Analysis of the Impact of Import and Export Trade on the Innovation Ability of Chinese Industrial Enterprises

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Abstract. In recent years, the process of economic globalization and industrial globalization has been accelerating. In order to consolidate their competitiveness in the international market, countries have deployed and implemented innovative development strategies. At present, although China has become a major industrial and manufacturing country in the world, and the only country in the world with all industrial categories, compared with the advanced level in the world, it still needs to strengthen independent innovation, improve the scientific and technological content and informatization level, improve the level of industrial structure, and promote high-quality economic development. With China's accession to the World Trade Organization, it continues to "go out and introduce", pushing Chinese manufacturing to the world, and also continuously bringing high-quality foreign resources and advanced technology into China. At present, a large number of scholars have also studied the innovation capabilities of enterprises and high-tech industries, but the selection criteria are not the same. This article is based on the innovation capability evaluation system proposed by the Ministry of Science and Technology of China, combined with the entropy weight method, and weights 10 secondary indicators selected from the evaluation system to calculate the comprehensive score of high-tech industry innovation capability for each province from 2010 to 2019. Select import and export trade as the core explanatory variable to study the impact of import and export trade on China's high-tech industry innovation capacity, and propose policy recommendations for this.

Keywords: High tech industry; Innovation ability; Entropy weight method; influencing factors; Countermeasure suggestions.

1. Introduction

In 2019, China's import and export trade volume reached us $4.5 trillion, an eightfold increase from 2001. As China's accession to the world trade organization, open doors to the world, constantly "go out, introduce", made in China to the world, also constantly foreign high quality resources and advanced technology into domestic, with technological change and innovation, in "made in China" to "made in China" on the road. China's high-tech industry has also witnessed rapid development in the past 15 years. The import volume of the industry has increased from 319.853 billion US dollars to 667.521 billion US dollars, an increase of nearly 108.69%. In terms of industry technology innovation, there are also very obvious results. The sales revenue of new products has increased from us $1376.572 billion in 2009 to US $5699.815 billion in 2018. The number of patent applications has also created new highs, from 39,254 to 147,689, with an annual increase of more than 30%. Although the innovation of China's high-tech industry has made great achievements, compared with the developed countries in the world, it is necessary to continuously increase investment and research and development to rank among the forefront of innovative countries.

Studying the impact of import and export trade on the innovation ability of China's high-tech industry is conducive to test the impact of import and export trade on the development of China's high-tech industry, better specify import and export trade policies, better stimulate the impetus of innovation, promote innovation to become a trend, and promote the precision of the whole industry.

Take the background and study the influence of import and export trade on China's high-tech industry. The full text consists of six chapters, with the specific content arranged as follows:

This paper adopts the literature research method to summarize the previous definition of innovation ability, integrates the construction of the evaluation system of innovation ability, and provides directional guidance for the research framework and research ideas of this paper. The text uses comparative analysis and empirical analysis to summarize the innovation performance of provinces and cities except Tibet. The entropy weight method was selected to assign 10 indicators in the innovation ability evaluation system, and then the panel regression analysis.

2. Theoretical foundation and literature review

2.1. Theoretical foundation

2.1.1. Economic growth theory

The economic growth theory that explains the law of economic growth and the influencing constraints, including two parts —— classical growth theory and modern economic growth theory. Classical growth theory is the foundation, including the neoclassical growth theory and the endogenous growth theory of the modern economic growth theory for the mature stage. According to the economic growth theory, economic growth is constrained by resources, technology and system.

(1) Adam Smith's classical theory of growth

Smith (1776), the theory of division of labor theory and capital accumulation theory are the basis of his economic growth theory. Among them, the theory of division of labor is based on its egoistic hypothesis, self-interest will be mutual benefit and mutual assistance, the method of mutual aid is exchange, exchange leads to the division of labor. In Smith's view, the division of labor increases the production in three main ways: first, the proficiency of the workers; second, it saves time if the workers do only one job; third, it simplifies the division of labor and procedures the work, which greatly increases the possibility of mechanical invention. In addition, the scope of the market will affect and restrict the division of labor to some extent, so there is a mutual promotion relationship between labor productivity and demand, which constitute the driving force of economic growth.

(2) Marshall's classical economic theory —— external economy and increasing income thought

Marshall (1890) emphasized the role of external economy. He believed that industrial organization, like the three production factors of labor, land and capital, had an irreplaceable role, while industrial organization included division of labor, improvement of machinery, expansion of production scale, management and industrial agglomeration.

A large number of highly specialized enterprises have common labor market resources and share intermediate inputs, and the knowledge spillover effect also plays a role in producing economies of scale and then forming regional agglomeration. Such areas are called "industrial zone" by Marshall. In the industrial area, enterprises make collaborative innovation, and the overall economic level rises, forming a healthy competition. Therefore, more related enterprises will join in and participate in the healthy competition under the influence of the environment.

(3) Robert Solow's neoclassical theory of growth

$Y=A(t)T^{1-\varepsilon}K^{\varepsilon}$ Robert Solow (1956) uses the Cobb-Douglas production function —— (regardless of technological advances). Solow's model takes labor input, capital and technological progress as the main influencing factors, which is the result of the organic combination of capital and labor. Due to the lack of technological progress factors, the technological progress and time factors were introduced, and the "Solo-Mead model" was formed, and the basic formula is:

$$G=a\frac{\Delta K}{K}+(1-a)\frac{\Delta L}{L}+\frac{\Delta T}{T} \tag{1}$$

(4) Endogenous growth

Arrow (1962) and Sheshinski (1967) want to avoid the impact of declining returns on scale, assuming that the creation of knowledge is a by-product of investment. Technological progress and knowledge spillover are in a virtuous cycle. Enterprises that have increased their material capital will constantly commit to improving production efficiency, and producers will also spread knowledge to other producers through knowledge spillover, so that the overall productivity will be improved. In Romer (1986), the production of knowledge is increasing, with diminishing returns of material output.

Lucas (1988) has established a theoretical framework of endogenous growth with technology changes, human capital and specialized human resources.

(5) Research and Development (R&D)

Romer (1986) added incomplete competition on the basis of R&D theory. The increase of R&D expenditure promotes the improvement of technology level and thus the remuneration. If the specific technological progress can be spread and shared among producers in the form of non-competitive competition, it will also help the whole industry, and such non-competitive competition is also reasonable. The new research also involves the diffusion of technology. Although it is related to technological progress, the diffusion is a kind of knowledge and technology sharing, rather than creation. It is easier than technological progress and technological creation.

2.1.2. Technical innovation theory

Joseph Schumpeter was the first economist to propose innovation and technological innovation. His view of innovation is the adoption of new combinations of factors of production. In addition, the five innovations he believes are summarized into five-one innovation of product, technology, market, resource allocation and system.

Independent innovation, imitation innovation and cooperative innovation constitute the strategic theory of technology innovation. Independent innovation is the innovation completed by enterprises. It has three characteristics: the endogeneity of technological breakthrough, that is, the complete independent creation, the pioneering of technology and market development, which is the pioneering nature of product market and the inherent nature of knowledge and ability support. From the perspective of enterprises, the reason for the implementation of independent innovation in China is that independent innovation is the ultimate goal pursued by enterprises and an important weapon to balance foreign technologies. Imitation and innovation is the transformation of the new technology introduced by enterprises into the technology for their own use, combined with consumer needs and enterprise characteristics, to develop more competitive products. Cooperative innovation is the joint innovation behavior between enterprises or between enterprises and universities and scientific research institutions. Cooperation is based on the premise of resource sharing and complementary advantages, and the main form of cooperation is R&D.

2.1.3. Learning and absorption effect

Coe and Helpman (1995), points out that the learning absorption effect is the enterprise in the production of products and imported foreign technology, equipment, improve the understanding of their field products, advanced technology and technology, from the study of the moment, technology diffusion began to happen, on the basis of learning, digestion and absorb new knowledge, secondary innovation, improve the old process, technology, production of new products. Acharya And Keller (2008) believe that in the whole dynamic learning process, import can promote the quality of enterprise innovation by enabling domestic enterprises to obtain overseas knowledge.

In terms of high-tech industries, the accumulation of R&D personnel investment in this industry can form the digestion and absorption capacity of imported products and technologies directly introduced from abroad. Tang Weibing et al. (2014) proposed that whether the directly introduced technology can eventually form the production technology is restricted by the learning ability, that is, the digestion and absorption ability. Digestion and absorption, including researchers, ability is not achieved overnight, are years in the process of learning continuous accumulation, the stronger the digestion and absorption ability enterprise has the stronger the learning ability, the foreign high technology products and technology to understand and accept the faster, the more in a short period of time to create more better quality technology, products, the innovation quality improvement faster.

2.2. Literature review

2.2.1. Status of foreign studies

Starting from the market demand, Nicola Cutting et al. (2019) and A nna Thum-Thysen et al. (2019) pointed out that the technological innovation ability of enterprises is the ability of enterprises to transform products and improve service quality under the guidance of the market needs [1] [2]. On this basis, Yuhan Hu (2019) pointed out that the core of enterprise innovation ability is enterprise management ability, value level, knowledge reserve and technological innovation [3]. Anabela Santos (2019) believes that this ability is only the knowledge and skills used to create technology [4].

Xavier Vives et al. (2019) pointed out that organizational management ability, knowledge acquisition ability and the ability to adapt to the environment, as well as practical creation ability are the concrete manifestations of enterprise technological innovation [5]. Liqun Zhuge et al. (2019) believe that the absorption ability is the main performance of the innovation ability, which is specifically manifested in the identification and digestion of external knowledge and information [6]. Malykhina et al. (2018) and Gil Denis (2018) believe that the technological innovation ability of enterprises is mainly technology mastery ability, organization and management ability, information acquisition ability, etc [7] [8]. Trabelsi Ramzi (2018) and others believe that information and knowledge are also factors of innovative production, and advanced technology should be integrated into innovation [9]. V. N. Borisov et al. (2018) pointed out that the innovation ability of enterprises should also include the prediction of the development of the industry [10]. Fares (2018) believes that enterprises build innovation capabilities based on the principles of malleability, contribution and imitation [11].

2.2.2. Status of domestic research

Liu Kang and Yang Xiaoyu (2015) believe that enterprise innovation is a dynamic ability, including enterprise innovative thinking, new product research and development, promotion, sales and management and other links, which runs through the whole process of innovation[13]. Li Chunhua et al. (2018) believe that the innovation ability of enterprises involves the technological innovation, system innovation and management innovation, among which the technological innovation ability should be divided into six aspects: investment, management, tendency, research and development, manufacturing and marketing [14].

Cheng Yuan et al. (2020) divided the evaluation index of innovation ability into two perspectives: input and output, among which the selection index of innovation input ability was R&D input fund and R&D personnel, and patent creation and new product development were selected as indicators to reflect the innovation output ability [17]. Wu Yonglin and Zhao Jiafei (2011) have constructed an evaluation index system of innovation ability including four aspects of innovation investment, research and development, digestion and absorption, and innovation output. The specific empirical sample is selected from Beijing high-tech enterprises [19]. Zheng Xia (2014) selected the output efficiency and benefit of technology as the measurement index of technological innovation ability, because it is considered that it is the final expression form of enterprise technological innovation ability [20].

Wang et al. (2020) conducted the regression analysis based on the two-dimensional analysis of social background diversification and occupational background diversification [15]. Zhou Li et al. (2020), in order to study the influence effect and influence path of venture capital investment on the innovation ability of the invested enterprises, adopted the propensity value matching method to establish the Logit model to estimate the propensity value, used the nuclear matching method to match the experimental group samples, and conducted the robustness test and mechanism test [18]. Luo Siping and Yu Yongda (2012) analyzed the special role of overseas talents in adopting the Negative Binomial fixed effect model of enterprises, and conducted empirical analysis based on the data of 806 photovoltaic enterprises [21].

Sun Ying et al. (2020) focused on three dimensions of customer innovation ability to solve customer service, market innovation ability to provide technical advice and promotion behavior, and the ability to integrate products and operation process [22]. Based on the production outsourcing model, Liu Weigang et al. (2020) enriched and deepened the research on the channels of enterprise innovation from the two dimensions of cost input and absorption technology [23].

3. Comprehensive evaluation of the innovation capacity of China's high-tech industries

This chapter on the basis of the national Ministry of Science and Technology latest innovation ability evaluation index system, from innovation ability, collaborative innovation ability, intellectual property ability and innovation drive ability four aspects comprehensive evaluation of China's high technology industry innovation ability, after comparing the several kinds of empowerment method for weight and score calculation, comparative analysis of the results.

Table 1. Construction of the evaluation index system.

Level 1 indicators	Secondary indicators	computational formula
Innovation investment capacity	Innovation funding and investment index	R&D expenditure amount / main business income
	Innovative manpower input index	Total number of PhD and master graduates / R&D in R&D
Collaborative innovation ability	Industry-university-research impact rate	Number of enterprises carrying out industry-university-research cooperation / number of industrial enterprises above designated size
	Industry-university-research cooperation rate	External expenditure of enterprise R&D The sum of universities and research institutions / the sum of external expenditure of enterprise R&D
	Innovation resource integration degree index	Technology introduction expenditure / R&D expenditure
	Independent research and development capability index	Total amount of digested and absorbed / total amount of funds for technology introduction
Intellectual property ability	Intellectual property rights creativity index	Number of provincial valid patents / number of national patents
	Intellectual property rights application index	Technology market transaction volume / main business revenue
Innovation-driven capabilities	Innovation value realization rate	New product sales revenue / main business revenue
	The Market influence index	Number of invention patents applied for by PCT / total number of invention patents

3.1. Selection of evaluation methods for the innovation ability of high-tech industries

The entropy method is an objective approach for assigning weights. Entropy, a concept originating from thermodynamics, was introduced by the American mathematician Claude Elwood Shannon in 1948. It measures uncertainty: the greater the entropy, the more uncertainty and information it contains, and vice versa. In short, the entropy value is used to judge the dispersion degree of the index to determine the degree of importance. If all the index entropy values are equal, the weight has no significance.

Compared with other methods, the entropy weight method has strong applicability, high accuracy and more scientific, so this paper selects the entropy weight method to conduct the index weight calculation.

3.2. Measurement process of innovation capacity of high-tech industry

3.2.1. Build the decision matrix

(1) Build the initial matrix

Collect the data and build the decision matrix:

$$X=\left(x_{ij}\right);i=1,2,\ldots m;j=1,2,\ldots n \tag{2}$$

x_{ij} represents the j th index of the i th index object.

(2) Standardized treatment

The indicators used are derived from different calculation methods, and as such, the measurement units and modes of the original data may not be consistent, making comparability a concern. Therefore, in order to ensure the comparability of the indicators, it is necessary to standardize the indicators. The nature of the selected indicators should be defined, including positive index, negative index, moderate index and interval index. Positive indicators, the value has a positive impact on the evaluation score, the larger the value, the better the evaluation. Negative indicators, that is, have a negative impact on the evaluation, and the smaller the index value, the more favorable to the evaluation. Moderate index, the numerical fluctuation is small, moderate and significant effect on the evaluation. Interval index, the value has a good evaluation value in the specified interval.For the positive and negative indicators, because the meaning is different, it needs to be treated by the extreme difference method, and then dimensionless.

$$Z=(z_{ij});i=1,2,\ldots m;j=1,2,\ldots n \tag{3}$$

Standardization of positive indicators:

$$z_{ij}=\left[\frac{X_{ij}\text{-}\min X_j)}{\max\left(X_j\right)\text{-}\min(X_j)}\right] \tag{4}$$

Standardization of negative indicators:

$$z_{ij}=\left[\frac{\max(X_j)\text{-}X_{ij}}{\max\left(X_j\right)\text{-}\min(X_j)}\right] \tag{5}$$

(3) Normalization builds a new matrix

$Z=(z_{ij})_{m\times n}$Normalization is performed to obtain a new matrix $P=(p_{ij})_{m\times n}$

$$\text{Where, } p_{ij}=\frac{z_{ij}}{\sum_{i=1}^{m} z_{ij}},i=1,2,\ldots m;j=1,2,\ldots n \tag{6}$$

The calculation can get the proportion of each province in each index.

3.2.2. Calculate the entropy value

(4) Seek information entropyE_j

$$E_j=k\sum_{i=1}^{m} p_{ij}\times \ln p_{ij},j=1,2,\ldots n,k=-\frac{1}{\ln m} \tag{7}$$

(5) Determine the index difference coefficientg_j

The greater the difference between indices, the more significant the evaluation difference, leading to a smaller entropy value. The computational formula is as follows:

$$g_j=1-E_j,j=1,2,\ldots n \tag{8}$$

3.2.3. Determine the weight

(6) Calculate the weight

The j th index weight is:

$$W_j=\frac{g_j}{\sum_{j=1}^{n} g_j} \tag{9}$$

Table 2. Weight of evaluation index of innovation ability of high-tech industries.

Level 1 indicators	weight	Secondary indicators	weight
Innovation investment capacity	0.085	Innovation funding and investment index	0.051
		Innovative manpower input index	0.035
Collaborative innovation ability	0.324	Industry-university-research impact rate	0.081
		Industry-university-research cooperation rate	0.084
		Innovation resource integration degree index	0.139
Intellectual property ability	0.423	Independent research and development capability index	0.021
		Intellectual property rights creativity index	0.180
		Intellectual property rights application index	0.243
Innovation-driven capabilities	0.168	Innovation value realization rate	0.040
		The Market influence index	0.128

Data source: calculated from China's economic and social big data platform, EPSDATA and National Bureau of Statistics.

Weight results are shown in the table above. However, in the first-level index, the highest weight of intellectual property capacity is 0.423, and the lowest is the innovation investment capacity is 0.085. In the secondary index, the IP application index has the highest weight of 0.243, followed by the intellectual property creativity index, with a weight of 0.180. The independent research and development ability index has the lowest weight, only 0.021.

3.3. Analysis of calculation results of innovation capacity of high-tech industries

3.3.1. Difference analysis of index ability scores

According to the weight and the original data of each index object, the score of each index included in the comprehensive score is calculated, and then the score of each index is added up to get the comprehensive score of innovation ability of each province per year.

Calculscores for each index in each province:

$$s_{ij}=W_j \times X_{ij}, i=1,2,\dots m; j=1,2,\dots n \tag{10}$$

3.3.2. Analysis of comprehensive scores

The annual total score of each province is calculated according to the total score of each index:

$$S_i=\sum_j^n s_{ij}, i=1,2,\dots m; j=1,2,\dots n \tag{11}$$

Table 3. Provincial score ranking of innovation capacity of high-tech industries.

province	2010	2019	province	2010	2019	province	2010	2019
Beijing	1	1	Zhejiang	4	6	Hainan	22	18
Tianjin	7	10	Anhui	12	7	Chongqing	5	15
Hebei	26	17	Fujian	14	25	Sichuan	19	13
Shanxi	28	23	Jiangxi	25	14	Guizhou	17	19
Nei Monggol	30	29	Shandong	9	11	Yunnan	24	26
Liaoning	21	16	Henan	20	22	Shaanxi Province	10	9
Jilin	23	5	Hubei	13	8	Gansu	11	21
the Heilongjiang River	15	20	Hunan	6	12	Qinghai	27	30
Shanghai	3	4	Guangdong	2	2	Ningxia	16	24
Jiangsu	8	3	Guangxi	29	28	Xinjiang	18	27

According to 30 regions except Tibet high technology industry innovation ability score, the first is always Beijing, Guangdong ranked second, Jiangsu from 2010 eighth rose to the third, in 2012, Shanghai was Jiangsu back after always stay in the fourth, Zhejiang also ranked higher, between the fifth, six, Anhui, Hubei overtake, into the top ten.

4. An empirical analysis of the impact of import and export trade on China's high-tech industry innovation capacity

4.1. Variable selection

4.1.1. Interpreted variable

Currently, there is no unified evaluation standard for industrial innovation ability, as scholars' perspectives on the evaluation criteria vary. Therefore, the evaluation standard of innovation ability in this study selected the evaluation standard system proposed by the Ministry of Science and Technology, and comprehensively calculated the comprehensive score of the innovation ability of high-tech industry in each province from 2010 to 2019.

4.1.2. The explanatory variables

The core explanatory variable is China's import and export volume (Trade).

4.1.3. Control variables

Level of economic development (Eco-Dev), measured by GDP per capita. With different levels of regional economic development, the development level of high-tech industries will be affected. The better the economic development, the richer the resource conditions, the more conducive to the innovative development of high-tech industries.

The Marketization Index (Market) adopts the marketization index in the Report of China by Province marketization Index compiled by Fan Gang to measure the degree of regional marketization. The larger the market index, the fiercer the market competition, and the higher the market openness, the fresher the market for the industry. For enterprises, they can obtain market information faster, grasp the market trends, conduct research and development according to the market demand, and promote the improvement of the innovation ability of the industry.

Table 4. Variable names and measurement methods.

variable	Name and symbol	Measure the way
explained variable	Industrial innovation ability score (Inno)	Comprehensive score of secondary index empowerment
explanatory variable	Import and Export Trade (Trade)	value of import and export
controlled variable	Economic Development (Eco-Dev)	Per capita GDP
	Market index(Market)	The ratio of the output value of the tertiary industry to GDP

4.2. Model setting

4.2.1. Unit root inspection

This paper performs regression analysis using Eviews7 based on balanced panel data.

The study data were balanced panel data with "large N small T" features, so the HT unit root test method was chosen. Although the property right protection rate (IPPR) and industrial structure (Str) failed the unit root test, it did not have much impact on the subsequent regression analysis results.

Some scholars proposed, "large N large T" feature of panel data pseudo regression will give consistent results, namely the stationary panel data and time series, the reason is that the stationary panel data regression parameter point regression but there will be inevitable standard deviation bias. However, the panel data selected in this study has the characteristics of "large N small T", so the pseudo-regression problem often does not arise.

4.2.2. Descriptive statistics

The basic characteristics of each variable are summarized in the following table. The mean innovation ability score for each province is 0.085, with a minimum of 0.026 and a maximum of 0.355. The standard deviation is small, indicating low variability, especially for the explanatory variables.

Table 5. Descriptive statistics for the variables.

metric	average	standard error	least value	crest value
Inno	0.161	0.578	0.026	0.355
Trade	15.318	1.560	10.906	18.508
Eco-Dev	10.763	0.459	9.482	12.009
Market	0.457	0.097	0.286	0.835

4.2.3. Model setting

The panel data were tested for fixed effects, random effects. First, mixed model tests and fixed effects tests were performed separately. Residual diagnosis was made without mixed regression in any setting to observe the normal distribution. According to the results, it is approximately a normal distribution.

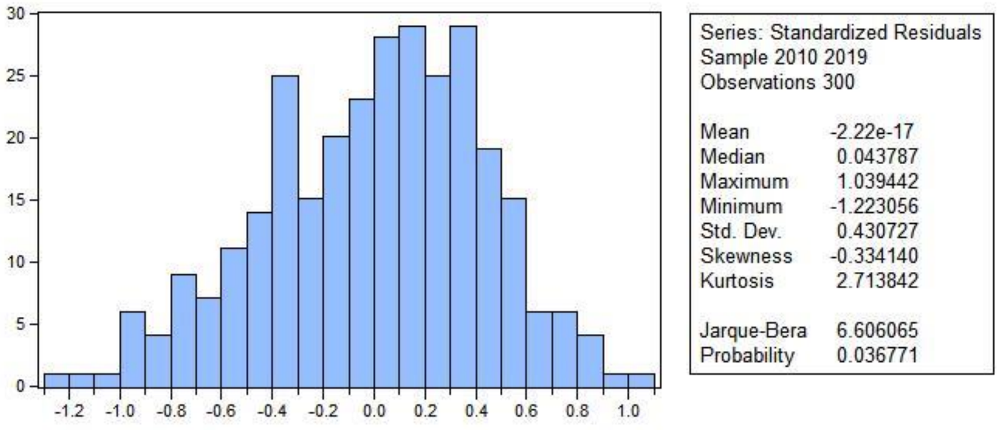

Fig 1. Residual Figure Fig.

A double fixed effect test was performed, and the null hypothesis was rejected, indicating that the panel data intercept term was changed and was judged as the variable intercept panel data. The next step was Hausman test and the results were not a double random effect. The individual and time are fixed respectively. The test results show that the time point is not random effect, and the individual is not random effect, so it is a model with fixed effect of both individual and time point. According to the analysis and test results above, the specific model is set as follows:

$$\mathrm{Inno}_{it}=\alpha_0+\alpha_1\mathrm{Trade}+\beta_i\sum_i^2\mathrm{Control}_i+\mu_{year}+\mu_{ind}+\varepsilon_{it} \qquad (12)$$

Among, InnoitIt is the comprehensive score of the innovation ability of the explained variable, Trade, the explanatory variable and the control variable, and the coefficient to be estimated, which represents the time effect, represents the individual effect, and is the residual term.

4.3. Empirical analysis process and results

4.3.1. Model Estimation Results

Table 6. Results of the model regression.

variable	Non-standardized coefficients	t	Sig.
C	-11.325	-6.593	0.000
Trade	0.219	1.750	0.081
Market	2.086	0.761	0.007
Eco-Dev	1.316	1.718	0.000
N	300		
Y ear	control		
Province	control		
Adj-R2	0.950		
F	179.070（0.000）		

Note: p <0.01, p <0.05, p <0.1

(1) Goodness of fit

After the adjustment of R2Was 0.95, and the regression model was fit well.

(2) F test

Model F value of 179.070 and p-value of 0.000, through the significance level test, indicating that the regression equation was overall significant.

(3) The t-test

From the t-value of the regression coefficient and the corresponding significance level, it can be seen that the p-value of the import and export trade volume (Trade) is less than 0.1, economic development (Eco-Dev) and market index (Market) is less than 0.05, and the coefficient is significant, which has a significant impact on the innovation ability of high-tech industries and is positively correlated with the innovation ability.

(4) Multiple collinearity test

Table 7. Statistics of variable correlations.

	I nno	Trade	Market	Eco-Dev
I nno	1.000			
Trade	0.690	1.000		
Market	0.366	0.392	1.000	
Eco-Dev	0.447	0.654	0.646	1.000

From the results of the correlation test in the above table, there is no obvious correlation between the variables.

4.3.2. Robustness test

Referring to the practices of other scholars, one of the robustness tests in this chapter adopts the method of replacing the explained variables, because the evaluation standard of measuring innovation ability is not unique, and it is more direct and scientific to measure the number of patent applications. The regression results after the replacement of the dependent variable are as follows:

Table 8. Results of the robustness test.

variable	Non-standardized coefficients	t	Sig.
C	-9.655	-6.416	0.000
Trade	0.028	1.071	0.003
Market	1.830	2.652	0.008
Eco-Dev	1.546	9.893	0.000
N	300		
Y ear	control		
Province	control		
Adj-R2	0.949		
F	177.471（0.000）		

Note: p <0.01, p <0.05, and p <0.1

From the above table, the F value is 177.471 and p is 0.000, the equation is significant, and the goodness of fit is up to 0.949. The regression results of the variables were all significant, and the import and export trade volume was significant at the significance level of 1%, which was positively correlated with the number of patent applications in the industry. In summary, the model and explanatory metrics have robustness.

4.3.3. Analysis of the empirical results

The import and export trade volume is positively related to the innovation ability of high-tech industry, that is, the import and export trade volume has a positive impact on the innovation ability of high-tech industry. For each unit of import and export trade, the innovation capacity increased by 0.219 points.

5. Conclusion: Strategies for Enhancing Innovation in China's High-Tech Industry

To improve the innovation capacity of China's high-tech industry, it is essential to adopt a multi-faceted approach. First, fostering a sense of competition through the strategic expansion of high-tech imports, particularly to the central and western regions, will help address regional imbalances and encourage local enterprises to enhance their innovation capabilities. Second, promoting innovation quality requires investing in research and development, attracting talent, and improving the research environment. This can be achieved through better cooperation between enterprises and government policies, along with enhanced incentives for R&D personnel. Lastly, coordinating development between regions is crucial. By leveraging the unique resources and industries of different provinces, building a collaborative system, and integrating industrial chains and technologies, China can accelerate innovation across both eastern and western regions, ensuring more balanced and sustainable growth in its high-tech sector.

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