprise R&D expenditures, whole society fixed assets investment, the torch plan implement project government funding support, population density, the actual foreign investment and regional GDP, explanatory variables.

Table 3. The results of DID model of policy effects of National Independent Innovation Demonstration Zone

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	IPA	IPA	IPA	IPA	IPA	IPA
<i>L</i>	0.0557* (1.82)	0.0547* (1.78)	0.0466 (1.51)	-0.0358 (-0.15)	0.0506 (0.24)	0.0211 (0.91)
<i>R & D</i>	0.0146 (0.49)	0.0172 (0.56)	0.0178 (0.59)	0.0802*** (3.35)	0.0430* (1.91)	0.0398* (1.78)
<i>T</i>	-22.45 (-0.01)	0.2304 (0.08)	0.23834 (0.74)	0.3173 (1.33)	-0.1555 (-0.67)	-187.6 (-0.08)
<i>D</i>	0.4675 (0.99)	0.48782 (1.02)	0.58643 (1.23)	-0.3249 (-0.87)	-1976.9 (-0.60)	-0.3279 (-0.98)
<i>T*D</i>	0.6150 (1.06)	0.5907 (1.01)	0.55474 (0.96)	-0.0659** (2.47)	0.1135*** (2.95)	0.1321** (2.74)
<i>GF</i>		-0.0255 (-0.43)	-0.0658 (-1.02)	0.0574 (1.14)	0.0883* (1.98)	0.0585 (1.22)
<i>K</i>			-0.0107 (-1.59)	-0.039*** (-6.29)	-0.035*** (-6.26)	-0.027*** (-3.73)
<i>PD</i>				-0.0012*** (-7.39)	-0.0089* (-1.69)	-0.0078** (-2.11)
<i>FDI</i>					0.0287*** (4.53)	0.0250** (3.71)
<i>GDP</i>						-0.0505 (-1.55)
<i>_CONS</i>	-0.4246* (-1.73)	-0.4084 (-1.63)	-0.1441 (-0.48)	0.0393*** (5.54)	0.1500 (0.28)	0.3973 (0.73)
<i>N</i>	72	72	72	72	72	72
<i>R²</i>	0.5416	0.5358	0.5466	0.7532	0.8116	0.8157
<i>F</i>	17.78***	14.66***	13.23***	28.09***	34.98***	32.42***

Source: Authors.

Note: *t* statistics in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

From dummy variable cross coefficient, it can be seen that the regression coefficient is positive, indicate that output in the establishment of national independent innovation demonstration zone can indeed significantly improve the park where the local authorized invention patent, help to improve the regional technology innovation ability, and in fact also proved this point.

High technology enterprise's scientific research personnel proportion coefficient is positive. It is proved that it has a positive effect on regional technological innovation capability, which is owing to an increase in the number of researchers and need a lot of money support, human capital transform for the output, which has greatly improved on the level of R&D technology.

The coefficient of High-tech enterprise R&D expenditures is positive, which is consistent with reality, reflecting the enterprises pay more attention to technology innovation. Generally speaking, corporate R&D investment intensity bigger, the more innovation output, technology innovation ability is stronger.

The coefficient of total social investment in fixed assets is negative, although side effects had little effect on that in the more developed regions. After the development of innovative environmental infrastructure to a certain extent, it has not like at the beginning of the reform and opening up of technological innovation ability has improved significantly with the increase.

The coefficient of population density is negative, theoretically, the greater population density areas more conducive to innovation, but in many cases, for example the official term effect of pure pursuit of GDP growth and ignore the long-term is more favourable to the output of innovation education, together with the population density of the region, the more foreign population, the lower the quality of human capital accordingly, which makes the population density and innovation output negative correlation.

The coefficient of actual foreign investment is positive, showing the positive effect, foreign investment has been a conscious to the high and new technology industries and strategic emerging industry, the government has improved the market for technology strategy, while the introduction of foreign and domestic competition will promote the enterprise technology innovation desire. Under the dual stimulation, the foreign investment introducing has an influence on technology innovation output slightly outweigh the disadvantages, but only have little effect.

The coefficient of regional GDP is negative, although this result is not significant. In general, in regional GDP higher area, the more developed the economy, but also pay attention to R & D investment accounted for the ratio did not increase with the increase of GDP. At the same time, government funding support variable coefficient is positive, indicating that capital investment is the benefit for the regional technological innovation ability.

In conclusion, in view of the relationship between the cross term coefficient, we can get that the establishment of National Independent Innovation Demonstration Zone can improve the ability of regional technology innovation, namely, the policy measures are significantly effective.

4.1 Robustness test

In order To make the conclusion correct, this paper use the fixed effect model benchmark regression model estimation, Table 4 is the results of robustness test, from this table, we found coefficient of cross multiplication (T*D) are different, but little difference and bith has a positive effect, at the 1% level significantly, after robustness tests the result still holds, that is robust in the National Independent Innovation Demonstration Zone Policy effect of DIDS model, namely, the National Independent Innovation Demonstration Zone Policy has a positive role in promoting regional technology innovation output.

Table 4. The results of the robustness of DID model in the policy effects of the National Independent Innovation Demonstration Zone

	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
	<i>IPA</i>	<i>IPA</i>	<i>IPA</i>	<i>IPA</i>	<i>IPA</i>	<i>IPA</i>
<i>L</i>	0.0163 (0.35)	0.0162 (0.35)	0.0200 (0.44)	0.0164 (0.36)	0.0483 (1.07)	0.0880* (1.78)
<i>R & D</i>	0.0428* (1.69)	0.0428* (1.67)	0.0431* (1.74)	0.0395 (1.57)	0.0164 (0.64)	0.0139 (0.56)
<i>T</i>	-0.7697 (-0.42)	-0.7856 (-0.40)	0.12860 (0.61)	0.0476 (0.21)	-0.0819 (-0.37)	-0.0917 (-0.04)
<i>D</i>	-0.1929*** (-3.14)	-0.1931*** (-3.09)	-0.2142*** (-3.50)	-0.2249*** (-3.60)	-0.21418*** (-3.60)	-0.2546*** (-4.07)
<i>T*D</i>	0.1316*** (4.01)	0.1317*** (3.93)	0.1359*** (4.18)	0.1366*** (4.20)	0.1399*** (4.52)	0.12338*** (3.89)
<i>GF</i>		0.0010 (0.02)	-0.0099 (-0.24)	-0.0142 (-0.34)	0.0817 (0.20)	-0.0270 (-0.61)
<i>K</i>			-0.0181** (-2.21)	-0.0155* (-1.78)	-0.0027*** (-2.91)	-0.0598 (-0.39)
<i>PD</i>				5.369 (0.88)	3.621 (0.62)	4.128 (0.72)
<i>FDI</i>					0.0187*** (2.66)	0.0184*** (2.67)
<i>GDP</i>						-0.0153* (-1.79)
<i>_CONS</i>	0.2901 (0.93)	0.2897 (0.92)	0.5496* (1.69)	-0.1694 (-0.19)	-0.4770 (-0.57)	-0.6609 (-0.79)
<i>N</i>	72	72	72	72	72	72
<i>R²</i>	0.4669	0.4669	0.5098	0.5165	0.5726	0.5969
<i>F</i>	10.16***	8.32***	8.32***	7.35***	8.04***	7.85***

Source: Authors.

Note: *t* statistics in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

5 Conclusions and prospects

This paper adpot the DID model to the evaluate policy effect of the National Independent Innovation Demonstration Zone, the invention of the patent can be used as the effect of the policy variables, scientific research personnel of high-tech enterprises, high-tech enterprise R & D expenditures, whole society fixed assets investment, the torch plan implement project government funding support, population density, the actual foreign investment and regional GDP can be used as explanatory variables. Through the analysis, we draw the following conclusions:

The establishment of National Independent Innovation Demonstration Zone has a significant role in promoting the regional technological innovation ability.

This shows that our country according to all levels from the overall planning, establish demonstration area, and then extended to the country, produce technology diffusion effect, to take the role, through policy to increase output of technological innovation activities, enhance the ability of regional technology innovation. From the perspective of previous measurement, it shows that the establishment of national independent innovation demonstration zone areas brings technological innovation ability promotion, demonstration zone was established to make government funding to support more targeted and aggregation,

stimulate enterprise science and technology personnel and funding of research and development investment. The establishment of the National Independent Innovation Demonstration Zone is more confident in the future of the enterprise. The demonstration zone demonstration should be in aspect of the investment policy, talent introduction, tax policy and financial policy aspects, in order to promote the technology innovation ability as the core goal to achieve, to achieve this, we must solve the current policy in the implementation process in the performance, outstanding technological innovation capability and technology innovation efficiency.

Innovative environment has a certain role in promoting the ability of regional technology innovation.

In a certain extent, the actual foreign investment will stimulate business activity, it bring enterprises to have a sense of crisis and "catfish effect". In order to survive, develop and grow, enterprises should improve their ability of technology innovation, but the same time, we also want to pay attention to wary of the purpose of occupying the Chinese market of foreign capital control the core technology, at this stage we should introduce the core technology, the initiative in their own hands, and human capital, technology digestion, knowledge spillover effect.

Scientific and technical personnel and scientific research funds has played an important role in improving the ability of regional technology innovation.

The increase of human capital on regional technological innovation capability is more important, this viewpoint in previous studies has been verified, but the promotion of population density on the quality of human capital without an obvious role in promoting, therefore, the effect of regional technological innovation capacity is not very obvious. This is mainly reason on the one hand, the quality of human capital increases are not overnight and mobility of the population also limits the government's support to education, on the other hand, the implementation of regional policy can attract more foreign population, making the quality of human capital at a lower level, it plays a negative role for regional technology innovation. The support of government funds, R&D expenditure is a kind of emphasis on R&D, which can stimulate enterprise development, give the confidence of enterprise technology innovation ability. In the future, it should be the purpose of the implementation of the special introduction of talent mechanism to accelerate the accumulation of human capital. Further aggregation of government innovation fund support, advanced industry into the focus of the object support, advocacy and corporate R&D investment at the same time, reduce the risk of enterprise development, in order to maximize the mobilization of demonstration zone enterprises technological innovation of enthusiasm. The combination of high and new technology industries together, which is conducive to the spread of technology and also easy to produce aggregation effect.

Due to the imperfect policy and short implementing period, the implementation of small area, policy and the possible delay, effect has not been fully demonstrated, the future will be tracking survey analysis from multiple perspectives of the national independent innovation demonstration zone policy effect; in addition, due to the availability of data, we did not refine the policy. In the near future will analysis the policy impact on the ability of technology innovation.

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