

Research on the Effect of Credit Term Structure on the Transformation of Innovation Achievements

Henghui Zhao

School of Management, Jinan University, Guangzhou, China

chiu_charles@163.com

Abstract. Innovation is the primary driving force leading development, and promoting the transformation of scientific and technological achievements is an important issue in implementing the innovation-driven development strategy. From the perspective of market participants, we use the relevant provincial panel data of 30 provinces in China from 2003 to 2019 to explore the impact and mechanism of credit term structure on the transformation of industrial innovation achievements. The study found that the long-term credit term structure has generally improved the economic transformation of my country's industrial innovation achievements, and this effect shows regional heterogeneity and time heterogeneity. After examining the impact mechanism, we found that the credit term structure affects the transformation of innovation achievements through the two paths of affecting the R&D investment of the real industry and the construction of social infrastructure. Further studies have found that the effect of long-term credit term structure on the transformation of innovation achievements is also affected by regional economic incentives, showing a threshold effect. This article expands the research perspective of finance in the real economy, enriches the relevant literature in the field of industrial innovation, provides certain evidence support for the strategy of serving the real economy and deepening the reform of the financial system.

Keywords: Credit Term Structure; Industrial Innovation Transformation; Infrastructure Spillover; Economic Incentives; Dynamic Threshold.

1. Introduction

The report of the 20th National Congress of the Communist Party of China pointed out that we must adhere to the core position of innovation in the overall situation of China's modernization drive, and accelerate the implementation of the innovation-driven development strategy. In the context of continuous and in-depth advancement of industrial innovation, how to promote the economic transformation of scientific and technological achievements has become an important issue in the context of innovation-driven development. In January 2022, the newly revised "Law of the People's Republic of China on Scientific and Technological Progress" was officially implemented. It specifically set up a chapter on "Applied Research and Transformation of Achievements", which puts the transformation of scientific and technological achievements in a more important position and highlights them. In September of the same year, the Ministry of Science and Technology issued the "14th Five-Year Plan" National High-tech Industrial Development Zone Development Plan, emphasizing the implementation and transformation of scientific and technological achievements in industrial parks. The economic transformation of regional industrial innovation achievements is an important basis for the sustainable development of regional innovation capabilities. If the achievements receive good market feedback, it will further promote the active participation of real departments in innovation activities and form a high-quality industrial innovation cycle. At present, research on innovation mostly focuses on innovation input and output, innovation ability, innovation efficiency, etc. (Hu et al., 2022; Chen and Wang, 2023; Han et al., 2019), and research on the transformation of innovation achievements is still limited.

In addition, General Secretary Xi Jinping also pointed out that it is necessary to water the real economy with financial precision and promote high-quality industrial development. A series of research perspectives on the impact of finance on the real economy mainly focus on economic growth (Yao et al., 2022), industrial structure (Hu et al., 2023), and return on capital (Zhang and Fan, 2021). The discussion on the role of transformation of innovation achievements needs to be further improved

According to data from the Survey and Statistics Department of the People's Bank of China, China's credit maturity structure has risen from 0.42 in 2000 to 3.11 in 2022, showing a long-term development trend as a whole. In the context of constantly emphasizing that finance serves the real economy, it is of great practical significance to discuss in depth the role of bank credit, especially the credit term structure, on the transformation of industrial innovation.

From the perspective of market participants, we use the relevant provincial panel data of 30 provinces in China from 2003 to 2019 to explore the impact of credit term structure on the transformation of industrial innovation achievements, and deeply study its impact mechanism. By affecting the transformation of innovation achievements through the two paths of affecting R&D investment in real industries and social infrastructure construction, the more long-term the credit term structure is, the more R&D investment in the real sector, the more obvious the spillover effect of infrastructure, and the fuller the transformation of scientific and technological innovation achievements. Finally, the results of the dynamic threshold model prove that the effect of long-term credit term structure on the transformation of innovation achievements is also affected by regional economic incentives, showing a threshold effect, and moderate economic incentives will strengthen the role of long-term credit term structure in promoting the transformation of industrial innovation achievements. Beyond a certain limit, economic incentives may weaken the interaction between them.

The research of this paper has important marginal contribution and practical significance:

First, it enriches the relevant literature in the field of industrial innovation. This paper can enrich the relevant research in the field of industrial innovation, deepen the understanding of industrial innovation activities, and provide a new direction for future research.

Second, it expands the research perspective of finance in the real economy. This paper attempts to focus on the economic transformation of bank credit to industrial technological innovation achievements from the perspective of market participants, providing a new perspective for the study of finance in the real economy.

Third, it demonstrates the promotion effect of the credit term structure on the transformation of regional enterprise innovation achievements, provides certain evidence support for the financial service real economy strategy and deepens the reform of the financial system, and further promotes the formation of a high-quality industrial innovation cycle.

2. Theoretical Analysis and Research Hypothesis

2.1 Analysis of the Effect of Credit Term Structure on the Transformation of Innovation Achievements

"Financial services serving the real economy" is a basic requirement for advancing credit policy reform, while a high-quality industrial innovation cycle is an important guarantee for the healthy development of the real economy. Zhang et al. (2012) pointed out that the financing constraints of the real sector have become a key factor affecting its innovation, and the structure of China's financial credit term system often reflects the financing constraints of enterprises in a region. At present, China's real sector often obtains financial support through bank credit. There is a clear difference between short-term loans and long-term loans in the real sector: Short-term loans are mainly invested in the daily expenses of the operation of the real sector, while long-term loans are mainly matched with the capital needs of real enterprises for technological innovation and fixed asset construction. If an enterprise wants to achieve major innovation breakthroughs, it needs to have sufficient capital chain circulation. Long-term loans will be very important to them. Obtaining a sufficient amount of long-term loans will become the cornerstone for enterprises to obtain technological breakthroughs and innovations (Wu and Shen, 2020), reducing the occurrence of "short-term loans and long-term investment" of real enterprises (Zhong et al., 2016), reducing liquidity risks; at the same time, it will also help the real sector have sufficient budget to develop the market for scientific and technological innovation achievements, and formulate longer-term The commercialization strategy forms a closed loop of high-quality industrial innovation. At the same

time, the transformation of industrial innovation results cannot be separated from the production factors provided by the territory, and the market transformation of any substantive innovation requires long-term, large-scale capital and human capital investment support (Hsu et al., 2014). Zhang and Fan (2021) also found that the increase in the credit term structure will have a certain promotion effect on the return on capital of the real economy, and with the increase in the return on capital, it will supplement more inputs of production factors and improve industrial innovation results. The possibility of popularization and realization in the region indirectly promotes the economic transformation of industrial innovation achievements. Based on the above analysis, we put forward research hypothesis H1:

H1: Long-term credit term structure promotes the transformation of industrial innovation achievements

2.2 Analysis on the Influence Mechanism of Credit Term Structure on the Transformation of Innovation Achievements

From the perspective of the real sector, the economic transformation effect of innovation results is often linked to the quantity of innovation results, and the output of innovation results is inseparable from the R&D investment of the real sector. In actual business, the process of scientific and technological innovation is often accompanied by high risk and high investment, which requires continuous and stable cash flow to support the project, and the results of R&D activities may face difficulties in the short term. Realize the risk of commercialization and realization. Therefore, if the real sector is subject to strong financing constraints, in order to pursue the principle of maximizing benefits and minimizing risks, it will reduce investment in innovation activities and invest funds in projects with higher economic benefits and faster payback, leading to the suppression of innovation in the real sector (Chen and Fan, 2015). After obtaining long-term and stable bank credit, it will encourage the real sector to allocate more funds to R&D and innovation activities, which will help create a good atmosphere for industrial innovation, stimulate healthy competition among the real sector, and improve the society of scientific and technological innovation achievements. Recognition (Zhuang and Wang, 2021) makes it easier for innovations to circulate in the market and indirectly affects the economic transformation of industrial innovations.

From the perspective of market interaction, industrial innovation may boost industrial development and economic growth through spatial spillover effects (Bai et al., 2017), and further accelerate the market transformation of scientific and technological innovation achievements. Xiong (2011) found that with the help of capital flow channels, human flow channels, and cultural exchange channels, scientific and technological innovation output can be disseminated and migrated in space, making innovation achievements popular in the region. The existing series also proves that China's Scientific and technological progress has a relatively obvious spatial diffusion effect (Wei and Wang 2020; Pan et al., 2017). Enterprises will be able to enjoy the dividends of technological spillovers, improve their own production process level, and the scientific and technological innovation achievements will also usher in a broader market space, greatly reducing sales, transportation and other costs in the process of market transformation. The long-term credit term structure is conducive to infrastructure construction with a long investment cycle in the region. Research by Zhang Jie and Ju (2017) also shows that China's credit term structure is positively correlated with the growth rate of infrastructure investment. To sum up, the credit term structure may also affect the transformation of innovation achievements by affecting the construction of social infrastructure. Based on the above analysis, we put forward research hypothesis H2:

H2: The credit term structure will affect the transformation of innovation achievements by affecting the R&D investment of real industries and the construction of social infrastructure.

2.3 Threshold Effect Analysis of Economic Incentives

Economic incentives include financial incentives and political incentives. Existing studies have shown that the credit term structure may be affected by financial incentives and political incentives

and show different degrees of influence on industrial innovation. With appropriate policy encouragement, local government officials will be encouraged to contribute to regional economy and innovation development (Zhou, 2022). Government officials will pay more attention to the healthy and sustainable development of the region, which is conducive to the closure of the innovation cycle. But at the same time, the literature points out that excessive economic incentives may hinder the development of regional economy and innovation. In the context of fiscal decentralization, Keen and Marchand (1997) pointed out that excessive fiscal incentives promote competition among local governments, leading to “deviations” in the structure of public expenditures, which may inhibit high-quality regional economies to a certain extent. Development (Wang and Liu 2021), inhibiting the development of innovation activities and the formation of commercialization of innovation results. In addition, local government officials also face political incentives, and government officials may respond rationally to political incentives (Xu and Wang, 2010). to form competition. This may cause local government officials to be short-sighted, cause government officials to show strong performance needs and motivations, guide the real sector to deploy high-yield projects, reduce the allocation efficiency of credit funds (Li et al., 2021), and reduce the need for long-term credit funds. Investment in projects such as industrial innovation with slow payback, inhibits the output and economic transformation of scientific and technological innovation achievements. Based on the above analysis, we put forward research hypothesis H3:

H3: Economic incentives will affect the effect of credit term structure on the transformation of innovation achievements, and show a threshold effect.

3. Research Design

3.1 Variable Selection and Explanation

The research year of this paper is from 2003 to 2019. Due to the lack of a large number of statistical data in Tibet, Hong Kong, Macao and Taiwan regions, we finally retains the panel data of 30 provinces (municipalities and autonomous regions) in China as research samples. Relevant data come from "China Statistical Yearbook", "China Financial Yearbook", "China Science and Technology Statistical Yearbook", "China Environmental Statistical Yearbook", sorted by EPS data platform, and missing data are manually supplemented by referring to provincial statistical yearbooks.

3.1.1 Explained Variable

This paper mainly explores the impact of credit term structure on the transformation of industrial innovation achievements. Previous related research mainly started from the perspective of input or output of innovation activities, and used R&D funds, the number of authorized patents, etc. to measure industrial innovation. However, this paper mainly considers the transformation and realization of industrial innovation achievements. Refer to Zhuang and Wang (2021), we select the sales revenue of new products of industrial enterprises above designated size (large and medium-sized) in the region to measure the transformation level of industrial innovation achievements (**Inno**) as the explained variable.

3.1.2 Core Explanatory Variables:

The core explanatory variable of this paper, credit term structure (**Termstr**), is measured by the ratio of the balance of long-term loans to the balance of short-term loans in provincial financial institutions, reflecting the credit term structure of the region. Among them, short-term loans refer to loans with a term of less than one year, and medium and long-term loans refer to loans with a term of one year or more.

3.1.3 Control Variables:

In order to alleviate the bias caused by omitted variables, this paper draws on the relevant research of Zhang and Fan (2021) and Jiang et al. (2013), and selects 6 factors that may affect the transformation of regional industrial innovation achievements as control variables. They are:

Industrial structure (**Ind**), measured by the ratio of the added value of the regional tertiary industry to the added value of the secondary industry. Environmental regulation (**Env**), measured by the ratio of regional pollution control investment to the added value of industry. Education level (**Edu**), expressed by the number of college students. Trade degree (**Com**), measured by the ratio of regional import and export trade volume to regional GDP. Government intervention (**Gov**), measured by the ratio of regional fiscal expenditure to regional GDP. Industry Business climate (**Ume**), represented by the unemployment rate.

3.1.4 Mediator Variable:

Referring to the existing literature, from the perspective of R&D investment in real industries, we choose to use the R&D internal expenditures of industrial enterprises above designated size (large and medium-sized) in various provinces and regions in China to represent the regional impact of the credit term structure. R&D investment level (**Rd**). From the perspective of social infrastructure construction, we choose to use the ratio of the total kilometers of roads and railways in each province to the area of the province to measure, reflecting the degree of infrastructure spillover effect (**Infra**) in each province.

3.1.5 Threshold Variable:

The previous analysis proposes that economic incentives will affect the effect of credit term structure on the transformation of innovation achievements, and show a threshold effect. Local economic incentives include two measurement indicators: financial incentives (**Fise**) and political incentives (**Poi**). Among them, the fiscal incentive (Fise) is represented by the decentralization of fiscal expenditure. Drawing on the research of Wang (2010), we use the ratio of provincial fiscal expenditure to the central fiscal expenditure to measure; political incentive (Poi) adopts the economic growth rate of each province. The target is measured against the economic growth rate of the previous year, and the greater the value of Poi, the greater the pressure for political promotion.

Table 1. Description of variable definition

Type	Symbol	Variable definition
Explained variable	Inno	New product sales revenue
Core explanatory variable	Termstr	Medium and long-term loan balance / Short-term loan balance of financial institutions
Control variable	Ind	The added value of the tertiary industry / The added value of the second industry
	Env	Investment in regional pollution control / Industrial added value
	Edu	Number of current university students
	Com	Import and export trade volume / GDP
	Gov	Fiscal expenditure / GDP
Mediator variable	Ume	Unemployment rate
	Rd	R&D internal expenditures
	Infra	Total kilometers of roads and railways / Province area
Threshold variable	Fise	Provincial fiscal expenditure / Central fiscal expenditure
	Poi	Economic growth target / Economic growth rate of the previous year

3.2 Model Design

3.2.1 Baseline Regression Model

In order to study the impact of credit term structure on the transformation of industrial innovation achievements, this paper takes the transformation of regional industrial innovation achievements as the explained variable and the credit term structure as the core explanatory variable, and establishes an econometric model as shown in ①.

$$\ln(Inno_{i,t}) = \alpha_0 + \alpha_1 \ln(Termstr_{i,t}) + \sum \alpha_j \ln(Control_{i,t}) + Year_t + Province_t + \varepsilon_{i,t} \quad (1)$$

3.2.2 Mediating Effect Model

In order to further study the influence mechanism of the credit term structure on the transformation of industrial innovation achievements, referring to the research of Baron and Kenny (1986), this paper adopts the stepwise regression method of intermediary effect to test, and takes the innovation input of the real sector and the construction of social infrastructure as the intermediary variables respectively. Test, the two-group mediation effect test model is as follows:

Innovation input mediation effect model group:

$$\ln(Rd_{i,t}) = \beta_0 + \beta_1 \ln(Termstr_{i,t}) + \sum \beta_j \ln(Control_{i,t}) + Year_t + Province_t + \varepsilon_{i,t} \quad (2)$$

$$\ln(Inno_{i,t}) = \gamma_0 + \gamma_1 \ln(Termstr_{i,t}) + \gamma_2 \ln(Rd_{i,t}) + \sum \gamma_j \ln(Control_{i,t}) + Year_t + Province_t + \varepsilon_{i,t} \quad (3)$$

Social infrastructure construction mediation effect model group:

$$\ln(Infra_{i,t}) = \beta_0 + \beta_1 \ln(Termstr_{i,t}) + \sum \beta_j \ln(Control_{i,t}) + Year_t + Province_t + \varepsilon_{i,t} \quad (4)$$

$$\ln(Inno_{i,t}) = \gamma_0 + \gamma_1 \ln(Termstr_{i,t}) + \gamma_2 \ln(Infra_{i,t}) + \sum \gamma_j \ln(Control_{i,t}) + Year_t + Province_t + \varepsilon_{i,t} \quad (5)$$

3.2.3 Dynamic Threshold Model

This paper modifies the panel threshold effect model proposed by Hansen (1999), and uses the dynamic threshold model to analyze economic incentives. In order to solve the estimation bias caused by the endogenous problem, we refer to the methods of Chen and Lin (2021) and Seo and Shin (2016). We put the dependent variable industrial innovation achievement transformation (Inno) lagged value into the model to form dynamic panel data, and estimate the corresponding threshold value, divide different interval levels, and use the system GMM estimation to evaluate the slope coefficient of different interval levels. $D_{i,t}$ represents the threshold variable, γ is the threshold variable value, $I\{\cdot\}$ is an indicator function.

$$\ln(Inno_{i,t}) = \alpha_0 + \alpha_1 \ln(Inno_{i,t-1}) + \sum \alpha_j \ln(Control_{i,t}) + \beta_1 \ln(Termstr_{i,t}) I\{D_{i,t} \leq \gamma\} + \beta_2 \ln(Termstr_{i,t}) I\{D_{i,t} > \gamma\} + Year_t + Province_t + \varepsilon_{i,t} \quad (6)$$

3.2.4 Descriptive Statistics

The descriptive statistical results of each variable are shown in Table 2. The minimum value of political incentive (Poi) is negative because the GDP of Liaoning Province declined in 2016, which made the growth rate in 2017 negative, making Liaoning Province's political incentive index (Poi) in 2017 to -2.6. There were no gaps and abnormalities in the remaining variables, which were in line with expectations.

Table 2. Descriptive statistics results

Variable	N	Mean	Std	Min	Max
Inno	510	3375.561	5690.214	3.6197	42970.1000
Termstr	510	1.836	1.007	0.517	6.0884
Ind	510	1.031	0.572	0.494	5.169
Env	510	0.004	0.003	0.001	0.029
Edu	510	73.781	47.571	2.612	231.965
Com	510	0.298	0.342	0.011	1.668
Gov	510	0.214	0.096	0.079	0.628
Ume	510	3.510	0.707	1.200	6.5
Rd	510	210.273	349.821	0.136	2300.000
Infra	510	0.818	0.499	0.035	2.188
Fise	510	0.153	0.088	0.014	0.504
Poi	510	0.890	0.212	-2.600	2.000

4. Empirical Analysis

4.1 Analysis of the Effect of Credit Term Structure on the Transformation of Innovation Achievements

In order to test the impact of long-term credit term structure on the transformation of industrial innovation achievements, the regression results are shown in Table 3 below. In Table 3, column (1) indicates the relationship between the term structure of long-term credit without control variables and the transformation of industrial innovation achievements, and columns (2) indicate effect after adding control variables. We can see that the estimated coefficient of the long-term credit term structure is 0.549 when no control variables are added, and it is significant at the 1% level; it can be seen from the regression results in column (2) of Table 3 that adding The estimated coefficient of the long-term credit term structure after all control variables is 0.343, which is also significant at the 1% level, indicating that it still has a promoting effect. Long-term loans are the cornerstone for enterprises to obtain technological breakthroughs and innovations. They will help the entity sector have sufficient budget to develop the market for scientific and technological innovations, formulate longer-term commercialization strategies, and promote the good market transformation of industrial innovations. Hypothesis H1 is established.

Table 3. Estimation results of benchmark regression model

Variable	Inno(1)	Inno (4)
Termstr	0.549*** (4.97)	0.343*** (2.98)
Controls	No	Yes
Year	Yes	Yes
Region	Yes	Yes
R ²	0.843	0.853
N	510	510

Note: *** p<0.01, ** p<0.05, * p<0.1, the same below.

4.2 Heterogeneity Analysis

4.2.1 Regional Heterogeneity

China has a vast territory, and there is a huge gap in the level of financial development among different regions, and the difference in bank credit obtained by each region is obvious. We first refer to the research of Li and Shen (2010), take per capita GDP as the main basis, divide China's provinces into developed regions and underdeveloped regions, and perform regression on the two regions. The results are shown in Table 4 column (1) and (2). At the same time, we also refer to the division method of the National Bureau of Statistics, and divide China into the central and western regions and the eastern region by geographical location. The regression results of sub-sample are shown in Table 4 columns (3) and (4) respectively.

The data shows that the long-term credit term structure has strong regional heterogeneity in promoting the transformation of industrial innovation achievements: For underdeveloped regions and central and western regions, the estimated coefficients of the long-term credit term structure are 0.400 and 0.364, indicating that the long-term credit term structure has significantly improved the transformation level of industrial innovation achievements. It is a huge supplement to underdeveloped regions where financial resources are scarce, and it helps to exert the efficiency of capital in supporting industrial innovation. For developed regions, the estimated coefficient of long-term credit term structure is -0.071, but not significant; for eastern regions, the estimated coefficient of explanatory variables decreases significantly at the 10% level. This may be because developed regions and eastern regions have established a relatively complete financial system with a high degree of marketization, which makes the effect of long-term credit term structure on the transformation of

industrial innovation achievements not significant. The above analysis shows that the long-term credit term structure has a significant impact on industrial There is regional heterogeneity in the impact of transformation of innovation achievements.

Table 4. Regression results of regional heterogeneity

Variable	GDP division		Geographical division	
	Inno(1)	Inno (2)	Inno (3)	Inno (4)
Termstr	0.400** (2.56)	-0.071 (-0.51)	0.364** (2.26)	0.316* (1.83)
Controls	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Region	Yes	Yes	Yes	Yes
R^2	0.846	0.932	0.866	0.861
N	374	136	323	187

4.2.2 Temporal Heterogeneity

The U.S. subprime mortgage crisis that broke out in 2008 was the world's largest financial crisis since the Great Depression in 1929, which reshuffled the rules of the financial industry in various countries around the world. The credit term structure may have different effects on the transformation of regional industrial innovation achievements before and after the financial crisis. Therefore, this paper divides the sample of China into two parts before and after 2008 for sample regression. Columns (1) and (2) of Table 5 give the estimation results of the two-period sub-sample model.

The data shows that the promotion effect of the term structure of long-term credit on the transformation of industrial innovation achievements has strong temporal heterogeneity: before 2008, the estimated coefficient was not significant. After 2008, the estimated coefficient of the term structure of long-term credit is 0.304, which is significant at the 5% level. It shows that since the outbreak of the global financial crisis, along with the country's implementation of credit structure reform and the introduction of loose monetary policy, more enterprises have chosen to make long-term loans with lower interest rates and longer terms and combine them with corporate technology R&D investment and fixed asset construction. To match the needs of capital and other funds, obtaining a sufficient amount of medium and long-term loans has become the cornerstone for enterprises to obtain technological breakthroughs and innovations and realize economic transformation.

Table 5. Time heterogeneity regression results

Variable	Inno (1)	Inno (2)
Termstr	-0.499 (-1.43)	0.304** (2.43)
Controls	Yes	Yes
Year	Yes	Yes
Region	Yes	Yes
R^2	0.735	0.697
N	150	360

4.3 Analysis on the Influence Mechanism of Credit Term Structure on the Transformation of Innovation Achievements

Analysis of the empirical results of the mediation effect model of R&D investment (Rd) in the real industry: Columns (1) and (2) in Table 5 give the empirical analysis results of the R&D investment of the real sector as an intermediary variable. From the data in the table, $\beta_1\gamma_2$ has the same sign as γ_1 , indicating that the R&D investment of the real sector has a partial intermediary effect between the long-term credit term structure and the transformation of industrial innovation achievements, accounting for 18.81%.

Analysis of the empirical results of the mediation effect model of social infrastructure construction (Infra): Columns (3) and (4) in Table 5 give the empirical analysis results of social infrastructure construction as an intermediary variable. According to the above analysis process, it can be concluded that there is a partial intermediary effect between the long-term credit term structure and the transformation of industrial innovation achievements in the construction of social infrastructure, accounting for 8.81%.

The R&D investment (Rd) of the real industry and the construction of social infrastructure (Infra) are put into the model as parallel intermediaries for estimation. The results are shown in Table 6 column (5). The coefficient of 0.261 in this model is significantly lower than the coefficient of 0.343 in the baseline regression. The above results show that the credit term structure will affect the transformation of innovation achievements by affecting the R&D investment of the real industry and the construction of social infrastructure. good conversion. Hypothesis H2 is established.

Table 6. Mediating effect regression results

Variable	Rd (1)	Inno (2)	Infra (3)	Inno (4)	Inno (5)
Termstr	0.138*	0.289**	0.096**	0.315***	0.261**
	(1.88)	(2.58)	(2.52)	(2.73)	(2.32)
Rd		0.394***			0.394***
		(5.56)			(5.59)
Infra				0.289**	0.292**
				(2.04)	(2.13)
Controls	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes
Region	Yes	Yes	Yes	Yes	Yes
R ²	0.950	0.862	0.883	0.854	0.863
N	510	510	510	510	510

4.4 Threshold Effect Analysis of Economic Incentives

Table 7. Threshold effect regression results

Variable	D=Fise (1)	D=Poi (2)
L.Inno	0.550***	0.593***
	(10.31)	(8.31)
Below_thres	0.659***	0.299***
	(5.57)	(3.82)
Above_thres	0.250***	0.109
	(3.80)	(1.33)
Controls	Yes	Yes
Year	Yes	Yes
Region	Yes	Yes
Threshold variable value	0.06	0.88
N	480	480

Since economic incentives include financial incentives (Fise) and political incentives (Poi), we use financial incentives and political incentives as threshold variables for estimation, and the results are shown in Table 7. It can be seen from the data in the table that when the financial incentives and political incentives are at a low level (Fise≤0.06, Poi≤0.88), the long-term credit term structure has a significant positive effect on the transformation of industrial innovation achievements. With the improvement of financial incentives and political incentives and further crossing the threshold (Fise>0.06, Poi>0.88), the slope coefficients of the credit term structure decrease, and the slope coefficients become insignificant when political incentives are used as threshold variables. The above results prove that economic incentives will affect the effect of credit term structure on the transformation of innovation achievements, and show a threshold effect. Hypothesis H3 is established.

A certain degree of economic incentives will promote local government officials to contribute to the sustainable and healthy development of regional economy and industrial innovation, and then strengthen the role of long-term credit term structure in promoting the transformation of industrial innovation achievements. With the improvement of economic incentives and breaking through the "tipping point", local government officials will downplay the emphasis on innovation, and the long-term credit term structure will have a reduced role in promoting the transformation of industrial innovation achievements.

4.5 Robustness Analysis

In order to make the conclusion of the study more credible, this paper uses three methods of replacing variables, eliminating samples, and instrumental variables to test the stability of the regression results.

4.5.1 Substitution Variables

On the one hand, considering the possible lag of the impact of long-term credit structure on the transformation of industrial innovation achievements, this paper selects the sales revenue of new products in the region with a lag of one period to replace the original explanatory variables for model estimation. The regression results are shown in Table 8 column (1). On the other hand, considering that the revenue of new products in each region may be affected by factors such as the economic and trade strength of the region itself, we use the ratio of the sales revenue of new products of industrial enterprises above designated size (large and medium-sized) in each province to the total sales revenue of the province (Innoper) to replace the original explanatory variables for model estimation, and the regression results are shown in column (2) of Table 8. It can be seen from the table that after the variable is replaced, the regression coefficient of the explanatory variable is still significantly positive, indicating that the conclusion is relatively stable.

4.5.2 Eliminate Samples

China's municipalities (Beijing, Shanghai, Tianjin, and Chongqing) have a relatively high level of financial development, and they gather significantly more innovation resources than other regions. In order to eliminate the biased estimation results caused by differences in regional financial development levels and enhance the universality of the impact of credit term structure on the transformation of industrial innovation achievements, referring to the practice of Zhang and Li (2022), the sample data of municipalities directly under the central government over the years are removed and then Regression is performed, and the results are shown in column (3) of Table 8. It can be seen from the table that the positive impact of credit term structure on industrial innovation transformation is still significant at the 1% level, indicating that the conclusion is relatively robust.

Table 8. Robustness test results

Variable	Substitution variables		Eliminate samples
	Inno(1)	Innoper (2)	Inno (3)
Termstr		0.263** (2.42)	0.322** (2.33)
L.Termstr	0.213* (1.86)		
Controls	Yes	Yes	Yes
Year	Yes	Yes	Yes
Region	Yes	Yes	Yes
R^2	0.830	0.261	0.856
N	480	510	442

4.5.3 Instrumental Variable Method

In order to better weaken the impact of endogenous problems, we also choose to use the instrumental variable method, that is, the two-stage least square method (IV-2SLS). In this paper, two instrumental variables are used for testing.

First, we construct multiple instrumental variables using both the lagged one and lagged two values of the explanatory variable (Termstr). The regression results are shown in column (1) of Table 9. Second, drawing on the method of Zhang and Fan (2021), we divide China into four major economic regions: East, Central, West and Northeast, and use the average value (Avertermstr) of the credit term structure in the same region as a tool for the credit term structure of each province variable. The four major regions have different natural conditions and historical and cultural differences. The overall financial system of each region will affect the credit term structure of each province in the region. The results are shown in column (2) of Table 9.

It can be seen from the table that a series of tests show that there are no problems such as weak instrumental variables, and the relationship of the credit term structure (Termstr) estimated based on the instrumental variable method is still significantly positive, indicating that the long-term credit structure promotes the transformation of industrial innovation achievements. The original results are consistent, which ensures the robustness of the research conclusions.

Table 9. Test results of instrumental variable method

Variable	Inno (1)	Inno (2)
Termstr	0.405** (2.52)	1.522*** (5.03)
Controls	Yes	Yes
Year	Yes	Yes
Region	Yes	Yes
Cragg-Donald Wald F statistic	220.140	75.459
R^2	0.964	0.951
N	450	510

5. Conclusion and Implications

5.1 Conclusion

From the perspective of market participants, this paper deeply explores the impact and mechanism of the credit term structure on the transformation of industrial innovation achievements. The research finds that: First, the long-term credit term structure will help the real sector have sufficient budget to develop the market for scientific and technological innovation achievements, formulate a longer-term commercialization strategy, and generally improve the economic transformation of China's industrial innovation achievements. The sub-sample study found that the credit term structure has spatio-temporal heterogeneity in promoting the transformation of industrial innovation achievements. For underdeveloped regions, the long-term credit term structure is conducive to the efficiency of capital support for industrial innovation, and significantly promotes the transformation of industrial innovation achievements. The rationalization of the credit term structure helps to exert the efficiency of capital in supporting industrial innovation, and significantly promotes the transformation of industrial innovation achievements. After 2008, with the introduction of the country's credit structure reform and loose monetary policy, the real sector preferred long-term loans with lower interest rates and longer years and matched them with capital needs such as investment in technology research and development and fixed asset construction, which became the cornerstone for enterprises to obtain technological breakthroughs and innovations and achieve economic transformation. After examining the impact mechanism, it is found that the credit term structure affects the transformation of innovation achievements through the two paths of affecting the R&D investment of the real industry and the construction of social infrastructure. The more long-term the credit term structure is, the more

R&D investment in the real sector and the more obvious the spillover effect of infrastructure, the transformation of scientific and technological innovation achievements will be more complete. Finally, the results of the dynamic panel threshold model prove that the effect of the long-term credit term structure on the transformation of innovation achievements is also affected by the financial incentives and political incentives, and shows a threshold effect. Moderate economic incentives will promote local government officials to contribute to the sustainable and healthy development of regional economy and industrial innovation, and then strengthen the role of long-term credit term structure in promoting the transformation of industrial innovation achievements. But once beyond a certain limit, excessive economic incentives may instead dilute the importance that local government officials attach to innovation transformation, and weaken the role between the credit term structure and the transformation of industrial innovation achievements.

5.2 Implications

First of all, since bank credit is an important source of funds for R&D and innovation activities and commercial transformation of the real sector, the term of bank credit will have different impacts on the market transformation of scientific and technological innovation achievements in different industries. Therefore, banks and other financial institutions can implement different targeted credit policies for different industries, focusing on increasing support for industries that rely on long-term bank loans for R&D and innovation, so as to maximize the efficiency of the use of long-term bank funds and improve the overall efficiency of the country's innovation transformation.

Second, due to the existence of regional heterogeneity, the reform of the financial system must match the level and stage of regional economic development, so that the structure of bank credit maturity is compatible with the intrinsic needs of industrial innovation-driven development. The market-oriented reform of the banking sector must be accelerated to reduce the distortion caused by economic incentives and government intervention. Banks and other financial institutions also need to strengthen the supervision and review of the use of loan funds in the real sector, prevent the excessive flow of long-term credit to the real estate industry, reduce the negative impact of the real estate "siphon effect" on the transformation of industrial innovation results, and make financial precision pour into the real economy.

Finally, for government departments, they can encourage banks and other financial institutions to provide more long-term loans for innovation in the real sector in the top-level design of innovation policies, guide financial institutions to provide long-term stable funds matching risks and returns for the real sector, help the real sector build a closed loop of innovation from research and development to economic transformation, and promote high-quality and sustainable development of industrial innovation.

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