

# Technology Credit, Technology Innovation and Industrial Structure Upgrading

Jiayi Li<sup>1,\*</sup>, Shujun Ye<sup>1</sup>, Yuanxiang Peng<sup>1</sup>, Ming Cheng<sup>2</sup>

\* Corresponding author: 793619129@qq.com

<sup>1</sup> School of Beijing Jiaotong University, School of Economics and Management, 100044 Beijing, China

<sup>2</sup> Greatwall Wealth Insurance Asset Management Co.,Ltd, 100035 Beijing, China

**Abstract.** Credit is the main source of financing for enterprises, and patent is an important output index of technological innovation. This paper focuses on the impact of Science and technology credit on industrial structure upgrading through technological innovation represented by three types of patents. Firstly, this paper researches the effect mechanism of technology credit on industrial structure through technological innovation. Secondly, using data from 30 provinces, municipalities and autonomous regions in China from 2009-2017 and building a GMM dynamic panel model to empirically test, it is concluded that : (1) China's technology credit has no significant effect on industrial structure, and the support of science and technology credit is insufficient. (2) The three types of patents have different effects on industrial structure upgrading. Invention patents can effectively promote the industrial structure upgrading, while utility model patents and design-type patents have no significant effect on industrial structure upgrading. (3) The effect of technology credit on the industrial structure through technological innovation is not obvious, and the development of science and technology banks is not perfect, and they cannot effectively improve the industrial structure through patent output.

**Keywords-**Technology credit; industrial structure upgrading; patents; technological innovation

## 1. INTRODUCTION

Under the factor-driven model, the marginal value of capital and labour input factors decreases, making it difficult to sustain the production model with low technology content and low added value, and creating problems such as unbalanced and uncoordinated industrial structure. Technological innovation is the driving force for economic development, and the upgrading of industrial structure needs to be driven by innovation. In addition to the promotion of technological innovation, the upgrading of industrial structure is also inseparable from the support of funds. The main financing channel for Chinese enterprises to carry out production activities is bank credit. Although the overall credit scale is very large in China, less science and technology credit funds are really allocated to science and technology innovation. This paper studies the influence of science and technology credit on industrial structure through technology innovation. Technological innovation is the driving force for economic development, and the upgrading of industrial structure needs to be driven by innovation.

Domestic scholars do little direct research on credit, technological innovation or patent, and industrial structure. Generally, they focus on financial development, technological innovation and industrial structure. Some scholars have concluded that financial and technological

innovation promotes industrial structure. Qian Shuitu and Zhou Yongtao (2011) concluded from empirical tests that loans to non-state-owned enterprises can actively promote technological innovation and industrial upgrading. Yu Meng, Liu Jingqing (2013), respectively, on the financial, technical innovation and industrial structure upgrade in relations between the two has carried on the granger causality test, expressed in R&D of technology innovation and industrial structure upgrade, and two-way causality between financial can optimize industrial structure, optimize and upgrade industrial structure need to raise the level of industrial technology and financial services support. Li Yuanyuan and Jin Hao (2015) obtained the promotion effect of financial innovation on technological progress and industrial structure by empirical study of data envelopment analysis (DEA).

Some scholars concluded that financial development can promote the technology innovation, in turn, promote the optimization and upgrading of industrial structure, Tao ai-ping, Sheng Wei (2015) to get the banking credit development and technology innovation can be two-wheel driven industrial upgrading, both can promote industrial upgrading by positive interaction, credit can optimize industrial structure by promoting technological innovation. Li Jian (2014) believes that there must be a positive interaction between finance and science and technology, and finance can more effectively support scientific and technological innovation through technological development to promote the change of economic structure. Lin Chun (2016) found that finance and the combination of finance and technological innovation can promote the development of the tertiary industry. Ding Yibing and Fu Yingjie (2014) added the interaction term between financial development and technological innovation into the equation and concluded that financial development in various countries could promote the optimization of industrial structure by promoting technological innovation. Xu Weihua et al. (2017) concluded that the coupling between financial deepening and technological innovation can promote the optimization and upgrading of China's industrial structure.

China is a bank-dominated financial structure, so it is particularly important to improve the efficiency of credit resource allocation and support technological innovation to promote the optimization of industrial structure. It is of certain practical guiding significance to study the influence effect of scientific and technological credit on the upgrading of industrial structure.

## **2. INFLUENCE MECHANISM AND RESEARCH HYPOTHESIS**

First of all, technological innovation cannot be separated from the support of capital input elements, and the credit market can improve the patent output and technological innovation level through the expansion of credit scale and the improvement of credit allocation efficiency. First, the expansion of credit scale can increase the source of funds, thus generating certain scale benefits for banks and other intermediaries, enriching the financing channels of enterprises, realizing the function of financing, alleviating financing constraints, increasing the investment of scientific research funds, and promoting the R&D and innovation of patented technologies. Second, improve credit market information asymmetry, optimizes the allocation of credit resources, the improvement of the risk management, and other functions, can improve the efficiency of credit allocation, improve the increase the amount of bank savings deposits into loans, lower the cost of financing, reduce loan approval procedure, shortens the loan process,

ease Sci-Tech enterprises financing difficult problem, increase the enterprise patent output results.

Secondly, the technological innovation represented by patents can promote the upgrading of industrial structure through the following ways: directly improve the utilization rate of production factors and labour productivity by improving the technical level, or directly change the market consumption demand structure to optimize the industrial structure; by the technology spillover effect and multiplier effect are generated by improving the technology level to promote the correlation between industries and form a spatial agglomeration state to realize the upgrading of industrial structure; by improving the technological level, the industrial competition pattern can be changed, the rise of new industries, the development of small and medium-sized enterprises and the improvement of traditional industries can be promoted, so as to optimize the industrial structure. From patent types and structure, the invention patent technology level is high, the more and more risky r&d funds, the upgrade of industrial structure should be larger, science and technology research and development of the credit for a patent for invention should be able to provide timely financial support, good promote invention patent output so as to promote the upgrading of industrial structure.

Therefore, the following hypotheses are proposed:

H1: Science and technology credit can promote the upgrading of industrial structure.

H2: The promotion effect of total patents on industrial structure upgrading is not significant; invention patent can significantly promote the upgrading of industrial structure; Utility model patent has no significant effect on industrial structure upgrading; The effect of design patents on industrial structure upgrading is not significant.

H3: Technological credit has a significant effect on the upgrading of industrial structure through invention patents, but has no significant effect on the upgrading of industrial structure through the other two types of patents.

### **3. EMPIRICAL STUDY**

#### **3.1 Indicators and data sources**

(1) Upgrading of industrial structure (AIS): this paper uses the proportion of the added value of the secondary industry and the tertiary industry in GDP to measure the level of industrial structure upgrading.

(2) Science and Technology Credit (LRD): Referencing the papers of scholars such as Yu Liping (2013), this paper selects the financial institution loan as the science and technology credit in "Internal Expenditure of Research and Experimental Development (R&D) Funds by Source Composition" to study the effect of science and technology credit on industrial structure upgrading.

(3) Technological innovation(P): In this paper, patents are divided into invention patents, design patents and utility model patents, and the logarithm value of the three types of patent grants in various provinces and regions in China is used to represent the level of each type of patent, they are invention patents (PFM), utility model patents (PSY) and design-based patents (PWG).

(4) Control variables:① Human capital (Labour) : the ratio of the number of college graduates to the total population in the region;② Government expenditure rate (GE) : the proportion of fiscal expenditure in GDP of each province (municipality directly under the central government) in that year;③ Fixed asset investment rate (I) : the ratio of total fixed asset investment to GDP in each region;④Foreign direct investment (FDI) : the annual ratio of foreign direct investment to GDP in each region, in which foreign direct investment is calculated by the average exchange rate between US dollar and RMB in that year.

The research objects of this paper are 30 provinces, autonomous regions and municipalities directly under the Central Government of China, excluding Hong Kong, Macao and Taiwan of China. In addition, due to incomplete data of Tibet, Tibet is also excluded. The data used are panel data of 30 regions from 2009 to 2017. The data comes from Wind database, CSMAR database, China Statistical Yearbook, China Financial Yearbook, China Statistical Yearbook of Science and Technology, Financial Data of Ministry of Finance of the People's Republic of China, World Bank, etc.

### 3.2 Model setting

Most continuity and lag of economic and social phenomenon, in order to solve the model of the hysteresis and endogenous problems, this paper introduce the lag of the dependent variable Dynamic panel model is established, the establishment of model (1) - (5), system GMM method to estimate the following model is used to reduce the set of error model itself.

$$AIS_{it}=\beta_0AIS_{it-1}+\beta_1LRD_{it}+\beta_2P_{it}+\beta_3Control_{it}+\mu_i+\xi_{it} \quad (1)$$

$$AIS_{it}=\beta_0AIS_{it-1}+\beta_1LRD_{it}+\beta_2PFM_{it}+\beta_3PSY_{it}+\beta_4PWG_{it}+\beta_5Control_{it}+\mu_i+\xi_{it} \quad (2)$$

$$AIS_{it}=\beta_0AIS_{it-1}+\beta_1PFM_{it}+\beta_2LRD_{it} * PFM_{it}+\beta_3Control_{it}+\mu_i+\xi_{it} \quad (3)$$

$$AIS_{it}=\beta_0AIS_{it-1}+\beta_1PSY_{it}+\beta_2LRD_{it} * PSY_{it}+\beta_3Control_{it}+\mu_i+\xi_{it} \quad (4)$$

$$AIS_{it}=\beta_0AIS_{it-1}+\beta_1PWG_{it}+\beta_2LRD_{it} * PWG_{it}+\beta_3Control_{it}+\mu_i+\xi_{it} \quad (5)$$

The coefficient of each type of patent and the coefficient of the cross term are observed to determine the effect of technology credit in promoting the upgrading of industrial structure through different types of patents.

### 3.3 Analysis of Empirical Results

Using Stata 11.2 software, the Xtabond command two-stage GMM method is used to conduct empirical test on models (1) -- (5), and the results are shown in Table 1, in which L.1 AIS is the lagged first-order value of the advanced variable of industrial structure.

**TABLE 1.** ANALYSIS OF EMPIRICAL RESULTS

	(1)	(2)	(3)	(4)	(5)
L.1 AIS	.41000308* ** (4.33)	.4230154*** (14.14)	.4526212*** (19.53)	.3765742*** (15.52)	.4773716*** (18.17)
LRD	.000083 (0.08)	.00058 (1.16)			
P	.002977 (1.63)				
PFM		.0020909** (1.88)	.0031915*** (4.36)		
LRD* PFM			.0000206 (0.36)		
PSY		.0011841 (1.57)		.0023206*** (4.49)	
LRD* PSY				.0000263 (1.39)	
PWG		.0003991 (0.36)			.0003915 (0.49)
LRD* PWG					.0000393 (1.64)
Labor	.009469 (1.05)	.0096597 (1.13)	.0084097* (1.95)	.0041987* (1.89)	.0126159*** (3.60)
GE	.0569606* (1.67)	.0633357*** (5.26)	.0568998*** (5.68)	.0499082*** (5.54)	.0544358*** (7.26)
I	.0026928 (1.38)	.0023521*** (2.64)	.0018322** (2.23)	.0023875*** (3.79)	.0020859*** (3.62)
FDI	.0494694 (0.70)	.0121689 (0.42)	.0124169 (0.54)	.0229395 (1.54)	.0291736* (1.74)
AR(2)	0.5255	0.6036	0.4118	0.6266	0.2681
Sargan test p-value	0.2068	0.1527	0.1443	0.2316	0.1966

The Sargan test of the model obtained from the table all rejected the null hypothesis, which proved that the instrumental variables were valid and there was no over-identification. AR test also proves that the variables do not have second-order autocorrelation and the model estimation is valid. The coefficient of the lagged first-order variable of the advanced industrial structure is significantly positive. The industrial structure of the previous period will play a fundamental role in promoting the industrial structure of the later period.

The effect of science and technology credit on the upgrading of industrial structure is not significant, so Hypothesis 1 is not valid. Constitution of provincial R&D funds in China is its own funds, the government funds and enterprise technology loans from financial institutions account for only a little less than 10% of the proportion, this reflects the lack of credit allocation of science and technology in China, the support for scientific research is far from enough, enterprises do not have enough external financing can devote to the scientific research activities, to the role of the industrial structure are clear enough. Although not significant, the coefficient is positive, indicating that if China increases the credit capital input to science and technology enterprises, gradually establish and improve the effective mechanism of science and technology credit, and develop science and technology banks and science and technology financial products,

the innovation ability of these enterprises can be stimulated and the upgrading of industrial structure can be driven.

Invention patents can still significantly promote the upgrading of industrial structure, but the total number of patents, utility model patents and design patents are not significant to the upgrading of industrial structure, and cannot effectively promote the upgrading of industrial structure.

This is basically the same as the hypothesis above. In the patent subsidy policy encouragement, China's total number of patents has five consecutive years far more than the United States, Japan and other developed countries, but the empirical results show that is not a patent can promote the upgrading of industrial structure, the inside of the patent "bubble" phenomenon is serious, high technical level of invention patent accounted for less than, the overall technical level and quality of patent than the developed countries. Therefore, the total number of patents does not reflect the real level of science and technology in China. Utility patents and design patents cannot effectively promote the upgrading of China's industrial structure, while invention patents can significantly promote the upgrading of industrial structure.

The invention patent can have a positive effect on the upgrading of industrial structure, and the utility model patent can also significantly promote the upgrading of industrial structure. Its coefficient is smaller than that of invention patent, and its promoting effect on industrial structure is also smaller than that of invention patent. However, the design patent cannot adjust the industrial structure. The cross terms between science and technology credit and the three types of patents are still not significant, indicating that science and technology credit cannot promote the upgrading of industrial structure through the production of patents. In China, 65% of invention patents are invented by small and medium-sized enterprises, and more than 80% of new products are created by small and medium-sized enterprises. As an important force of independent innovation, small and medium-sized innovative enterprises need more credit and capital support, and there is still a lot of room for improvement in the support of science and technology credit for small and medium-sized enterprises and invention patents.

#### **4. CONCLUSIONS**

This paper combed the credit through the conduction mechanism of the industrial structure upgrade of technological innovation, and has carried on the empirical test, finally get the following main conclusions: ① the financial institution loans on behalf of science and technology in R&D source credit can significantly promote the upgrading of industrial structure, R&D input in science and technology credit to upgrade industrial structure effect is not significant, but is positive; ② the three types of patents have different effects on the upgrading of industrial structure. China's invention patents can effectively improve the industrial structure, while neither utility model nor design patents can significantly promote the upgrading of industrial structure; ③ the promotion effect of China's science and technology credit on the upgrading of industrial structure through patents is not significant, science and technology credit cannot have a benign interaction effect with patents, and there is insufficient support for promoting the transformation and upgrading of industrial structure by increasing the output of three kinds of patents. R&D and innovation activities have not been supported by sufficient credit funds, and credit and patent output have not reached the state of mutual coordination and

coupling, which cannot jointly promote the upgrading of China's industrial structure by promoting patent output and patent industrialization.

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