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The New Development Pattern of Chinese Patent under the dual-circulation Policy

-- Empirical Research based on DID Models

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Abstract

In the context of the suddenness of the new crown epidemic and the instability of the international situation, my country has formulated a dual-circulation development strategy. Based on this, based on the number of patents and scientific research index data as support, this article conducts research on the future development pattern of patents. Through the use of linear correlation and regression analysis to explore the factors affecting the development of patents. Through correlation analysis, the index factors that specifically affect the number of patents is clarified. Regression analysis is used to study the influence of the internal circulation and external circulation indicators on the number of patent grants, and a double difference model is established to calculate the effect and mechanism of the dual circulation policy on the innovation and development of Anhui enterprises. The conclusion is that the turnover of the technology market has a significant impact on the number of patents granted, and the dual-circulation policy at home and abroad has a driving effect on the innovation and development of domestic enterprises.

Keywords

Double Loop, Regression Analysis, Double Difference Model.

1. Introduction

The dual-circulation policy is conducive to my country's major deployment of breakthroughs in science and technology, technological restrictions of foreign powers, and foreign trade protectionism [1]. The dual-circulation development of science and technology is the key to achieving China's comprehensive national strength. Focusing on the number of domestic patent applications and the quality of inventions will help to get rid of the patent threat caused by the blockade of foreign high-tech introductions to China. Based on the domestic technology cycle, the development of new domestic patent formats will be built. The production pattern will also have important practical significance.

2. Literature Review

Chinese scholars have made relevant research on patent development. Yan Zhe proposed that patents are an important support for my country's innovation-driven development and the building of a strong intellectual property country, and what are the main factors affecting patent quality, and the specific

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role of each influencing factor. The actual effect has been studied[2]. Nguyen Phuc Canh's GMM estimation results using unbalanced panel data show that higher foreign direct investment inflows have a positive impact on the number of patents. [3] Peking University related scholars study the impact of China's effort to promote technology inventions and results show that the provided partial funding led the way for improving China's patent quality.[4].

3. Source and Processing of Data

The data used in this article was collected by the National Bureau of Statistics and published statistics on the number of patents granted in different provinces over the years, with a total of 851 records. At the same time, in order to study the comparison between the development of Chinese patents and foreign patents, three kinds of foreign patent authorization data were collected. Considering that the "dual cycle policy" proposed in 2020 will cause many changes in patent influencing factors, we collected patent data in 2020 and macro data in the past ten years, including internal expenditures, full-time equivalent, and full-time R&D expenditures in 31 provinces across the country. Number of patents, technology market turnover, GDP, etc.

4. Preparation of the Model

Since the "double cycle" new development pattern was proposed, the academic circles have launched intense discussions, and a large number of results with both theoretical depth and practical guidelines have been formed. However, most of the existing literature discusses the new development pattern of "dual cycles" from a theoretical level, and existing research stays at a broader macro level, and there are few studies on the pattern of patent development from an empirical perspective. Based on the regression model and the double difference model, this article analyzes the new development pattern of Chinese patents under the "double cycle" policy from the perspective of the combination of macro and micro, and proposes the following hypotheses. Hypothesis 1: The turnover of the technology market has a significant impact on the number of patents granted. Hypothesis 2: The domestic and international dual-circulation policy has a driving effect on the innovation and development of domestic enterprises.

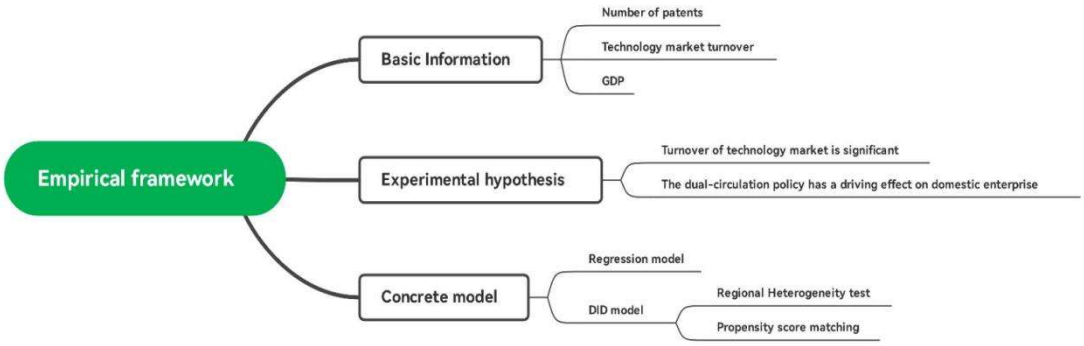

Figure 1. Empirical framework diagram

The knowledge production function model is a widely used model for analyzing the innovation performance of R&D factors. The knowledge production function is mainly used to describe the relationship between the R&D investment in a region and the output of R&D results. It is a type of non-linear relationship function. The basic model is as follows.

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5. Patent Number Analysis based on Knowledge Production Model

5.1 Model Settings

The knowledge production function model is a widely used model for analyzing the innovation performance of R&D factors. [5]The knowledge production function is mainly used to describe the relationship between the R&D investment in a region and the output of R&D results. It is a type of non-linear relationship function. The basic model is as follows:

$$Y = Ae^{\lambda t}k^{1-\alpha}L^{\alpha}R_i^{\beta_1} \tag{1}$$

In formula (1), Y represents productivity, k and L respectively represent R&D investment and employee input, and R_i represent the $i-th$ type of R&D investment.

$$\frac{\bar{T}}{T} = \lambda + \beta_i \frac{\bar{R}}{R} \tag{2}$$

In formula (2), $\frac{\bar{T}}{T} = \lambda + \beta_i \frac{\bar{R}}{R}$ Indicates the growth rate of production, indicating that the rate of technological progress is determined by various R&D investments. So the model of this article is set as formula (3):

$$Y = C \cdot R_i^{\beta} \tag{3}$$

In formula (3), Y represents innovation output, R_i represents the R&D expenditure of different channels, and C represents other deterministic factors in the system that affect innovation output. Take the logarithm of both sides of equation (3), and sort out the model equation (4) of this article:

$$\mathrm{Ln}Y = \mathrm{Ln}C + \beta_i \mathrm{Ln}R_{\mathrm{i}} + \mu \tag{4}$$

In order to explore the impact of different domestic scientific and technological indicators on the development of patent numbers under the dual-circulation background, we selected 5 relevant indicators based on existing research results, namely the full-time equivalent of research and experimental development personnel, and the expenditures for research and experimental development. Technology market turnover, number of scientific and technological achievements registration, research and experimental development basic research expenditures, and use SPSS software to analyze the Pearson correlation coefficient of 5 indicators and the number of patent applications. The closer the correlation index is to "+1", it is positively correlated, the closer to "-1" it is negatively correlated, and the closer the absolute value is to 0, it doesn't matter [2]. Generally, the absolute value of correlation between "0.3" and "0.8" can be regarded as weak correlation.

5.2 Analysis of Running Results

Based on the above model analysis, there is a significant positive correlation between the variables, which has a significant fitting effect. The results are as follows:

It can be seen from the results that the turnover of the technology market has the greatest impact on the number of patents, reaching 0.987. Patent is the embodiment of technological innovation. On the one hand, the realization of patent value can promote the integration of technology into enterprises,

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on the other hand, the development of enterprises requires technological innovation. The technology market and the realization of patents complement each other. Under the bi-cyclical background, promoting the growth of technology market turnover can have side effects on the number of patents, which is conducive to the development of national science and technology. On the other hand, research and experimental development expenditures and basic research expenditures for research and experimental development also have a significant impact on the development of the number of patents. The correlation index between the full-time equivalent of research and experimental development personnel and the number of patent grants can reach 0.952. It shows that the investment of talents will promote the growth of patent data, and the development of patent powers should focus on the cultivation of talents.

Table 1. Pearson correlation analysis results

Pearson correlation coefficient	Number of patents granted	Full-time equivalent of personnel	Expenditure	Technology market turnover	Number of results registered	Basic research expenditures
Number of patents granted	1	.952**	.967**	.987**	.979**	.976**
Full-time equivalent of personnel	.952**	1	.989**	.947**	.985**	.971**
Expenditure	.967**	.989**	1	.971**	.985**	.993**
Technology market turnover	.987**	.947**	.971**	1	.961**	.989**
Number of results registered	.979**	.985**	.985**	.961**	1	.974**
Basic research expenditures	.976**	.971**	.993**	.989**	.974**	1

In order to explore the impact of the external circulation of science and technology on the number of domestic patent authorizations, we selected 7 indicators, involving the import and export of industrial products, the import of high-tech industries, and the import of foreign intellectual property rights, using the above 7 indicators. The overall regression analysis of the indicators shows that the P value of each indicator is less than 0.05, which is significant. The model results are as follows:

According to the model results, among the seven indicators, the import value of telecommunications, computer and information services has the most significant impact on domestic patent authorization, and the standardization coefficient is as high as 0.986. It is proved that the import projects of high-tech technologies such as telecommunications and computers in the scientific and technological field can also promote the development of the number of domestic patent authorizations. It also reflects that, to a certain extent, my country is dependent on the import of foreign high-tech technology, and the development of science and technology is constrained by the power of science and technology. Therefore, when implementing the domestic and foreign dual-circulation policy, it is necessary not only to accelerate the formation of a domestic cycle as the main body, but also It is necessary to connect the domestic market with the international market, and make better use of resources under the new situation to promote the new development pattern of domestic scientific and technological output.

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Table 2. Regression results of patents granted by external circulation technology indicators

Model	Unstandardized coefficient		Standardization factor	t	p
	B	Standard error	Beta		
(constant)	5.026E-16	.202		.000	
Industrial products export value	1.538	.811	.738	1.896	.007
Primary product exports	.166	.497	.166	.333	.049
Imports of industrial products	-.997	1.127	-.697	-.885	.010
Imports of primary products	.141	.439	.441	.321	.025
Information service imports	50.969	6.278	.986	0.119	.004
Imported amount of intellectual property royalties	17.380	7.496	.313	2.319	.025
High-tech export	-2.529	.386	-.415	-6.545	.002

6. The Establishment and Empirical Analysis of the DID Model

6.1 Model Setting

In order to examine the effect and mechanism of the dual-circulation policy on the innovation and development of enterprises, this article first takes Anhui Province as an example. Based on the above regression analysis results, the number of patent applications is used as a response indicator of the degree of enterprise technological innovation development. Based on this article, the proposed dual-circulation policy in July 2020 is the starting point for the implementation of the policy. Based on this, this article takes listed companies in Anhui as the policy experimental group and listed companies in overseas regions as the control group. The international and domestic dual-circulation policies are proposed Time node 2020 is the starting year of the policy quasi-natural experiment. This paper uses the double difference method for regression, and regards the preparation and implementation of the dual-circulation policy as an exogenous policy shock, which basically avoids the endogenous problem caused by two-way causality.[6] Empirical research is carried out through the DID method, and the model is established as follows:

$$\ln patent_{it} = \delta_0 + \delta_{1s\_} sxhit + \sum_{j\sigma j} \times \text{control}_{it} + \alpha_t + \iota_i + \kappa_{it}$$

$$s\_sxhit = ah_i \cdot sxht$$

The subscript i in the model represents different listed companies in Anhui Province, and the subscript t represents different years, the same below. The explained variable $\ln patent$ reflects the level of scientific and technological innovation of listed companies, and the logarithm of the number of patents applied for by various listed companies that year plus 1 is used as a proxy variable. It can be concluded that the level of technological innovation of an enterprise can be measured by the number of patent applications. And the patents are divided into invention type, utility model and appearance design type, the structure of which is similar to the number of patents. The main explanatory variable s_sxh reflecting the quasi-natural experiment of the double-loop policy is an

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interaction term, which is obtained by the interaction between the dummy variable ah of whether it is a listed company in Anhui Province and the dummy variable sxh of whether the double-loop is prepared or not. If ah is 1, it is For the experimental group, 0 is the control group, sxh is based on the year 2020 when the dual-circulation policy is started, the year after 2020 is 1, and the year before 2010 is 0, and $control$ reflects the company and the province's active and technological The control variable combination of development indicators, including the regional economic development and development level $\ln gdp$, the scale of listed companies $size$, the age of the company $\ln age$, the total number of employees $scale$ and the rate of return on total assets roa. α represents a set of annual dummy variables that do not change with individuals, ι is a set of individual dummy variables that do not change with time, and κ indicates random interference items.

Table 3. Names and meanings of main variables

Variable name	Corresponding meaning
$\ln patent$	$\ln(patent+1)$
$\ln model$	$\ln(model+1)$
$\ln invent$	$\ln(invent+1)$
$\ln appear$	$\ln(appear+1)$
Explanatory variables	
s_sxh	Quasi-natural experiment of double loop
Mechanism variable	
$tech$	Technological human capital
Control variable	
$\ln gdp$	Regional economic development and opening up
$size$	Operation and management of listed companies
$\ln age$	$\ln(year-age+1)$
$scale$	$\ln(scale)$
roa	Total net profit/assets

This paper uses stata14.0 software to solve the benchmark results, and the results are shown in the following table:

From the results in the table, it can be seen that whether it is for the total number of patent applications, or for inventions, utility models, and designs, the proposal and implementation of the dual-circulation policy is helpful to the innovative behavior of Anhui enterprises, and The result remains significant at least at the 5% significance level. From the point of view of the coefficient size, it shows that the proposal and implementation of the dual-circulation policy will help Anhui enterprises to increase patent applications by 11.2%, while the number of invention patent applications will increase by more than 17%, utility models will increase by nearly 7%, and the design The number of applications increased by nearly 9%. From the analysis of the results of the double difference model, it can be seen that under the background of the double cycle, all provinces can increase the technological content and technological innovation level under the improved scientific research environment. From the perspective of the control variables, the size of the company, the company's materials, and the per

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capita GDP of the region are all important factors that affect the development of the company's technological innovation.

Table 4. Results of the double difference model

Variable name	ln*patent*	ln*model*	ln*invent*	ln*appear*
s_sxh	0.112**	0.175**	0.069***	0.087***
	(2.077)	(1.293)	(2.041)	(2.399)
size	-0.009	-0.073	-0.047*	-0.026*
	(-0.169)	(-1.402)	(-1.733)	(-1.809)
ln*age*	-0.42	-0.422	-0.0961	-0.088
	(-1.568)	(-1.364)	(-0.586)	(-1.255)
scale	-1.433	-1.47	-0.657	-0.355
	(-1.436)	(-1.674)	(-1.363)	(-0.576)
roa	-0.086	-0.046	-0.02	0.078
	(-0.578)	(-0.568)	(-0.447)	(-1.475)
ln*gdp*	0.04	0.096	-0.067	0.047
	(-0.532)	(-0.490)	(-0.536)	(-0.568)
Constant term	4.698***	4.525***	2.749***	0.896**
	(-3.043)	(-3.643)	(-2.366)	(-2.636)
Individual fixed effect	control	control	control	control
Annual fixed effect	control	control	control	control
Observations	16 379	16 379	16 379	16 379
R^2	0.627	0.494	0.534	0.464

Note: ***, **, and * represent the significance levels of 1%, 5%, and 10%, respectively. The numbers in parentheses are the t-values of the two-tailed test.

7. Analysis and Testing of Empirical Results

7.1 Analysis of Regional Heterogeneity

Although it can be concluded from the results that the introduction of the dual-cycle policy has significantly increased the level of investment in science and technology of Anhui enterprises, the response of the policy in the eastern, central and western regions of the country is not the same. [7] Therefore, in order to verify whether there are regional differences in the domestic and regional driving effects. The impact of the international double-cycle policy on the innovation and development of enterprises. This article will discuss the regional heterogeneity test of the international and domestic double-cycle policy to promote the development of regional enterprises. The city was divided into three parts: east, middle and west, and then tested. The results are as follows:

Observing models A, B, and C in Table 5, it can be found that the domestic and international dual-circulation policy has a significant promotion effect on the innovation and development of enterprises in the eastern and central pilot areas, and has a stronger driving effect on the eastern region, but it is not significant for the western region. The result based on the above phenomenon may be due to the highest level of scientific and technological innovation development in the eastern region. Both the

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R&D capital investment system and the enterprise innovation operation mechanism are more perfect, and the scientific and technological achievements transformation industry is more developed. In recent years, the central region has been weaker than the eastern region in terms of government investment in technology and finance and attractiveness to high-end talents, resulting in policy effects that are significantly positive but lower than those in the eastern region. The western region has even shown an insufficient demand for technological output. The regression coefficient is not significant.

Table 5. Results of regional heterogeneity test

	lnpatent1	lnpatent2	lnpatent3
	modelA	modelB	modelC
East	1.8946***		
	(0.3904)		
Middle		1.5720***	
		(0.4029)	
West			0.3600
			(0.2403)
size	-0.0874**	-0.1207***	-0.072***
	(0.0386)	(0.0182)	(0.0879)
lnage	0.0872***	0.0609**	0.1744***
	(0.0294)	(0.0162)	(0.0128)
scale	0.0062***	0.0052***	0.0028***
	(0.0006)	(0.0004)	(0.0003)
roa	0.0635*	0.0082	0.06
	(0.0325)	(0.03781)	(0.0629)
Time effect	yes	yes	yes
Regional effect	yes	yes	yes
Constant term	2.3252***	3.2635***	1.3634***
	(0.4636)	(0.1743)	(0.1836)
Sample size	1220	1220	960
R^2	0.6466	0.5720	0.5844

7.2 Propensity Score Matching

In order to ensure that the experimental group and the control group have parallel trends, Table 10 reports the regression results after PSM+DID. After propensity score matching, it can be seen from the results in Table 6 that the experimental group and the control group not only have no significant differences in all corporate financial control variables, but there are also significant differences overall, which guarantees The basic requirements of DID.

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Table 6. Propensity score matching process

average value				Decrease%		T test	
variable	Match	test group	test group	deviation %	|deviation|	t	P
ln*gdp*	Unmatched	28.056	27.925	3.2		1.32	0.009
	Matched	28.056	28.037	1.5	74.31	0.55	0.464
size	Unmatched	17.624	17.273	12.4		6.89	0.000
	Matched	17.624	17.579	4.3	74.26	0.26	0.757
ln*age*	Unmatched	4.075	4.011	24.8		4.32	0.000
	Matched	4.075	4.069	5.2	88.09	0.36	0.474
scale	Unmatched	7.824	7.529	-19.2		-7.72	0.000
	Matched	7.824	7.602	2.2	94.6	0.32	0.691
roa	Unmatched	0.037	0.029	8.4		2.46	0.043
	Matched	0.037	0.032	2.6	89.2	0.33	0.763

8. Conclusions and Recommendations

From the conclusion, it can be concluded that the technology market transaction volume has the greatest significance for the development of the number of patent authorizations, and the correlation reaches 0.987. The number of registrations of scientific and technological achievements and patent authorizations next. Research and experimental development expenditures and basic research expenditures for research also have a significant impact on the development of the number of patents, and the correlation coefficients are 0.967 and 0.976. The development-related performance of the full-time equivalent of the number of patents granted by the research and test development personnel reaches 0.952.

Second, through regression analysis it is concluded that the technology market turnover has the largest influence on the number of patent authorizations, and the standardization coefficient is as high as 0.937,following rhe number of R&D projects. In terms of external circulation, imports of telecommunications, computer and information services have the most significant impact on domestic patent authorization, with a standardization coefficient of 0.986,which proves that China highly depends on foreign technology in the high-tech field.

Third, according to the benchmark results, whether for the total number of patent applications or the three types of patents subdivided, the proposal and implementation of the dual-circulation policy will help Anhui. The size of the company, the company's materials, and the per capita GDP of the region are all important factors that affect the development of the company. It is concluded that the domestic and international dual-circulation policy has a driving effect on the innovation and development of domestic enterprises.

According to the analysis of the data modeling results provided by different databases, the main suggestions are as follows:

Pay attention to the training of scientific research personnel. 2. Increase investment in scientific research funds. 3. Pay attention to the amount of scientific research projects approved.

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